A public meeting of the Ecosystem-Based Management Subcommittee of the Pacific Fishery Management Council’s (Council’s) Scientific and Statistical Committee (SSC-EMS of Subcommittee) was held on April 19-20, 2011 at the Pacific Fishery Management Council (Council) offices in Portland, Oregon. Members of the Ecosystem Plan Development Team (EPDT) and the Ecosystem Advisory Subcommittee (EAS) were in attendance, as well as several members of the public and agency representatives. Day two of the meeting was held jointly with the EAS and included a presentation by Dr. Phil Levin and Dr. Brian Wells of the California Current Integrated Ecosystem Assessment program at Northwest Fisheries Science Center (NWFSC) and Southwest Fisheries Science Center (SWFSC). The primary purpose this meeting was the development of recommendations for the June 2011 Council meeting on incorporating relevant ecosystem science considerations into fishery management. This report provides a summary of discussion points and recommendations developed by the subcommittee for SSC review and presentation to the Council.

**Attendees**

**Subcommittee Members in Attendance**
Dr. Ramon Conser, National Marine Fisheries Service, La Jolla, CA  
Dr. Martin Dorn, National Marine Fisheries Service, Seattle, WA  
Dr. Vladlena Gertseva, National Marine Fisheries Service, Newport, OR  
Dr. Selina Heppell, Subcommittee Chair Oregon State University, Corvallis, OR  
Dr. Peter Lawson, National Marine Fisheries Service, Newport, OR  
Ms. Cindy Thomson, National Marine Fisheries Service, Santa Cruz, CA  
Dr. Theresa Tsou, Washington Department of Fish and Wildlife, Olympia, WA

**Subcommittee Members Absent**
Dr. Todd Lee, National Marine Fisheries Service, Seattle, WA  
Dr. André Punt, University of Washington, Seattle, WA

**EAS Members in Attendance**
Mr. Ben Enticknap, Oregon  
Ms. Kathy Fosmark, California  
Mr. Steven Fukuto, California  
Mr. Don Maruska, California  
Mr. Scott McMullen, Oregon  
Mr. Dan Waldeck, Washington  
Mr. Frank Warrens, Oregon
Others in Attendance
Mr. Steve Bodnar, Coos Bay Trawlers Association, Coos Bay, OR
Mr. Mike Burner, Council Staff, Portland, OR
Ms. Tanya Chesney, Oregon State University Graduate Program, Corvallis, OR
Ms. Yvonne deReynier, EPDT Chair National Marine Fisheries Service, Seattle, WA
Mr. John Field, EPDT Vice Chair, Santa Cruz, CA
Mr. Greg Krutzikowsky, CPSMT, Oregon Department of Fish and Wildlife, Newport, OR
Dr, Phil Levin, EPDT, National Marine Fisheries Service, Seattle, WA
Mr. Steve Marx, Pew Environmental Group, Portland, OR
Mr. José Montero, Oregon State University Graduate Program, Corvallis, OR
Mr. Corey Niles, EPDT, Washington Department of Fish and Wildlife, Montesano, WA
Mr. Tom Rudolph, Pew Environmental Group, Portland, OR
Ms. Cyreis Schmitt, EPDT, Oregon Department of Fish and Wildlife, Newport, OR
Dr. Brian Wells, National Marine Fisheries Service, Santa Cruz, CA

Meeting Objectives

1. Identify procedures, advisory bodies, and a framework for review of ecosystem condition reports, ecosystem models, and their incorporation into assessments, Council advisory materials, and strategic planning.
2. Recommend a review process and potential changes to Terms of Reference (TOR) documents for Fishery Management Plans (FMPs) to incorporate ecosystem data into stock assessments. Discuss development of a TOR for an Ecosystem Fishery Management Plan.
3. Identify critical data needs and workshops to review the state of ecosystem science as it may be applied to Council activities.
4. Meet with developers of the California Current Integrated Ecosystem Assessment (CCIEA) to discuss options for review of the structure and application of new models and evaluation tools.

