National Scientific and Statistical Committee Workshop V
"Providing Scientific Advice in the Face of Uncertainty: from Data to Climate and Ecosystems"

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NOTE: *This draft summary report is for the purposes of the CCC meeting. The recommendations are still being reviewed by the NSSC Steering Committee and working towards consensus. This is for the CCC participants' reference only.*

Summary of Common Issues and Findings

SUBTHEME 1.a: Acceptable Biological Catch Specification for Data-Limited and Model-Resistant Stocks

Discussion Summary

A tiered system of rules and criteria provides the basis for setting overfishing limits (OFL) and acceptable biological catches (ABCs) in data-poor situations (Tiers 4-6) and data-rich situations (Tiers 1-3). Both situations have their own issues with which the respective Regions must deal.

The Caribbean and Western Pacific Regions are data-poor, while the South Atlantic and Gulf of Mexico Regions are considered data-moderate. To get out of these situations, these regions must invest in resources to enhance their ability to collect fishery-dependent and fishery-independent information and/or better analyze existing information to generate assessments. However, changing one's data situation may not reduce the uncertainties and risks in the ABC specification. Each tier has different associated risks, which should be clearly communicated to the Council prior to decision-making. Shifting to a higher tier does not necessarily lessen the uncertainties. Regardless of the data situation, ad hoc decisions are still required.

Because different stocks have different quantity and quality of scientific information associated with them, examining stock-based approaches rather than striving for uniform but unrealistic assessments may be advisable. Additionally, in data limited situations, other approaches to manage the stock besides catch limits should be considered, such as spatial management, effort controls, and gear restrictions.

The New England, Mid-Atlantic, Pacific and North Pacific Regions are considered data-rich, but their models do not always behave as expected or do not converge or fit as well as the modeler hopes given the data on hand. One participant called the problem “model-resistant.” More accurate terms might be model-misspecification, model-conflict, data-conflict, or lack-of-fit. This problem is more prevalent in New England. “Model resistance” is a new concept and could be related to lack of information on the long-term population dynamics and associated variability or to the information in the data being poor or due to a number of assumptions being violated or assumptions that are inappropriate. A broader, overarching issue surrounding “model resistance” is the unpredictability of climate change effects on the population dynamics of the stocks being managed.

The role of the SSC is to identify risk and provide the Council with scientific advice regarding potential impacts of the various risk levels on the stock. The Council’s responsibility is to manage for risk, but often the tools with which to accomplish this are not made available. The Council can help the SSC develop the risk assessment framework by providing it with the components the Council needs to make its decisions. Some regions have a strong policy framework to characterize uncertainties and risks, but lack the science to feed into that policy.

One obvious gap is the limited socioeconomic information needed to understand the cost associated with risk. National Standard 1 focuses on preventing or ending overfishing, and economic yield and fishery profitability are often not fully considered. The cost should be balanced between: 1) maintaining and improving the yields; 2) profitability of the fisheries being managed; 3) and improving the scientific information needed to minimize the losses associated with poor or ill-informed decision-making.

Findings and Recommendations

- Invest in resources to improve the ability of regions with a significant number of data-poor stocks to collect and analyze pertinent data needed to comply with the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requirements in specifying ABCs.
- Develop and implement management alternatives for data-poor stocks that allow the use of best available science that is not based on maximum sustainable yield (MSY) and reference point systems.
- Provide funding support and technical assistance to regions with numerous data sources to augment insufficient analytical resources (man-power and expertise) to produce and review products needed for management.
- Invest resources to explore different approaches for assessing stocks with different data informing their abundance and dynamics.

- Identify additional methods to evaluate risks of data limited assessments provided to Councils for decision-making.
- Enhance the communication of risks associated with shifting tiers to Councils and stakeholders so they do not confuse the detailed quantitative nature of the lower tiers (stocks with assessments and well quantified risks) with increased rigor or performance.
- Use the stock prioritization process to identify stocks that are data poor, model-challenged, and vulnerable to overfishing and invest resources to improve the data and analysis for these stocks.
- Provide more guidance to data-rich regions dealing with “model-resistant” stocks on when to downgrade to data-limited approaches, and on the need to document the available information not used and the risks associated with not using it.

