Improving Science in Marine Fishery Management: Looking at Other Disciplines for Strategies to Develop New Models

George W. Boehlert, Ph.D.
NOAA Pacific Fisheries Environmental Laboratory*

Summary

The fundamental basis of many models used in fishery management was conceived when fisheries were under the paradigm of exploitation and expansion. In order to protect marine ecosystems, fishery managers need new models based on scientific information that successfully integrates ecosystem considerations and environmental variability. Experiences in atmospheric and oceanic science offer possible examples for strategies to develop new operational models that integrate up-to-date research. The development and effective use of such models, however, will require significant financial and intellectual resources. Creation of an oversight body to coordinate all federal programs that affect the marine environment may speed this process.

Does the Environment Matter in Fishery Management?

Moving from single-species management to ecosystem-based management, which considers complex information on predators, prey, competitors, habitat, and the physical environment, is a recurring theme in improving fishery management (NRC, 1999; NMFS, 1999). Variability in the physical environment, however, is also known to affect single species, so it is useful to evaluate its current application in fishery management.

The impact of environmental variability on marine populations and ecosystems depends upon the scale of the variation. Small-scale variability can affect survival of young stages of fish while larger-scale environmental variability exerts a wider impact over the broad geographic distributions of marine fishes. As a result, larger-scale variability may have greater potential for use in fishery management. El Niños, for example, can affect the distribution of mobile species living in open oceans while also affecting the productivity of more sedentary species. On time scales of decades to centuries, changes have been documented in fish stock productivity, ecosystem carrying capacity, and other fluctuations independent of fishery activities (Steele, 1996). Given the relatively short length of time series of fisheries data, however, it is still difficult to separate effects of fishing from the effects of environment on many species.

A great deal of environmental information is available for use in fishery management (Boehlert and Schumacher, 1997). Large-scale research programs in fishery oceanography (e.g., the International Oceanographic Commission's Ocean Sciences in Relation to Living Resources; National Oceanic and Atmospheric Administration's Fisheries

*The views expressed in this paper are those of the author and not necessarily those of the National Marine Fisheries Service, NOAA.

Oceanography Coordinated Investigations; and the Global Ecosystem Dynamics Program) have established linkages—proposed since the early 1900s (Hjort, 1914)—between variability in the environment and variability in fish populations. Unfortunately, aside from input to recruitment forecasts (Megrey et al., 1996) or experimental approaches, these data have not been used for fishery management.

"A concerted, priority effort to develop the next generation of models is overdue."

Many fishery management models still in use are based on theory dating back several decades when the typical fishery paradigm was one of exploitation and expansion, as opposed to conservation and sustainability. While dependent upon large numbers of input parameters, these models generally do not take environmental variations into account (Gulland, 1983). Many of the models do a good job estimating stock size but are not designed with forecasts in mind. Alternative, ecosystem-based models (Pauly et al., 2000) are generally used as comparative research tools but may be inadequate for practical, *operational* fishery management. A concerted, priority effort to develop the next generation of models is overdue.

Research and Operational Models: Adequacy of the Tools

The lack of significant advances and improvements in fishery management models is in marked contrast with the advances in atmospheric or oceanographic science (Parsons, 1996). The mechanisms of model development and implementation in these disciplines may provide prototypes for similar applications in fishery management. The national defense and weather communities provide good examples.

In the United States Navy, the model development process proceeds through four phases: exploratory/advanced technology development, demonstration and validation, operational implementation, and operations. The Naval Research Laboratory serves as the "corporate laboratory," developing the models and participating in the first three phases, finally turning the models over to the Naval Meteorology and Oceanography Command, which uses the models to provide operational products in support of the Department of Defense missions.

An analogous process exists in the civilian sector in the National Weather Service and the National Centers for Environmental Prediction at the National Oceanic and Atmospheric Administration. The process is highly rigorous, with review panels, committees, and well-documented steps. Shortcomings in operational models are dealt with through aggressive programs to fund and develop new generation models as part of the process.

High stakes are involved in the accuracy of these models—defense models deal with national security issues and weather forecasts with safety and economic impacts. The results affect human or political conditions. Consequently, society provides the resources and intellectual talent to improve them. It is time for society to decide whether the stakes are now equally high in the health of fish

stocks and marine ecosystems.

It is tempting to examine approaches that separate the research and management functions in a regulatory agency, removing the research from short-term demands and the vagaries of politics. The danger, however, is that the research may become less relevant or responsive to the needs of management. The Navy's approach to research and operational model development has potential applicability. Short-term research dictated by operational needs exists side-by-side with long-range research meant to improve how the work is done.

With marine fisheries in crisis, marine ecosystems need to be protected while multiple uses are preserved, requiring significant new resources. NOAA proposed a budget initiative called the Stock Assessment Improvement Plan (SAIP), which has strong support and includes several steps known as Tiers of Assessment Excellence. Tier one will improve assessments using existing methodologies; tier two will elevate all assessments to a nationally acceptable level; and tier three will develop next-generation assessment models to incorporate ecosystem considerations and environmental variability.