General Considerations for Incorporating Ecosystem Science into Management

The integration of ecosystem considerations into fisheries assessment and management is a complex and evolving process. Ecosystem information, such as annual and decadal variability in physical processes that affect fish populations, the role of managed species in the food web, and cumulative effects of large- and local-scale events and human activities can provide valuable information for management, as discussed in the planning documents provided by the EPDT. Our discussion focused on the spectrum of ways that the information could be utilized in Council decision-making, and the level of scientific review that would be needed to assure that the tools and recommendations comply with the SSC’s current standards for best available science. In general, the SSC is a review body; nevertheless, some novel aspects of ecosystem-based fishery management suggest a need for advice on how these considerations could be incorporated into Council activities, and over what time periods. At this stage, the recommendations are necessarily broad because there has not been an evaluation of the models or data that might be utilized.
“Ecosystem considerations” is a generic term that needs to be defined for each application or management context. There are two primary categories of ecosystem considerations that can be incorporated to west coast fishery management: variability in the physical environment that directly or indirectly affects the vital rates (growth, survival, productivity) of fish stocks, and trophic interactions that affect predators and prey. These may interact, and join the current ecosystem considerations of habitat and bycatch that have been of particular importance in FMPs since the Sustainable Fisheries Act of 1996. As employed by the North Pacific Council, these considerations can be evaluated as effects of the environment on the fishery and effects of the fishery on the ecosystem.

The Subcommittee identified several applications of ecosystem considerations to management, including general ecosystem evaluation, assessments, risk management, and reference points (Table 1). The level of review required for each application largely depends on the scientific information or tools that are used and whether the information is purely advisory, part of a longer-term strategy to reduce ecosystem impacts, or for tactical decisions such as annual harvest guidelines. As the specificity of recommendations based on ecosystem information increases (i.e., becomes more quantitative), the rigor of review and justification for modification of existing management guidelines should also increase. Some ecosystem models may be good tools to address particular management question, but lack sufficient data to parameterize the model reliably. It is the role of the SSC to establish minimum standards and best practices for adopting ecosystem-based tools and evaluations in the management process.
TABLE 1. Likely applications, value and suggested review bodies of ecosystem-based approaches to fisheries management. Note that applications that directly or quantitatively affect management decisions (tactical) require more intensive review than those that are advisory. Long-term, “strategic” applications are dependent on pre-determined management goals, and may require intensive review if they are likely to have a large effect on Council decision-making. MSE = Management Strategy Evaluation; IEA = Integrated Ecosystem Assessment (including applications of the Atlantis ecosystem model or similar approaches). Advisory body acronyms: ETT = Proposed Ecosystem Technical Team. SSC-EMS = Ecosystem Subcommittee of the Science and Statistical Committee. EAS = Ecosystem Advisory Subpanel. MT = Management Team (FMP-specific). STAT = Stock Assessment Team. STAR = External Science and Technical Review Team. STT = Salmon Technical Team. SSC-E = Economics Subcommittee of the SSC.

