DEVELOPING A COMPREHENSIVE COASTAL RESEARCH AGENDA

By Donald Scavia

ESTUARINE, COASTAL, and Great Lakes ecosystem issues should be at the center of environmental policy development because of the enormous economic and ecological benefit these regions provide to the country (NSTC, 1995a). Coincident with that attention, there should be a demand for improved data and information and an advanced understanding of how these ecosystems function and how human and natural processes interact to cause changes within them. However, for a variety of reasons, our community is instead faced with waning attention and shrinking budgets. Although there are probably a number of reasons for this, I believe that at least some of it results from problems generated by traditional piecemeal approaches to research and management and by lack of dialogue within and among the research and management communities. I would like to suggest ways to help overcome at least some of this problem.

The Need for an Expanded Research Scale

To begin, we should evaluate the scales of our research efforts. Traditionally, efforts have focused on the extremes of the research spectrum—investigator-initiated, fundamental research at one end and, at the other, mission-focused and mandated data collection. These efforts will remain important into the future because they form essential underpinnings for both science and management; however, they alone are not adequate for supporting newly emerging policy and management models, including those associated with the notions of sustainable development, integrated coastal management, and adaptive management (Lee, 1993; ESA, 1995). To remain effective, we should increase our focus on scales of research relevant to more comprehensive environmental management models.

As the decision-making community moves closer to these emerging management paradigms, our research must expand appropriately to ensure that the best scientific information is available at the right time, space, and problem scales. This expansion should occur in four dimensions.

Larger Spatial Scales

We must move to larger spatial scales because cumulative spatial impacts can and do override small-scale processes and individual actions. This requires working from watershed perspective, paying more attention to ocean-estuarine and land-sea interactions, and looking to "distant" impacts such as atmospheric transport and climate effects. An important component of this attention to larger scales is understanding and predicting how information and processes scale up from small plots and experiments to mesocosms, macrocosms, and natural systems.

Longer Time Scales

We must move to longer time scales because cumulative temporal effects can mask contemporary impacts. This includes understanding and accounting for historical drivers that often leave system memories, recognizing that expanded time scales are required for understanding and predicting the outcomes of restoration and recovery efforts, and working within adaptive management strategies that require a continuing need for science support. Working at longer time scales requires a recognition that long time-series data sets and monitoring within a research context (and *vice versa*) are essential to both effective management and comprehensive science agendas.

Multiple Issues and Multiple Stressors

We must increase efforts to address multiple issues and multiple stressors because cumulative drivers are more the rule than the exception. Stressors, both natural and anthropogenic, rarely act independently. We are only beginning to understand those interactions and management approaches that attack one issue at a time seem to be failing. A critical step toward managing multiple stressors is to develop an understanding of the "impact equivalencies" or "common currency" among stress effects that will allow for their cumulative assessment and prediction.

The Human Dimension

Environmental managers and policy makers recognize that the interaction between human and natural systems is two-way—people both produce ecosystem change and are influenced by that change. Environmental research, with its traditional focus on one-way interactions (i.e., understanding how people influence natural systems) has produced valuable information (and even predictions) on how altering human activities affects natural systems. However, because environmental management is more about altering human behavior than it is about managing ecosystems, failure to understand the interactions as two-way has left critical impediments to implementing effective policies, and it has weakened the links between science and management. In addition to understanding the effects of human drivers on natural systems, there is a need to increase efforts to understand how society responds to environmental change. Two important steps toward including the human dimension in our research are to develop quantitative, predictive information on the effects of ecosystem change and management options on human behavior, and to support advisory services that bring to the public results from both the natural and social sciences.

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Implementing Expanded Research Scales

Some aspects of each of the above expanded perspectives are employed in current research; however, significant advances in "scaling up" our assessment and predictive capabilities across all four perspectives require simultaneous full implementation in enough places to take advantage of, and learn from, comparisons and analyses across systems. This is an enormous task that requires new approaches, as well as new resources. In the following paragraphs, I suggest three powerful tools that can help us get from here to there. These tools are the powers of prediction, partnerships, and consensus.

