Introduction/Executive Summary

The Pacific Fishery Management Council was pleased to host the sixth national meeting of the Scientific Coordination Subcommittee, or SCS, formally known as the national SSC meeting. The SCS is charged with advancing scientific understanding and to discuss scientific issues of national importance to inform decisions made by the Regional Fishery Management Councils. ●

Theme of the Sixth National Meeting of the Scientific Coordination Committee Meeting

The theme of the Sixth National SCS meeting was "The Use of Management Strategy Evaluation (MSE) to Inform Management Decisions Made by the Regional Fishery Management Councils." An MSE assesses the consequences of management actions by analyzing trade-offs associated with alternative management strategies. MSEs have evolved and are increasingly used in Council processes and natural resource (or fisheries) management worldwide. MSEs provide the opportunity for greater stakeholder involvement, fuller characterization of uncertainty in management decision-making, and exploration of social and economic effects of management decisions.

Four invited speakers with expertise in conducting MSEs provided their insights to inform three sub-themes of the Sixth National SCS meeting:

1. Use of MSEs in Evaluating and Modifying Harvest Control Rules;
2. Estimating and Accommodating Uncertainty; and
3. Adjusting Harvest Control Rules (HCRs) in Changing Environments/Non-Static Maximum Sustainable Yield (MSY).

An open discussion followed the presentations of the invited experts to synthesize findings, recommendations, and to answer any outstanding questions.

The meeting materials for the Sixth National SCS meeting are available at http://www.fisherycouncils.org/ssc-workshops/sixth-national-ssc-workshop-2018.

Management strategies are combinations of data collection schemes, the specific analyses applied to those data, and the harvest control rules used to determine management actions based on the results of those analyses. MSEs simulate alternative management strategies and evaluate their performance. They are widely considered to be the most appropriate way to evaluate the trade-offs achieved by alternative management strategies and to assess the consequences of uncertainty for achieving management goals.

An MSE is better characterized as a process than an analysis, where scientists from diverse fields engage with managers and stakeholders to identify alternative management strategies designed to accomplish a specific objective. While it is important to clarify the objectives and consider the need for a full MSE before initiating the process, management objectives do not need to be fully defined at the outset of an MSE. An MSE is best viewed as an iterative process where management objectives can be clarified as the process evolves. In some cases, a simpler analytical approach will suffice to accomplish a management objective. An MSE process may better inform the trade-offs associated with alternative management strategies when there is a diverse set of stakeholders with differing objectives, or when the predicted outcomes of management strategies are highly uncertain due to a dynamic physical or socioeconomic environment. It is important to understand that MSEs do not generally attempt to identify optimal strategies for accomplishing management objectives; however, they do tend to identify poor management strategies.

Stakeholder engagement is critical in an MSE process and stakeholders can help clarify management objectives and define performance metrics against which simulation results are compared. It is important to clarify stakeholder roles and responsibilities in an MSE process before it begins. Stakeholders are diverse, and the type of stakeholders involved depends on the scope and extent of the MSE. Some stakeholders will be fully engaged and others will be less engaged, but still affected by management decisions. Stakeholders should be aware of the need to be engaged, and should be encouraged to stay engaged in an often long and iterative MSE process. Social scientists and economists can help identify and bring less engaged stakeholders into the process directly or indirectly by collecting data from or about them.

Scientists may not be best placed to lead an MSE process. It can be productive to have independent and skilled facilitators lead an MSE process. If appropriate, stakeholders can choose chairpersons and help design the engagement process. How best to run an MSE process will vary depending on circumstance.

Analysts conducting an MSE should not be perfectionists and should avoid complex analyses where possible. In many cases economic and social data are scarce, making quantitative economic and social analyses challenging. Some trade-offs can be effectively characterized qualitatively. Social scientists and economists should be engaged in an MSE process at conception, bringing perspective as well as expertise.