SUBTHEME 1.b: Implementation of National Standard 2 in the Face of Uncertainty

Discussion Summary

Each region has a system in place to review assessments and other scientific information that the SSC uses to advise the Council on fishery management decisions. Some are independent panel reviews, such as the Center of Independent Experts (CIE), and others include the SSC and Plan Team. Several issues were raised during this session: 1) conflicting opinion on best scientific information available; 2) timeliness, transparency, and throughput of the reviews; 3) the inability of the best available science in some regions to generate the information required by the MSA; and 4) lags in the review process that results in the SSC making recommendations on ABCs based on incompletely reviewed information.

The SSC’s role in the review process is critical. Some regions assign SSC members to chair the review panel. This, however, is not the case if the review is through the CIE (with exemption insome regions where the CIE review panel is chaired by an SSC member). In some regions, when the CIE or panel review results and the SSC’s perspectives do not conform, the SSC must provide justification for the disagreement. It was noted that the review panel and the SSC approach the assessment from different perspectives. Panel reviewers (depending on the terms-of-reference) typically comment on the technical aspects of the assessment while the SSC also addresses locally grounded specifics of the fishery provided by stakeholders. When reviews conflict, one opinion must take precedence. It was suggested to clearly separate ideas from actual flaws in the method, model, or data. Ultimately, the SSC must make an ABC recommendation and the SSC will have a final say in which advice to use for setting ABCs.

The management timeframe that requires reviewed assessments/scientific information is typically shorter than the generation of assessments and their succeeding review. The SSC, more often, is put into a position where it is forced to make a determination of best available science to set the ABCs. The short-term fix is to add a disclaimer or caveat that the best available science existing at the time was used to set the ABCs. A backup or fallback process should be established so that everyone is clear on what scientific information is to be considered by the Council.

Some regions are experiencing significant delays in using the most up-to-date assessment or scientific information due to the rigorous review process where too much weight is placed on transparency to the detriment of throughput. The National SSC V viewed transparency as important; however, it thought more effort is needed to get assessments reviewed and finalized. One way is to reduce the number of benchmark assessments and increase the number of standard assessments and/or assessment updates. The National SSC V believed that Councils seem to think benchmark assessments are always the way to go. However, these assessments require more resources for the assessment group and more rigorous review, thus throughput is reduced. The Councils and stakeholders should be clearly informed about the different requirements for each type of assessment and associated review process.

Reviews are typically focused on models, assumptions, and parameterization and not so much on the data and data sources that go into the assessments. This may also contribute to the “model-resistant” situation.

In cases where the SSC is not the peer-review body, it must work within the constraints of the existing information contained in the assessment. The SSC’s involvement in the review process is critical as it increases buy-in and allows the analysis to address the concerns of both the SSC and the independent reviewers. Most of the time, independent reviewers are not familiar with the intricacies of the data and the background on why a certain model was used. The SSC’s participation allows for the reduction of that steep learning curve. The review should also focus on the technical aspect of the scientific information and not weigh in on the management application of the assessment results.

Findings and Recommendations

- Provide more clarification and/or guidelines for determining whether a quantitative assessment with large uncertainties or information from data-poor approaches is the best available science.

- Develop a process to enhance the throughput without sacrificing the transparency of the determination process for regions where information from assessments is urgently required.
- Develop procedures for situations when the SSC and NMFS do not agree on the best science available.
- Revise the existing process to separate the review based on best available science and the recommendation for use of the information for management.
- Give more effort to the review of the data that goes into the model.
- The Western Pacific and Caribbean Regions face similar challenges in acquiring the best available science to manage data-limited stocks. Enhanced dialogue, communication, and exchange between these two regions is needed to address such issues as identifying an alternative management procedure (framework) to the usual MSY-based reference point procedure, which utilizes an automated annual evaluation of indicators (e.g., mean length, catch per unit effort, reported landings, fishery independent data streams) for all species, and to explore annual adjustments to a wider range of harvest control rules, e.g., seasonal closures, spatial closures, and minimum size.