The Power of Prediction

Being able to predict, with reasonable certainty and lead times, ecosystem and human impacts of policy options has the potential for reducing conflict within environmental policy debates, which are often polarized on ecological and economic grounds. In fisheries, for example, conservation interests tend to push for accepting the lower error boundary on stock assessments, while economic interests tend to push for the upper boundary. More accurate predictions (i.e., ones that reduce the error boundaries) effectively narrow the distance between extreme views and potentially reduce conflict.

Although producing such accurate predictions remains a significant challenge, the path toward prediction provides two important guidelines. The first guideline that is established within a prediction framework is a recognition that to make progress, one must include all the essential elements of a comprehensive science agenda. You can't get to a prediction endpoint without an appropriate balance among monitoring, process research, model development, synthesis, and data management, thus eliminating, for example, the false dichotomy between research and monitoring. The second, and perhaps more important, guideline provided within a prediction framework is that relevant predictive capabilities require an up-front analysis of what is to be predicted and why. This forces one first to understand management, policy, and decision-making requirements, then to cast appropriate scientific questions that lead to improved and relevant predictions. Within this policy-relevant prediction context, a research agenda can be formed that is still investigator initiated, intellectually challenging, and hypothesis driven.

The Power of Partnerships

Research at the scale described here cannot be achieved by federal, state, or academic scientists alone. Efforts that address fairly large complex problems require the diverse talents, perspectives, and capabilities of the best people from all of these sectors and, increasingly, fiscal support from more than one agency. Each sector brings its own perspective and strengths. For example, universities and federal and state agencies each have differing strengths among maintaining long-term monitoring and data bases, investigator-initiated process research, larger-scale project design, and model development. However, although effective partnerships must bring together researchers from all sectors, they must also go well beyond that. These partnerships also require interactions among scientists and policy makers and, as mentioned above, this interaction has to occur "up front," rather than after-the-fact, to ensure that appropriate science questions are being asked.

Although the need to provide data and information to address today's problems will always be pressing, the need for new information to support larger-scale policies requires a more deliberative approach than is traditional. One key for successful science/policy partnerships at this scale is to bring together researchers and managers to articulate management and policy questions that must be addressed in a 5- to 10-yr time frame and then to develop scientific questions that, when answered, should improve the basis for those longer-term management and policy actions.

Experiences throughout NOAA's Coastal Ocean Program suggest that projects with effective "prediction partnerships" seem to have the following attributes in common. They begin with an effective interaction between scientific and policy leaders to develop the long-range management or policy context within which appropriate science questions are defined. Their research strategies designed to address these questions are sufficiently long and adequately funded, have specific life cycles (i.e., a beginning, a middle, and an end) that define roles, responsibilities, deliverables, and measures of expected performance, and they encourage routine interactions among the scientists and the ultimate users of the information. They are open to investigators from all research sectors to compete for support in clearly defined, open peer-review processes. Most importantly, the projects are managed locally by strong leadership with the intellectual and managerial skills to integrate and synthesize results coming from a wide range of investigations and investigators.

The Power of Consensus

Our greatest challenge, however, is in attracting new resources to support this expanded scale of effort. Accomplishing this, while protecting the rest of the research spectrum, will require a unified voice that comes from forming a national consensus—endorsing it, pushing its agenda, and sticking by it. This approach has worked well for communities that have used it in the past. It could work here. To build such a consensus, we must move away from "fund in my backyard" or "fund my particular issue" approaches. These piecemeal strategies hurt the community because they cause divisiveness and unproductive competition among players, institutions, and regions. They are also relatively weak strategies in that they can only be as strong as the more narrow issues they address. That is, they lack the larger and stronger social and economic messages that can come from a unified argument for the coastal case.

Such consensus always helps in making strong cases for change, but in the present environment, any hope of diverting significant funds from other areas to estuarine, coastal, and Great Lakes research demands consensus among all coastal constituencies.