The content and intent of SAIP are appropriate, and there is no shortage of ideas within the agency and elsewhere for improvements appropriate to tier three (Mace, 2000). The difficulty arises, however, in achieving tier three under budget constraints and in the face of compelling needs under tier one and tier two. The tiers represent, whether intentionally or not, a sequential time line or set of priorities. In the federal budget process, the lower priority items, such as tier three, are relegated to "out-year" budget initiatives. This leads to problems in developing and implementing new advances, particularly in a political environment.

The Problem of Implementation

Ecosystem-based management is not a new idea at the National Marine Fisheries Service (NMFS). From 1987 to 1989, NMFS launched an internal initiative called Ecosystem Monitoring and Fisheries Management. It included a formal "program development plan" complete with seven "large marine ecosystems." NMFS generated detailed plans for each ecosystem and presented the program to a combined meeting of representatives of the regional fishery management councils. The approach was not well received by this group, and all traces of this program disappeared, except for a few gray literature reports (Fougner and Boehlert, 1989), and individual efforts to keep the concept alive within the agency.

"Ecosystem-based management is not a new idea at the National Marine Fisheries Service (NMFS)."

Congress generated the next attempt at ecosystem-based management. The Magnuson-Stevens Fishery Conservation and Management Act required NMFS to establish an advisory panel to "develop recommendations to expand the application of ecosystem principles in fishery conservation and management activities." NMFS convened the panel and it produced a report, which the secretary of commerce delivered to Congress (NMFS, 1999). A clear plan to fund and implement the recommendations in the report remains to be developed through the

budget initiative process.

As a principal agency regulating marine fisheries, NMFS is a management agency with constituencies whose political agendas lead to fundamental conflicts. Frequent changes in NMFS leadership, new mandates, and changes in long-range plans also hinder progress in implementing programs.

"A Marine Ecosystem Commission, modeled on the pattern of the independent Marine Mammal Commission, could develop the requisite oversight of programs—including fisheries—that affect the marine environment."

Concluding Comments

The problems of fishery management defy simple solutions. Increased public awareness of the failings of fishery management is in part responsible for the rapid movement toward marine protected areas. Although increasing the number of protected areas is certainly recommended as a component of ecosystem management (NMFS, 1999), marine fisheries represent only part of man's use of the marine ecosystem. Numerous agencies impact the marine ecosystem, either through direct action, promulgation of regulations, or permitting authorities. A Marine Ecosystem Commission, modeled on the pattern of the independent Marine Mammal Commission, could develop the requisite oversight of programs—including fisheries—that affect the marine environment. Such an entity could become the driving force behind developing a comprehensive approach to marine ecosystem management.

References

Boehlert, G.W., and J.D. Schumacher, eds. 1997. Changing Oceans and Changing Fisheries: Environmental Data for Fisheries Research and Management. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-239.

Fougner, S., and G.W. Boehlert. 1989. Objective frameworks for ecosystem program planning in the Southwest Region. National Marine Fisheries Service/Southwest Fisheries Science Center Administrative Report, LJ-89-01.

Gulland, J.A. 1983. *Fish Stock Assessment: A Manual of Basic Methods.* London: Wiley.

Hjort, J. 1914. Fluctuations in the great fisheries of northern Europe viewed in the light of biological research. *Rapports et Procs-Verbaux des Reunions, Conseil International; pour I'Exploration de la Mer.* Mer. 20:1–228.

Mace, P.M., ed. 2000. Proceedings of the Sixth National Marine Fisheries Service National Stock Assessment Workshop. National Oceanic and Atmospheric Administration. NOAA Technical Memorandum NMFS-F/SPO-46.

Megrey, B.A., A.B. Hollowed, S.R. Hare, S.A. Macklin, and P.J. Stabeno. 1996. Contributions of FOCI research to forecasts of year-class strength of walleye pollock in Shelikof Strait, Alaska. *Fisheries Oceanography* 5:189–203.

NMFS. 1999. National Marine Fisheries Service. Ecosystem-based fishery management. National Oceanic and Atmospheric Administration. NOAA Technical Memorandum NMFS-F/SPO-33.

NRC. 1999. National Research Council. *Sustaining Marine Fisheries.* Washington: National Academy Press