<table>
<thead>
<tr>
<th>Application</th>
<th>Role</th>
<th>Potential “Value”</th>
<th>Outputs primarily Qualitative or Quantitative ?</th>
<th>Potential models</th>
<th>Suggested Review bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem condition report</td>
<td>Advisory</td>
<td>Advice for setting OY, levels of precaution for ACLs; leading (1 – 4 yr) indicators of system change</td>
<td>Quantitative</td>
<td>Mostly statistical</td>
<td>ETT, SSC-EMS</td>
</tr>
<tr>
<td>Ecosystem status indicators for assessments</td>
<td>Varies, will be Advisory at first</td>
<td>Improve assessment</td>
<td>Qualitative</td>
<td>EBM (IEA), condition reports</td>
<td>ETT, EAS, SSC-EMS</td>
</tr>
<tr>
<td>Environmental drivers of recruitment, growth, etc.</td>
<td>Tactical (stock assessment)</td>
<td>Improve stock assessment, status determination criteria</td>
<td>Quantitative</td>
<td>Mostly statistical</td>
<td>STAT, STAR, SSC</td>
</tr>
<tr>
<td>Salmon escapement forecasts</td>
<td>Tactical</td>
<td>Improve predictions, set catch limits</td>
<td>Quantitative</td>
<td>Various; statistical correlations with environmental variables</td>
<td>STT, MT, SSC-EMS, SSC</td>
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<tr>
<td>Cutoffs or modifiers used in Harvest Control Rules</td>
<td>Strategic</td>
<td>Develop HCRs that consider ecosystem role or context, OY determination</td>
<td>Quantitative</td>
<td>Population model with MSE or EBM</td>
<td>STAT, SSC-EMS, STAR, SSC, MT</td>
</tr>
<tr>
<td>Cumulative effects evaluation</td>
<td>Strategic</td>
<td>Advice to long term planning, OY determination</td>
<td>Qualitative</td>
<td>EBM (IEA), MSE</td>
<td>ETT, EAS, SSC-EMS, possible STAR</td>
</tr>
<tr>
<td>Trade-offs of management approaches</td>
<td>Strategic</td>
<td>Cross-FMP effects on fisheries, communities</td>
<td>Qualitative</td>
<td>EBM (IEA) with MSE</td>
<td>ETT, EAS, SSC-EMS, SSC-E, possible STAR</td>
</tr>
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</table>
How Can Ecosystem Considerations Become Part of the Council System?

Much of the two day meeting focused on how to operationalize EBFM in the Council’s current framework, concentrating on the review process for evaluating the scientific soundness of ecosystem tools and applications for fisheries management.

Advisory Committees

Regardless of whether the Council chooses to develop and adopt an Ecosystem FMP, or increase the use of ecosystem considerations in the existing FMPs, the SSC-EMS recommends that ecosystem information be reviewed and evaluated by a set of committees, similar to the Council’s current ancillary bodies. This system will evolve over time, as new tools and applications are developed. Importantly, committees that are associated with evaluation of ecosystem information should coordinate review with the Technical and Management Teams of the affected FMPs, as well as the SSC when scientific information needs to be reviewed.

The following list of ancillary groups can serve as a starting point:

Ecosystem Plan Development Team - Provides initial guidance for the Ecosystem FMP and incorporation of ecosystem information into existing FMPs and stock assessments.

Ecosystem Technical Team (ETT)

Primary Duties:

a. Distill Ecosystem Status Report into FMP-specific implications (advisory information to Council – see below).

b. Identify best stocks for incorporation of ecosystem considerations in assessments.

c. Prioritize ecosystem-related research projects that could result in guidance for management, e.g., cross-FMP cumulative effects on species or habitats, forage fish harvest guidelines, identification of indicators of ecosystem status, development of tools for socioeconomic evaluation of effects on communities.

d. Serve as liaison between the Council and Science Center Integrated Ecosystem Assessment Teams.

e. Coordinate reviews and presentations of ecosystem information for the SSC and Council.

SSC Ecosystem Management Subcommittee (SSC-EMS)

Primary Duties:

a. Review work plans and products of the ETT

b. Determine when external review (STAR Panels) of models or products is needed, and lead those reviews.

c. Participate in Methodology Reviews that include ecosystem considerations.

SSC – review reports, products, and determine if “best available science” has been employed in evaluations.

Stock Assessment Teams (STATs) – should include at least one scientist with ecosystem expertise, assist with development of ecosystem considerations section of assessment.
Management and Technical Teams (MTs) – should review and provide feedback on management implications of ecosystem science products, as they affect each FMP.

Agencies

NMFS –
- Integrated Ecosystem Assessment Team – develops and runs models, evaluations.
- Provide support for consistent sampling of ecosystem indicators, including diet analysis and evaluation of ecosystem indicators.
- Summarize State of the California Current reports.

States and Tribes –
- Contribute to long term sampling or other monitoring that contributes to ecosystem-level evaluations.