SUBTHEME 2: Evaluating Existing Acceptable Biological Catch Control Rules: Issues, Challenges and Solutions

Discussion Summary

Each region has unique processes to specify ABCs, risk policies, harvest control guidelines, and uncertainty characterizations for the different fisheries in its fishery ecosystem/management plan. For example, New England uses the proportion of the F to FMSY relative to catch to ABC as a metric for its fisheries. The National SSC V suggested creating a working group to look at existing control rules and management performance across all the regions and to develop criteria and standards based on common metrics.

Integrating Management Strategy Evaluation (MSE) into the fishery management process is another topic area of interest. Current risk policies are focused on preventing overfishing and measuring fishery outputs. MSE brings in other important and maybe more critical factors that are not necessarily biological in nature. A clear understanding of fishery objectives by the Council and stakeholders is important to make management performance measurable. Comparative analysis of various management/regulatory measures can be accommodated through an MSE-type process. Application of MSE would formalize expert judgment/opinion to advance a more strategic-oriented approach to management and would in turn help build trust in the science underpinning management. MSE can also be used to evaluate the utility and effectiveness of non-MSY based management strategies especially in data-limited areas where the fishery is multi-species and multi-gear and has low value and high effort.

Communication among the NMFS Fisheries Science Center, SSC, and Council regarding the various aspects of the ABC control rule and the risks associated with the specified ABC is another issue. In some regions, the Science Center does not clearly understand the expectations of the SSC and the SSC has no clear guidance from the Council on the science it needs to make management decisions.

Regions that are data poor have growing concerns about ecologically important species, which are, to some extent, keystone species. Fishery managers and scientists are being increasingly pressured to increase understanding of the ecology and dynamics of these species and to more conservatively approach their ABC specifications. In the Caribbean, a lawsuit triggered the reevaluation of the ABC specifications for parrotfish and angelfish relative to these species' roles as herbivores in protecting endangered coral species. Similarly, on the East Coast, environmental groups pushed for consideration to be given to the ecological importance of forage fish to marine mammals. With pressure coming from various sides, prioritizing species for research and stock assessments becomes challenging. The NMFS stock assessment prioritization process accommodates ecological importance of species.

In the North Pacific, ABC specifications are tied to the generation of stock assessments, updates are tied to new information coming from new surveys, and MSEs are used to inform the Council on proposed changes to management approaches. Using new information builds confidence in the assessments. The success of the North Pacific system is seen in its generation of stock assessments (45 per year) tied to the monitoring system and the ability of the SSC to review the assessments. The CIE often reviews one or two assessments per year, and the CIE provides recommendations directly to the authors on ways to improve the assessment. The CIE comments, and the assessment response, are shared with the plan teams and SSC.. More frequent stock assessment updates are conducted in order to increase the assessment throughput. Meanwhile, the West Coast process builds upon identified information gaps during the assessment review to generate research priorities. Once the data is gathered, the information is incorporated in the assessment. The East Coast process may result in a complete overhaul and advances may follow a different path.

Findings and Recommendations

- A standard approach may be needed for MSEs with specific objectives (e.g., evaluating control rules or setting overfishing limits).

- In setting ABCs, consideration should be given to species or species within a complex to whether the species' play an important role in the ecosystem (e.g., keystone and forage species)
- Report on the performance of ABCs, based on the development of consistent performance measures that are common to all regions.
- Strive for consistency in describing risks associated with ABCs across regions.

SUBTHEME 3.a: Incorporating Ecological, Environmental, and Climate Variability in Stock Assessment and Ecosystem-Based Fishery Management [Part 1]

Discussion Summary

Each region has a different strategy in its use of ecosystem models and ecosystem considerations in fishery management. Data-rich regions use ecosystem models in a tactical manner to predict the strength of recruitment (e.g., salmon, sardines) from which they can make appropriate adjustments to the harvest controls. Other regions use ecosystem indicators and environmental variables in risk policies of their respective Council. Most regions have no multispecies ecosystem models developed specifically for management use.

Commonalities among the regions are the lack of technical expertise to generate or develop ecosystem models and the shared goal to be able to predict or forecast fishery productivity in order to make suitable adjustments in the setting of ABCs and ACLs.