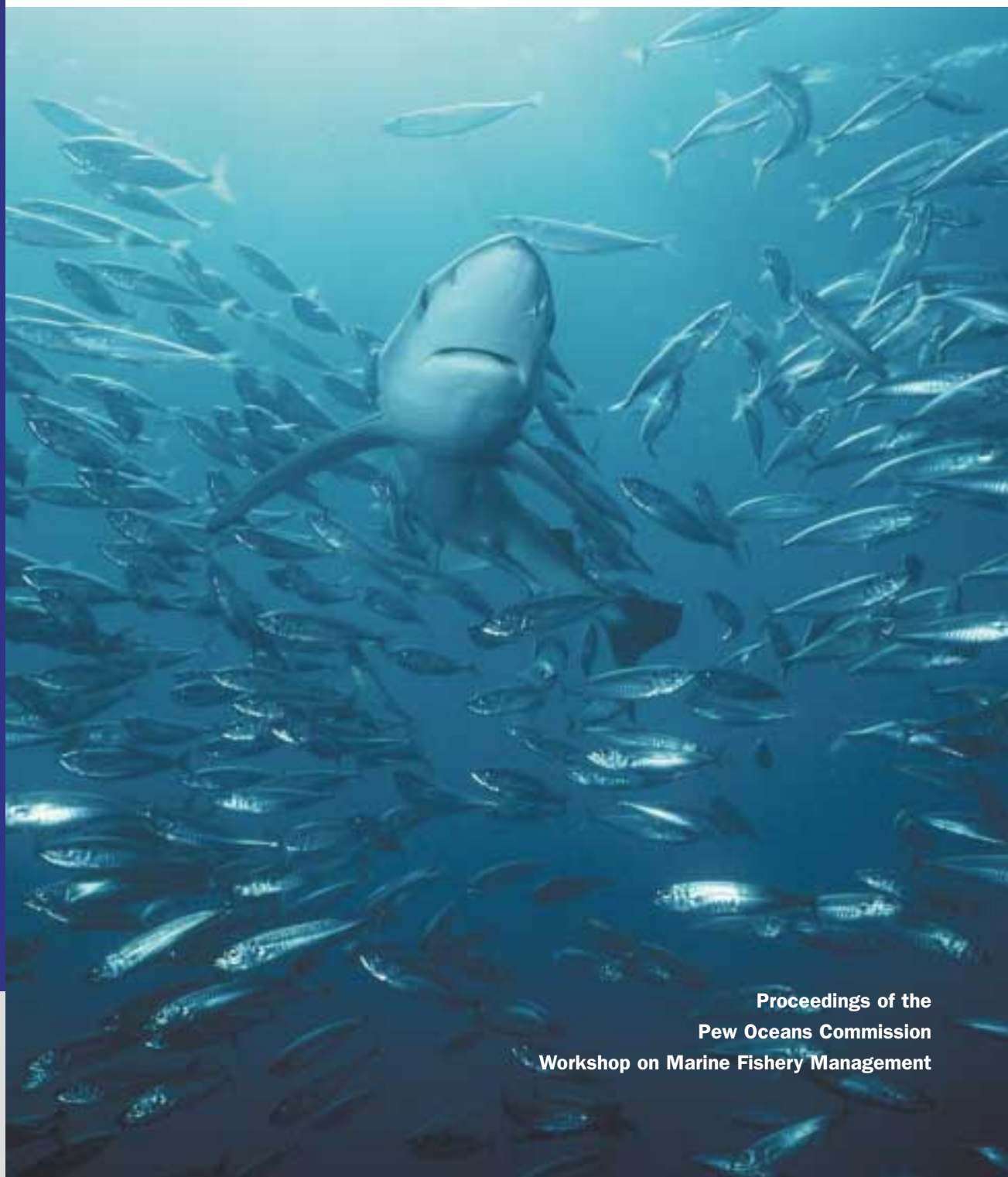
Parsons, T.R. 1996. Taking stock of fisheries management. *Fisheries Oceanography* 5(3/4):224–226.

Pauly, D., V. Christensen, and C. Walters. 2000. Ecopath, Ecosim, and Ecospace as tools for evaluating ecosystem impact of fisheries. *ICES Journal of Marine Science* 57:697–706.

Steele, J.H. 1996. Regime shifts in fisheries management. *Fisheries Research* 25(1):19–23.

Managing Marine Fisheries

IN THE UNITED STATES



Proceedings of the
Pew Oceans Commission
Workshop on Marine Fishery Management

PEW OCEANS COMMISSION

Pew Oceans Commission

Connecting People and Science to Sustain Marine Life

The Pew Oceans Commission is an independent group of American leaders conducting a national dialogue on the policies needed to restore and protect living marine resources in U.S. waters. After reviewing the best scientific information available, the Commission will make its formal recommendations in a report to Congress and the nation in early 2003.

The Pew Oceans Commission gratefully acknowledges the assistance of editor Scott Sanders of High Noon Communications, who prepared the workshop papers for publication. The Commission is also grateful to Scott Highleyman, who facilitated the Pew Oceans Commission Workshop on Marine Fishery Management.

The views expressed in the papers included this report and the interpretations of references cited in the papers are those of the authors.

Citation for this report: Pew Oceans Commission. 2002. Managing Marine Fisheries in the United States: Proceedings of the Pew Oceans Commission Workshop on Marine Fishery Management, Seattle, Washington, 18–19 July 2001. Pew Oceans Commission, Arlington, Virginia.

Pew Oceans Commission
2101 Wilson Boulevard, Suite 550, Arlington, Virginia 22201

Printed on 10% recycled paper.