

Develop a set of operational objectives for the southeastern Bering Sea ecosystem

In 2004, the U.S. National Marine Fisheries Service (NMFS) completed a comprehensive assessment of the overarching conservation and management policies and objectives of the Alaska groundfish fishery management plans. As a consequence of that review, the North Pacific Fishery Management Council (NPFMC) adopted a high-level policy statement with broad objectives for the fishery, including 45 specific objectives classified under nine priority issues. Four of the nine issues address social and economic concerns, whereas the remaining five address conservation of species, communities and ecosystems. Conservation objectives, indicators, and reference points are well-defined for commercially exploited groundfish and invertebrates, as well as some other taxa, such as marine mammals and seabirds that are listed under the U.S. Endangered Species Act.

The annual NMFS *Ecosystem Considerations* appendix includes hundreds of ecosystem and management indicators. Some of these are composite indicators that monitor ecosystem-level objectives related to maintaining predator-prey relationships, diversity, and energy flow and balance. The report establishes linkages between many indicators and the conservation objectives adopted by NPFMC. Although specific limit reference points are not yet formally defined for ecosystems/communities, these indicators are used to evaluate sources and amounts of change in Alaska marine ecosystems that might warrant further research or possible change in management. When indicators suggest a potential conservation problem, the *modus operandi* of NPFMC is to develop a problem statement and to consider a detailed analysis of the situation, along with management alternatives and their ecological, social, and economic impacts. Then, NPFMC selects an alternative in which specific conservation limits and management actions are adopted. This process involves high levels of stakeholder input, along with review, comment, and recommendations by a Scientific and Statistical Committee. One of several examples of recent actions taken to address ecosystem

conservation issues includes closure of 95% of the Aleutian Islands management area to bottom trawling to protect deep-sea corals based, on observed coral bycatch, distribution of fishing activity, habitat mapping, and recent discovery of 25 species of corals endemic to the area.

The objectives adopted by NPFMC and the Ecosystem Status Indicators and Ecosystem Assessment in the *Ecosystem Considerations* appendix formed the initial basis for reviewing Bering Sea objectives and indicators for the Indicators project. Two open meetings were arranged to solicit feedback from the scientific and stakeholder communities on the completeness of this set of objectives and indicators. These meetings attracted participants with interests in developing ecosystem-based approaches to management of the southeastern Bering Sea and Gulf of Alaska. The first meeting occurred on January 25, 2006, in Anchorage, in association with the annual *Marine Science in Alaska* Symposium, and the second was held on February 8, 2006, in Seattle, during a meeting of the North Pacific Fishery Management Council. These meetings were preparatory to the PICES/NPRB Indicators workshop that was convened on June 1–3, 2006, in Seattle.

Operational objectives can be categorized under two broad dimensions: (1) conservation of species and habitat; and (2) socio-economics of marine ecosystems. A logical sequence is to develop socio-economic operational objectives and indicators after the boundaries of conservation have been identified by scientists. Scientists can then determine the means to move, within ecological limits, toward these socio-economic objectives.

Although much progress has been made in defining conservation objectives for the Bering Sea, as already mentioned, there is a continuing need for greater specificity by developing operational objectives in an open public process with a high level of stakeholder involvement. For instance, among the 45 specific objectives

developed by NPFMC, many are not sufficiently specific to allow a determination about whether they have been met.

The use of ecosystem-scale indicators could be a way to identify conservation issues before they reach crisis points so that management does not need to routinely operate in a reactive mode. However, the science of ecosystem-based management has not yet developed sufficiently to allow the setting of scientifically defensible conservation limits at the fish community and ecosystem levels. Best available science should be used to assess the ecosystem benefits to be derived from various management alternatives. Indeed, some research in these areas is currently underway. Also, research is needed on the application to the Bering Sea of ecosystem-level indicators that have proven useful in other jurisdictions, such as aggregate biomass, biomass groupings and biomass-ratio indicators. Useful biomass groupings are:

- gelatinous zooplankton,
- cephalopods,
- planktivores,
- scavengers,
- demersal fishes,
- habitat-forming epifauna,
- piscivores,
- top predators.

Biomass-ratio indicators might include piscivore/planktivore, pelagic/demersal, and infauna/epifauna ratios.

Socio-economic objectives and indicators were explicitly omitted from this project owing to the scope of supported work, not because they are unimportant. Whereas the *Ecosystem Considerations* appendix links indicators to NPFMC conservation objectives, there is a pressing need to develop operational objectives and associated indicators for the socio-economic dimension. This might be best achieved by conducting a series of workshops involving economists, social scientists, and stakeholders, not unlike the workshop we have conducted with respect to ecosystem objectives and indicators. It is recommended that the results of these workshops should be used to transform the existing NMFS *Economic Status* report into an annual *Socio-economic Considerations* report that relates social and economic status indicators to socio-economic objectives much in the same way that the *Ecosystem Considerations* report links indicators to conservation objectives. In the United States, NPFMC should play a central role in shepherding the development of these socio-economic objectives and indicators for the southeastern Bering Sea and Gulf of Alaska ecosystems.