Two regions have used climate models for multispecies projections through various climate research programs. The goal was to assess performance of alternative harvest strategies as affected by a changing climate regime. The North Pacific Region utilized the regime shift of 1976-77and its impact on ecosystem structure and fish production as a factor in estimating biological reference points in several assessments. The SSC requested that the authors of the ecosystem considerations chapter annually report on a discrete suite of leading ecosystem indicators as well as any unusual ecosystem conditions. The status of these indicators is considered prior to discussions to set biological reference points. Authors of stock assessment reports include an ecosystem section that focuses specifically on potential interactions with the assessed species. The Pacific Region proposes a three-pronged approach to move forward with ecosystem-based fisheries management: 1) incorporate environmental variables into single species stock management; 2) enhance use of ecosystem models by the Council to evaluate ecosystem impacts to fisheries; and 3) incorporate the integrated ecosystem assessment (IEA) process into the Council process.

Regarding the incorporation of environmental variables into single species assessments, the National SSC V noted that some regions could explore approaches that are somewhere between attempting to identify specific environmental covariates as drivers and treating environmental effects as purely random noise. The model can be configured to use an auto-correlated error structure for recruitment deviations in assessments and forecasts, as environmental conditions are typically temporally auto-correlated.

The Pacific Region developed an Atlantis model for the California current ecosystem. The model was applied to analyze food web impacts, such as evaluating trophic impacts of forage fish harvest policies on abundance and yield of other fishery species and ranking of potential fishery management strategies; to evaluation of risks of climate change and ocean acidification; and to "simulate test" with MSE new methods of stock assessment, data collection, and metrics for indicators of ecosystem attributes.

The Pacific Region SSC recommended that other SSCs begin to think about review of ecosystem models and IEA reports as the next steps toward incorporating ecosystem-based fishery management (EBFM) into the Council process.

Findings and Recommendations

- National guidance is needed on: a) a systematic approach to determining keystone species for which ecosystem-based reference points might be needed; b) determining when a regime shift or other major environmental change compels a change in parameter inputs and resultant reference points; c) appropriate responses to sudden and adverse changes in parameters; and d) costs and benefits of considering multispecies models alongside single species models during the assessment process.
- Enhance regional capabilities to examine ecosystem dynamics and effects of natural and anthropogenic factors on production dynamics of exploited species.
- Enhance research to model both the extent and the strength of interrelationships between environmental factors as affected by climate change and habitat associations of the different species in the fishery to gain a better understanding on how to offset the impacts.
- Incorporate ecosystem considerations into stock assessments only if it would improve the models significantly; otherwise, ecosystem considerations or information can be supplementary information along with stock assessments and be made available to the Council when making management decisions.

- Incorporate an ecosystem-based fisheries management framework into the Council process via review of ecosystem models and IEAs applicable to the fisheries being managed.

SUBTHEME 3.a: Incorporating Ecological, Environmental, and Climate Variability in Stock Assessment and Ecosystem-Based Fishery management [Part 2]

Discussion Summary

The biggest challenge dealing with climate change is the uncertain impacts to fishery stocks. One expected impact is the shifting of the species distribution, so a Region could face species with which it had not dealt with previously. The management structure should accommodate better collaboration and partnership among Councils and/or between governments to manage shared transboundary stocks if species range expands or to transfer management authority if species relocate to another management area. Councils need to lay the groundwork to enhance collaboration between regions and ensure that the whole ecosystem is covered. Collaboration between adjacent jurisdictions should begin early when distribution shifts are evident, so a smooth transition can take place to avoid disruption in the fisheries management and assessment process and the fishery itself. Increasing cross fertilization between SSCs and Councils will allow for a coordinated work on common issues affecting different regions. In addition to developing or enhancing regional collaboration, guidance needs to be developed to separate science and management strategies related to decreased species biomass due to lowered productivity and species relocation due to migration to other jurisdictions.

Some regions are successfully incorporating environmental parameters in single-species assessments. However, explicit procedures need to be developed for deciding when and how to modify reference points or develop harvest control rules that will perform well under various climate change scenarios.

An ecosystem approach to fishery management may be a more cost effective means for managing stocks than the usual quota-based approach for regions that are dominated by data-poor or data-moderate stocks. Transitioning to EAFM will enable a more holistic evaluation of anthropogenic impacts.