Ecosystem MSEs are especially challenging. Predicting the results of any management action in an ecosystem context is very uncertain because the dynamics of ecosystems are complex and poorly understood. There are several types of ecosystem MSEs, including climate-related MSEs, which

examine how climate-linked harvest control rules (HCRs) inform management, MSEs focused on spatial management (e.g., addressing behavioral responses to area closures), MSEs that consider multiple objectives (e.g., biophysical, economic, social) using integrated approaches such as the Atlantis ecosystem model, and MSEs that account for predation. There is also what has been termed a "bolt-on" MSE, which is a single species MSE that calculates ecosystem metrics.

The complexity of ecosystem MSEs makes it important to bring experts in different fields into an ecosystem MSE. Multiple operating models, such as Models of Intermediate Complexity for Ecosystem assessments (MICE), empirical models, production models, age-structured models, etc. are used in ecosystem MSEs. Ecosystem modeling may require extensive data mining from various institutions.

It is important to determine the types of information decision-makers need when conducting an ecosystem MSE to avoid overwhelming them with too much detail. One useful approach is to make conservative assumptions in a data-limited situation and attempt to provide support for revising them through an MSE modeling exercise. When developing an ecosystem MSE, it is helpful to have diet information for relevant species, as well as data on abundance at lower trophic levels. Well-informed behavioral models are also useful

Effectively communicating the results of an MSE is a particular challenge. Analysts are not always skilled at communicating the science, uncertainty, and risk to stakeholders and decision-makers, and may want to consult others who are better equipped for this task. For example, the International Pacific Halibut Commission consulted with the Psychology Department at the University of Washington to improve their communication of MSE results. Alternatively, others who are good at communication can be tasked with presenting MSE results.

The best practices for communicating science, uncertainty, and risk portray MSE results clearly to stakeholders who may not have the technical expertise to understand model outputs and statistical analyses. Analysts' writing should be edited to make sure it is straightforward and does not contain language that will confuse, or that is too informal or too technical. Frequency/proportional occurrence is more easily interpretable than probability. "One in eight" is more easily interpretable than 12.5%. "Fifty year flood" is helpful even if the result is more complex than once every 50 years. Tell a story and have a conversation; describe what we do not know rather than just using "uncertainty." Start simply, then extrapolate.

Simplicity is better when presenting MSE results using graphs, tables, and pictures. Complex graphs may be appropriate for colleagues and publications, but they are not as effective for communicating results to stakeholders and decision-makers. The challenge is how to present results for more complex analyses, such as MICE and ecosystem models, in which the optimal fishing rate for one species can depend upon the fishing rate for other species. Consistency in presentation over time and across analyses and species may be limiting, but greatly improves understanding as the audience is able to draw relational contrast in analytical results. Getting advice on presentation, colors, etc. can be helpful in developing more effective graphics.

Different audiences (such as Council members and other stakeholders) require different communication approaches and skills and often have different agendas. An iterative MSE process allows analysts and communication experts to better engage with stakeholders. Listening to their questions and being receptive to their input builds trust and facilitates better communication and understanding.

It is important for scientists and stakeholders to understand how uncertainty should be used in making management decisions. Consider reporting uncertainty first, before reporting the point estimate, as uncertainty intervals in parentheses are often ignored. Eighty percent confidence intervals tend to work best for interpretation; 95% or 99% confidence intervals are not nearly as intuitive. Use metrics that are meaningful to stakeholders and Council members when presenting MSE results. Present performance of a management strategy by answering questions such as, "how often/likely fishing will have to be shut down?" and "how often/likely will inseason actions/actions between Council meetings be needed?"

Explain the mechanisms underlying uncertainty. This helps open up dialogue; stakeholders appreciate when scientists admit that they don't know something. Describe not just scenarios but, to some extent, why they differ. List research that could address some of the mechanisms underlying the uncertainty. Communicate research needs that might resolve critical uncertainties if funding were available to conduct such research.

In conclusion, a well done MSE results in better understanding of the science, the uncertainty associated with the analyses, and the risk involved in making complicated management decisions by those making the decisions and those affected by the action. A successful MSE process results in better stakeholder trust and buy-in in the science informing management decisions.