Annual Ecosystem Report to the Council

A “State of the California Current” report should be developed for Council review each year, either at the November or April meeting. The purpose of this annual update is to provide information about the physical and biological conditions of the system in the previous year that have the potential to affect recruitment, distribution, or vital rates of managed stocks. Possible information to include would be El Niño/La Niña conditions, environmental indices such as the Pacific Decadal Oscillation, upwelling start and end time, extent of the hypoxic zone off the central coast, krill, copepod or crab larvae abundance, and marine mammal and seabird trends. Information in the report should be put in the context of Council management. Currently, a quarterly report of climate and ecosystem conditions in the Current available on-line at http://pacoos.org/. However, this report is highly technical and is not developed specifically for fisheries management applications; as such, it would need to be distilled and summarized to provide an update on the available science and ways it should be considered by the Council. The NPFMC has produced an annual Ecosystem Report (http://www.afsc.noaa.gov/refm/docs/2009/ecosystem.pdf) but the document is over 200 pages; any comparable report for the California Current would need to be summarized according to implications for each FMP to be useful for consideration in setting optimum yields (OYs) or prioritizing research needs.

Research and Data Needs

As new ecosystem-based tools are developed and adopted for Council use, the Research and Data Needs document will be refined. The goal should be to provide specific recommendations for prioritization of research or monitoring needed to improve the reliability and predictive power of ecosystem models.

SSC Review of Ecosystem Models and Products

Several products and tools have been introduced to the Council that can increase management focus on ecosystem processes. Depending on the application of those products (see Table 1), the SSC-EMS should evaluate the need for external review and reporting to the SSC, which in turn can provide recommendations to the Council about the applicability of the tools to particular management questions. Advice on model reliability and robustness to uncertainty will be an important consideration for all review bodies, including Technical Teams and Management...
Teams. Modifications to existing TOR for each FMP may be needed as new ecosystem-based assessment tools are employed; if an Ecosystem FMP is developed, the SSC-EMS should draw up a TOR specific to that Plan and analyses or models that may be used under it, such as applications of Atlantis to cumulative effects modeling. The EFMP TOR authors can find guidance for best scientific practices related to evaluation of models and approaches to ecosystem-based management in two documents: *FAO Fisheries Technical Guidelines for Responsible Fisheries*. No. 4, Suppl. 2, Add. 1. Rome, FAO. (2008), and *Report of the 2nd National Ecosystem Modeling Workshop (NEMoW II): Bridging the Credibility Gap - Dealing with Uncertainty in Ecosystem Models*. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-102 (2010).

As recommended in a recent update to the coastal pelagic species (CPS) TOR, incorporation of new tools or data that affect status determination, catch recommendations, or harvest guidelines should undergo methodology review. The SSC-EMS recommends that plausible mechanisms be provided before incorporating physical or biological factors in recruitment functions, parameter estimates, selectivity functions, catchability coefficients, or other components of a stock assessment. A sensitivity analysis that shows the effect of the ecosystem-based component should be provided, as well as model hindcasting to evaluate how previous assessment results might have been affected by the component. For example, a model to forecast salmon returns that relies on correlations of ecosystem indicators with salmon survival and age at spawning should include a plausible mechanism for the correlation and validation through hind-casting.

The value of ecosystem-based approaches and the effects of alternative management strategies that incorporate ecosystem considerations should be examined with a Management Strategy Evaluation (MSE) when feasible. MSE is a process that involves several steps and interacting models to demonstrate trade-offs in things that are affected by management (e.g., biomass, yield, probability of overfishing, status of ecosystem components) while explicitly considering uncertainty in biological processes, fishing behavior, data collection, and management response. MSE is gaining popularity as a tool to compare management options and identify which changes will most effectively achieve management goals.

Many ecosystem models are extremely complex, which may make MSE or even simple sensitivity analysis difficult. The SSC will need to consider “how high to set the bar” of review, given that very few single species models have undergone rigorous evaluations such as MSE. Nevertheless, it will be important to evaluate the trade-offs associated with adoption of new tools and strategies that include ecosystem considerations. All ecosystem-based models or status evaluations used to inform management can be evaluated for scientific rigor, and the SSC should retain its high standards for review even though the tools and applications may be novel.