Different regions are on different phases in their transition to EAFM, under which climate change considerations fall. Regions need to proactively deal with climate issues in an incrementally progressive way rather than deal with them intermittently once a problem and its impacts are at hand. Expected changes and factors need to be identified and incorporated into monitoring programs so that changes can be detected quickly and incorporated into assessments and management. These issues should be addressed across the full range of possible scenarios. Councils need to develop a contingency process for management for potential climate change impacts on communities, stakeholders, and the fishing industry based on scenarios predicted by the ecosystem models.

Regime shift is usually associated with climate change. The rate and extent of the shift's impact on stocks may not currently be predictable. Regime shifts are a system level effect, which will impact multiple stocks at the same time but potentially at different rates. The indicators being monitored should have thresholds to signal when the regime shift occurs. Monitoring the indicators and knowing the threshold are the keys.

Not all regions have the capacity, resources and/or data to develop ecosystem models. In areas where ecosystem models are still being developed, a systematic approach is needed to identify vulnerable stocks that are sensitive to climate change and lack resilience to change. Vulnerability assessments are needed to evaluate important habitats, climate change impacts to the habitats and the existing factors impacting the species.

Each region has different climate related factors that may have more effect on its stocks than changes in temperature. These factors may drive species distribution and can change assessment and management needs. Identifying these specific factors is essential. Models should differentiate between distributional shifts and productivity shifts. Genetics can help distinguish the difference. There is a need to improve cross boundary data collection and assessment. It would also behoove Councils to engage IEA teams to support the development of ecosystem models for fishery management.

Findings and Recommendations

- Regions with adjacent jurisdictions need a mechanism for collaboration so management strategies are consistent and conflicts in management goals are avoided, particularly when species populations shift due to climate change impacts.
- Guidance needs to be developed, particularly for regions with adjacent jurisdictions, to discern low productivity from spatial shifts in abundance and to specify catch quotas in these situations.
- The Gulf, South Atlantic, Caribbean, and Western Pacific Regions should develop appropriate monitoring frameworks to assess the impacts of ocean acidification and increased sea surface temperature on stock productivity in vulnerable ecosystems, like

coral reefs, and establish contingency management measures to respond to such changes in fishery resource availability, distribution, and quality.
- Conduct vulnerability assessments to determine stocks that are likely to be impacted by climate change.
- Incorporate environmental variables as much as possible in single-species stock assessments.
- Use ecosystem models to evaluate impacts of fisheries and other factors on fishery stock productivity.
- Engage various IEA teams to develop useful products to assist Council decision-making

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SUBTHEME 3.b: Building Habitat Condition in the Stock Assessment Process and Fishery Management Strategies

Discussion Summary

Regions with developed fisheries that are data-rich use habitat information as either spatial and/or habitat effects in single-species assessments and ecosystem models. Consideration of spatial and/or habitat effects can improve the precision of abundance indices from both fishery-dependent and fishery-independent survey data. For example, fishery-dependent information is being used to develop recreational indices in upcoming nearshore rockfish stock assessments in the Pacific Region. Geo-statistical delta Generalized Linear Mixed Models have been developed to make use of fishery-independent information. This method statistically models spatial autocorrelation, which implicitly incorporates the effect of unmeasured habitat attributes. The South Atlantic is using habitat information gathered through bottom mapping activities, along with temperature, depth, habitat type, location and other factors, to develop indices of relative abundance for stock assessments.

The importance of habitat considerations has been recognized in the South Atlantic as evidenced in its consideration of essential of fish habitat (EFH) in the fishery management plans (FMPs) for corals and sargassum, as well as its comprehensive ecosystem FMP. The South Atlantic also considers habitat in the designation of marine protected areas (e.g., to protect grouper and tilefish) and habitat areas of particular concern (HAPC) as well as in the management of artificial reefs.