Evaluate the two ecosystem status reports

Two ecosystem status reports were discussed during the Indicators workshop. *Ecosystem Considerations for 2006* is an appendix to the annual *Stock Assessment and Fishery Evaluation* (SAFE) report published by NPFMC. *Marine Ecosystems of the North Pacific* is a compendium of overviews of regional marine ecosystems that was published for the first time, in 2004, by PICES. *Ecosystem Considerations* demonstrates that considerable progress has been made to link a large suite of ecosystem status and management indicators to the broad objectives identified by NPFMC for managing groundfish fisheries in the Gulf of Alaska, Aleutian Islands and eastern Bering Sea. *Marine Ecosystems of the North*

Pacific provides a very useful region by region comparison of ecosystems in the entire North Pacific.

Describing complexity is a challenge. It is difficult, even for experts who understand the meaning of individual indicators and their interconnections, to identify the major patterns of ecosystem change in the hundreds of indicators contained in these two reports. The most recent versions of *Ecosystem Considerations* partly address this issue by including an executive summary that shows recent important and/or interesting trends from a subset of indicators.

Identify steps to validate indicator performance, improve the monitoring network, and integrate into predictive models

It was noted that although the *Ecosystem Considerations* appendix contains an assessment section where a subset of important indicators is presented, this subset has not been subjected to an objective evaluation and selection process. Different methodologies for indicator evaluation and selection were presented at the Indicators workshop. The Rice–Rochet framework was recommended as a more structured process to evaluate and screen indicators. This framework identifies eight steps for selecting a suite of indicators for fisheries management. Steps that have not yet been done with *Ecosystem Considerations* are to score the indicators in the report against screening criteria and to use those scores and user input to select the suite of indicators on which to report.

The Driver-Pressure-State-Impact-Response (DPSIR) framework was also thought to be useful

in exploring the key pressures of human activities and climate on marine ecosystems and might be used to organize indicators by pressure points or threats. Composite indicators can be derived from existing data, but there are many ecosystem components that could serve as “pulse points” but they are not well-monitored. A number of gaps in the monitoring network were identified at the Indicators workshop.

Predictive models of future change were not a central focus of the Indicators workshop. However, it was recognized that the use of risk assessment and scenario approaches, such as those employed in Australia, were worthwhile avenues for making progress. It appears that a number of modeling approaches are being advanced and improved upon in Alaska. In addition, future climate scenarios are being developed to drive some of the models.

Investigate methodologies that monitor system-wide structural changes within the marine ecosystem

The workshop was successful in establishing two benchmarks for the use of indicators in the Bering Sea.

The first benchmark is that the use of indicators has utility as a communication technique between fisheries managers and supporting scientists. While scientists will point to the overall complexity of the ecosystem, and managers would like defensible environmental information to take actions that have potential economic consequences, semi-quantitative indicators provide, at present, a known and tested technique for reaching a common understanding in fisheries throughout the world.

The second benchmark is that there are now management objectives in place for the Bering Sea, based on the work of NPFMC and the Alaska Fisheries Science Center (AFSC). There is a concern in the literature that indicators should be

matched to specific objectives. This concern was a major consideration in planning the workshop. It was clear from the presentations and discussions that the Bering Sea is in good shape with regard to management objectives. For example, the management objective “to preserve the food web” could have an operational objective “to maintain the mean trophic level between 3.3 and 3.7” which is the trophic-level range of the catch in recent years after banning new fisheries on forage species. Other examples of management objectives in the eastern Bering Sea are to:

- prevent overfishing,
 - manage bycatch,
 - avoid seabird and marine mammal impacts,
 - reduce impacts on habitat,
- each with appropriate operational objectives and indicators.

The situation for the Bering Sea was commented on by scientists from Australia, the Canadian and U.S. east coasts, and by the Co-chairman of the SCOR/IOC Working Group 119 on Quantitative ecosystem indicators for fisheries management, Dr. Villy Christensen, as well as by Bering Sea specialists. They emphasized that unlike many other large marine ecosystems, management of the Bering Sea is not in “desperation mode”, as the Bering Sea is not generally overfished. Factors they saw as missing or under-represented included:

- a risk management framework,
- a formal process of indicator selection;
- a lack of reference points to determine when the value of an indicator should initiate action.

In further discussion, however, it was noted that because the Bering Sea is not in desperation mode, the present method of adaptive management, where the system is monitored for change and issues are dealt with as they arise, was a better approach for the Bering Sea than setting formal reference points for a large number of indicators.

The review team concluded that, unlike many other regions that deal primarily with the

consequences of overfishing, the Bering Sea needs both management objectives and ecosystem status objectives. Because the Bering Sea lies between the North Pacific and the Arctic, its ecosystem and commercial fisheries are subject to climate variability and climate change, as has been seen in both historical records and in climate projections. Thus, it is important to develop and include indicators that link climate to ecosystem changes.

While the workshop was successful in reviewing objectives and management indicators, it leaves for the future the task of selecting an appropriate set of ecological indicators. Any synthesis of information should discuss both the interpretation of what is meant by ecosystem status and the methodology for reducing the number of potential indicators. It was suggested that selection criteria should be: relevant, integrative, sensitive, correct, defensible, vetted and economical.

The methodologies used to develop indicators cannot be separated from the process of how the information will be used. So their communication to managers must be sufficiently convincing to allow them to take and defend their actions.