_Ecosystem effects reports for stock assessments_

The North Pacific FMC and some eastern FMCs are adding a section of ecosystem considerations to single species assessments, even if ecosystem processes are not directly included in the assessment model. Such information may be valuable in subsequent assessments for identifying forcing factors that may have impacted the distribution or status of the stock. The scope and level of detail of a required ecosystem considerations component will evolve over time as new analyses and tools are reviewed. The NPFMC guidelines can serve as an initial template
(Box 1); each assessment would require at least a qualitative treatment of the items listed. The required section should focus on relevant data on ecosystem processes that may affect stock or parameters in the stock assessment in the future (including potential impacts of changes in other fisheries). It is expected that text on the basic ecosystem considerations for a stock would be consistent among assessments, but a timely condition report for some or all components would be a valuable addition. One component of the CCIEA that is currently under development is a species-specific “ecosystem report card” that could serve as a report for an assessment.

Box 1. Excerpt from the NPFMC’s Stock Assessment and Fishery Evaluation Guidelines, outlining required components for the ecosystem considerations section of stock assessments.

Adding an ecosystem reporting component to stock assessments would require additional time and expertise. STATs could add an ecologist, oceanographer, or other scientist with expertise in ecosystem processes and the assessed stock to review and compile relevant data and help write this section of the assessment. Identifying collaborators for this role will also help the SSC-EMS and ETT to find the required expertise for methodology reviews.
Application of ecosystem models to harvest control rules

Harvest control rules (HCRs) and status reference points used for management may benefit from incorporation of ecosystem considerations if the models or statistical analyses used to develop harvest guidelines are robust to uncertainty. Because of the role of forage fishes in marine food webs, and the current use of “cut-offs” for harvestable biomass in the sardine and mackerel assessments, an exploration of ecosystem considerations for CPS stocks seems to be an obvious place to start. Desirable model and analysis characteristics include: uncertainty evaluation, simulation consistency, and strong evidence that the alternative approach meets management goals better than the status quo. The effects of ecosystem-based control rules on the fishery and target stock can be evaluated with an MSE, although trade-offs in ecosystem response may be more difficult to model. Rigorous evaluation of ecosystem-based harvest control rules in an ecosystem context may not be possible with existing data, particularly on diet and distributions of predator and prey species.

Ecosystem Effects on the Stock

The following factors should be discussed:
Prey availability/abundance trends (historically, in the present, and in the foreseeable future). These prey trends could affect growth or survival of a target stock.
   1) Predator population trends (historically, in the present, and in the foreseeable future). These trends could affect stock mortality rates over time.
   2) Changes in habitat quality (historically, in the present, and in the foreseeable future). Changes in the physical environment such as temperature, currents, or ice distribution could affect stock migration and distribution patterns, recruitment success, or direct effects of temperature on growth.

Fishery Effects on the Ecosystem

The following factors should be discussed:
   1) Fishery-specific contribution to bycatch of prohibited species, forage (including herring and juvenile pollock), HAPC biota (in particular, species common to the target fishery), marine mammals, birds, and other sensitive non-target species (including top predators such as sharks, expressed as a percentage of the total bycatch of that species).
   2) Fishery-specific concentration of target catch in space and time relative to predator needs in space and time (if known) and relative to spawning components.
   3) Fishery-specific effects on amount of large-size target fish.
   4) Fishery-specific contribution to discards and offal production.
   5) Fishery-specific effects on age at maturity and fecundity of the target species.
   6) Fishery-specific effects on EFH non-living substrate (using gear specific fishing effort as a proxy for amount of possible substrate disturbance).
Regardless of the model chosen or the issues raised, it was agreed that the appropriate review process is to have a review panel of SSC and outside experts delve into a detailed review which is presented to the full SSC for review. The Methodology Review TOR documents should be reviewed or updated to include review of ecological approaches to developing harvest control rules.

**Review of Existing Science in Support of Ecosystem-Based Management**

The group discussed a number of data deficiencies and model evaluation needs that should be prioritized as ecosystem information is incorporated into Council processes. This will require an update of the Research and Data Needs document.