The North Pacific is improving its fishery-dependent information by linking the catch to its explicit location. The Region has developed a Catch-in-Areas database using haul by haul catch information, which provides detailed catch information on a small scale, so that analysts can examine the intensity of fishing effort (and catch) by different gear types and fisheries. The NMFS Office of Science and Technology is also looking at the amount of habitat that cannot be trawled, which may resolve some trawl survey and stock assessment issues. Research funded by NMFS's Habitat Assessment Improvement Plan (HAIP) has helped define ecoregions in the Bering Sea. Generalized Additive Model can estimate habitat suitability for deep-water corals. The Mid-Atlantic Council is developing an FMP amendment to conserve and protect deep-water corals using a habitat suitability index to predict the occurrence of corals.

The Gulf Council has a written habitat policy in addition to a generic amendment for addressing EFH requirements within its FMPs. The overall goal of the policy is to "protect, restore, create, and otherwise improve EFH upon which commercial and recreational marine fisheries depend and to improve their productive capacity for the benefit of present and future generations." The policy objectives are to: 1) maintain the diversity and productive capacity of habitats in a quantity needed to sustain managed fisheries and their food base; 2) restore and rehabilitate the productive capacity of habitats that have already been degraded; and 3) create productive habitats where increased fishery productivity will benefit society.

In New England, EFH is a somewhat limiting concept in developing management measures because most areas are EFH for one or more species. Hence, New England factors additional considerations, especially the rarity and vulnerability of different habitat types, in its management measures. Areas that need management attention due to those considerations extend beyond areas designated as HAPCs and are referred to as Habitat Management Areas. Additional areas include Designated Habitat Research Areas and spawning protection areas, which at this time are being considered for enhancing spawning success of only groundfish.

The Gulf Region has several HAPCs that are protected entirely or seasonally from fishing. A total of 280,800 km^2 of offshore and coastal habitats in the Gulf are under some form of protection. Nonetheless, the habitat characteristics of broad areas of the region remain unknown. Ongoing studies, some of which have been funded by HAIP, are adding to the inventory of the Gulf's known pelagic and benthic habitats.

The Caribbean and Western Pacific Regions are primarily concerned with coral reef habitat. Coral reef fish distributions are strongly affected by benthic habitat type, location, and condition. Other important components are :1) water quality (e.g., turbidity, sewage discharge), which is exacerbated by narrow insular shelves that allow watershed activities to impact areas across the shelf; 2) landscape considerations due to the highly patchy nature of key habitats across the shelf (e.g., sea grass, mangroves, and shallow, mesophotic, and deep reefs), as fish diversity, abundance, and productivity are enhanced in areas of high habitat diversity; and 3) varied use of habitat across species and ontogenetic stages, which results in all habitat types being identified as EFH, a result that is not helpful for prioritization.

Dependence upon benthic features varies among managed species. That dependence should be described and will determine the extent to which benthic properties should be factored into both assessment and management, i.e., protection and/or restoration strategies. Similarly, responsiveness to properties of the water column will vary among managed species. Properties of the water column cannot be affected as readily by management, but management can still respond to those properties and incorporate them into models when they improve predictive capabilities or into dynamic spatial management strategies.

One commonality across all regions is that EFH and HAPC are used separately and do not feed directly into fishery management decisions. They are being updated regularly, are thoughtfully designated but are used merely for consultation purposes.

Findings and Recommendations

- Regions with coral reefs utilize habitat information to design marine protected areas.
- More information is required on the relationship between habitat attributes and stock productivity, as this information has direct impacts on stock assessment advice.
- More work is needed to link habitat impacts and ecosystem-level productivity.
- Consideration should be given to an additional National Standard to minimize non-fishing impacts to EFH.
- New tools are needed to analyze habitat information and develop management measures, particularly to distinguish resilient EFH areas and less resilient EFH areas, which may need additional management.
- Strengthen mechanisms to integrate watershed impacts on EFH and fisheries productivity, as well as linkages to local jurisdictions.
- Define EFH on a multispecies, multi-habitat basis to identify key shelf areas for priority protection.
- Engage local jurisdictions when designating marine reserves in key inshore areas within a larger network.
- Hypoxia, the Deepwater Horizon oil spill, destructive fishing gears, and the ecological versus fishery function of artificial reefs are pressing habitat-related issues affecting fisheries sustainability in the Gulf.

- Provide additional attention to key life history patterns, particularly spawning habitat, spawning aggregations, and nursery habitat, especially in shallow environments that have heavy anthropogenic or climate impacts.