**Review of Model Structure, Parameterization and Assumptions**

While specific applications of ecosystem considerations to Council operations will be reviewed individually, models such as Ecosim/Ecopath and Atlantis are likely to be used to explore a variety of questions that affect fisheries management. The SSC could benefit from a review of the basic model structure, data requirements, and critical uncertainties and assumptions of these models. The SSC-EMS recommends a workshop to review the state of the art in ecosystem science, particularly models that would likely be applied to west coast fisheries. The workshop should cover the following: What models are available, what data are available, what can/cannot be evaluated, which models are ready for intensive external review? Some of this has been done by the EPDT, and it would be prudent to hold such a workshop after specific applications of ecosystem-based tools have been explored by the Council or CCIEA Team.

**Biological/Oceanographic Information needs**

The SSC-EMS is concerned about scientific uncertainty in the CCIEA and modeling tools that have been presented to date. In particular, a time series of diet and trophic interactions is not available for the California Current, and ecosystem models are sensitive to the trophic relationships among species. Existing groundfish surveys could collect and analyze stomach samples to get the time series started, and the CCIEA Team is compiling data on diets of top-level predators such as seabirds and marine mammals. Oceanographic information is largely available, but exists at different spatio-temporal scales that may not match those that are relevant to West Coast fisheries. Evolving uses of Ocean Observation Systems to monitor physical conditions of the system should improve our ability to link fish population dynamics and distributions to oceanography, but the information most relevant to our fisheries may not yet be available.

**Ecosystem Considerations in Socioeconomics**

Good cross-FMP analyses were suggested by the Ecosystem Plan Development Team, including: (1) summary of cumulative bycatch in all FMP fisheries, (2) characterization of spatial/temporal patterns of fishing effort, (3) consideration of cumulative effects of management actions in terms of effort shifts between FMP fisheries and also between FMP and non-FMP fisheries. Some of these analyses could be done now, and can be prioritized with help from the ETT and SSC-EMS.

Coastal communities are best considered in terms of cumulative effects across FMPs, but the desired outcome of community ‘well-being’ is difficult to define and measure. “Vibrant” and
“resilient” are terms that are often used to describe desired community characteristics, but these terms are often ill defined and the resulting analyses tend to be qualitative and general. Currently there are few if any meaningful indicators of well-being. Without an operational definition of well-being there can be no good way to forecast how management actions affect community well-being. If we are to develop economic indicators to examine the trade-offs associated with ecosystem-based approaches to fisheries management, we need to develop better metrics for measuring community effects and socioeconomic impacts. For example, effort shifts could be evaluated by quantifying fishing patterns as changing predator responses to available prey, with the added drivers of markets and other social factors.

The SSC-EMS and SSC-ES recommend a workshop to develop guidelines on how ecosystem information can be included, developed, or reviewed for socioeconomic impacts; this will be a topic discussed at the National SSC meeting in October, 2011. Our workshop topics could include development of alternative definitions of community well-being, as well as measurable and meaningful indices of well-being that can be linked to Council actions. Workshop participants should include regulatory analysts, managers, economists and social scientists who are currently working on these issues, but also individuals with relevant expertise who have not been previously consulted (e.g., economic geographers), individuals who have had some success in considering community effects in other (non-fishing) resource management contexts, and/or individuals who have expertise on economic/policy issues associated with other coastal issues, such as harbor management. The SSC Subcommittees can work together on the scope and planning of this workshop.

*California Current Integrated Ecosystem Assessment*

Dr. Phil Levin (NWFSC) presented an overview of the CCIEA. The Assessment is a process involving multiple models and synthesis products that addresses "the science needed for a healthy California Current." Initiated after an external review of ecosystem science in 2006, its purpose is to organize the relevant science of ecosystem processes, assess the stressors and conditions of the ecosystem, and provide strategic advice to management. A current report has been distributed to the Council and is available at www.nwfsc.noaa.gov/publications/iea.pdf.

The CCIEA is not a single model, but rather a collection of models that are used as a toolbox. The spatial scale of evaluations is generally the entire California Current but some analyses also try to look at how CC-wide indicators reflect upon more local conditions. Current status evaluations are based on the most recent 5-year period. Currently, salmon and 17 groundfish species representing different feeding guilds (trophic levels) are being modeled; seabirds and mammals will be added over the next year.

While the CCIEA can serve as an advisory document now, the IEA Team is particularly interested in working with the Council to develop or modify their existing ecosystem-based assessment tools to address particular questions posed by management. The IEA process to date has involved three primary approaches: collation of information on the effects of ecosystem components or stressors on particular species, evaluation of correlations between physical and biological conditions and recruitment (particularly salmon in the southern CC region, as presented by Brian Wells from SWFSC), and development and parameterization of the ecosystem model Atlantis for evaluation of indirect and cumulative effects of fisheries and
ecosystem change on the CC system. A current emphasis of the program is identification of indicators of ecosystem condition that can predict future change. All of these approaches and tools have the potential to benefit PFMC (see Table 1). Considerable interaction among the IEA team, SSC, EPDT, and EAS will be needed to accomplish the Council's ecosystems-based fishery management goals.

Sensitivity analysis is the first level of uncertainty analysis used for review of stock assessments – not only for this Council but throughout the fisheries world. Because of the large number of parameters, it is difficult (in some cases, impossible) to conduct comprehensive sensitivity analysis of a complex ecosystem model like Atlantis. This creates a level of scientific uncertainty and obscurity that could be problematic for review when the model is used for a prescriptive (tactical or strategic) application to fisheries management. The CCIEA Team is keenly aware of the need for scientific rigor and evaluation of the consistency of model results when parameter or model structure uncertainty is considered, and will work with the SSC on reasonable guidelines for sensitivity analysis in model and application review.

**Tasks to meet short term implementation goals**
The SSC-EMS reviewed recommendations by the EPDT for implementing ecosystem-based management, including a timeline for incorporation of ecosystem considerations into stock assessments and development of ecosystem status reports. The Subcommittee agrees with the general plan to gradually incorporate ecosystem considerations, starting with the next assessment cycle and upcoming methodology reviews for CPS stocks. Once the Council has determined if and when an Ecosystem FMP is to be developed, the SSC-EMS can begin work on a TOR for that Plan. Modifications to existing FMP TORs can begin as soon as the SSC Subcommittees will allow, and should include consultation with the SSC-EMS and each FMP Management Team. Finally, the SSC should discuss options for ecosystem workshops in 2012, including a model review workshop and development of socioeconomic indicators workshop.
Subcommittee Recommendations

- Incorporation of ecosystem considerations into management will continue to be an evolving process. All science can and will be reviewed and held to a high standard of scientific rigor, but the precise nature of those reviews will depend on specific applications (Table 1).
- The best framework for employment of an Ecosystem Fishery Management Plan is one of advisory and science teams, similar to the existing FMPs. This should include an Ecosystem Technical Team and an Advisory or Management Team. The SSC-Ecosystem Management Subcommittee expects to take a role as a bridge between these teams and the SSC. This framework may be valuable even if an Ecosystem FMP is not developed in the short term.
- Ecosystem information is available now to provide advice on physical processes, habitat, and food web dynamics that are affecting Council managed stocks. However, this information needs to be distilled into a useful product for Council review and discussion.
- An ecosystem considerations section should be added to all stock assessments, starting with the 2013 assessment cycle. The detail and length of the section will vary and evolve over time. Stock assessment teams should include a scientist with expertise in ecosystem processes and the affected stock to assist with this section development and stock assessment review.
- The SSC will need to modify Terms of Reference for each FMP to include review of ecosystem consideration sections of assessments and application of ecosystem processes in assessments and harvest control rules. The next revision of the Research and Data Needs document should explicitly include needs for ecosystem models.
- Workshops should be planned to discuss ecosystem models and their application to biological and socio-economic evaluations.
- The Council should identify an Ecosystem Technical Team to work with developers of the CCIEA to prioritize applications of the models to specific questions, such as cumulative effects evaluation and forecasting models for salmon.

The SSC-EMS thanks the EAS, EPDT and other meeting attendees for a fruitful discussion, and looks forward to continued collaboration on this important and evolving topic.

PFMC
05/24/11