Developing a National Consensus

Consensus, of the type discussed above, is of three types—among agency science programs, among academic scientists, and among policy and decision makers. The ultimate challenge is to blend all three into a common agenda.

Significant work done within and across a number of sectors makes progress toward a unified agenda possible. For example, an initial framework for this consensus from the federal science agency perspective has been developed by the Subcommittee on U.S. Coastal Ocean Science (SUSCOS), which was formed in 1992 under the Federal Coordinating Council on Science, Engineering, and Technology. SUSCOS inventoried federal programs, reviewed agency priorities, and developed a framework for a new science direction. This framework was not built from whole cloth, but rather from a review and analysis of >50 government and

academic reports published between 1987 and 1993. The framework has just been rereviewed and endorsed by President Clinton's National Science and Technology Council (NSTC, 1995a).

The primary goal that emerged from that study is to establish improved predictive capabilities for coastal ocean systems that link physical processes, biogeochemical cycles, and the interactions of living marine resources. The report encourages approaches focused around four strategic issues: protecting coastal ecosystem health, sustaining use of coastal resources, protecting life and property, and ensuring national defense. It also highlights four integrating science priorities: advancing coastal and estuarine observation systems, building multidisciplinary prediction capabilities, improving how we manage and share data and information, and filling gaps in our understanding through process research in nine specific areas. The SUSCOS agencies are now focusing on developing ways to improve interagency cooperation and to develop joint efforts to implement this framework.

The academic community is also converging on consensus priorities. In response to a request from the Water Resources, Coastal and Marine Environments (WRCME) subcommittee of the National Science and Technology Council, the National Research Council's Ocean Studies Board has prepared a report on *Priorities for Coastal Ecosystem Science* (Boesch and Urban 1995; NRC, 1995). Although the NRC was asked to focus on ecological aspects of the coastal science agenda, they identified many of the same strategic issues and presented a set of priorities similar to those of SUSCOS: improving monitoring and observation systems, improving predictive capabilities, and improving the understanding of system processes. In comparing their priorities with those of the WRCME subcommittee (NSTC, 1995b) and of the nine regional federal, state, and academic teams convened under the Regional Marine Research Program (RMRP), the NRC identified significant common ground.

The National Sea Grant College Program has also recently released a network strategic plan (Sea Grant, 1995) representing their consensus on Sea Grant's priorities nationwide. This broad plan, with foci in areas of economic leadership, coastal ecosystem health and public safety, and education and human resources, includes priority areas consistent with those identified in the SUSCOS and NRC studies. Unique among the efforts cited here, the Sea Grant plan extends beyond monitoring, research, and prediction into important aspects of education and outreach.

These efforts, along with a new study underway within the National Association of Marine Laboratories (NAML, 1996) that is both moving toward a similar research agenda and exploring new ways to employ the extensive research infrastructure present in the marine laboratories, have clearly set a path toward a common research agenda.

Views are also beginning to converge on how to move forward on a common agenda. The Consortium for Oceanographic Research and Education (CORE) has built upon a 1992 NRC report on "Oceanography in the Next Decade: Building new Partnerships" (NRC, 1992) through its interagency partnership initiative that brought together representatives from government, academia, and industry. Although the study encompassed an oceanographic agenda broader than coastal (CORE, 1996), its recommendations to academia, executive agencies of government, and the U.S. Congress apply equally well to coastal and blue-water endeavors. Its focus on "how ocean science ought to be done, rather than on what should be done" makes it an important complement to the reports cited above on priorities.

Next Steps

It appears that federal science agencies and the academic community are converging on a common research agenda. We should take the final steps necessary to articulate a single set of clear priorities. But that will not be enough. Although coastal managers and policy makers were involved to varying degrees in the converging priorities developed by SUSCOS, NRC, WRCME, RMRP, Sea Grant, and NAML, they must now be more formally engaged in the process. We should take the converged set of research priorities (defined from our perspective) to the management and policy communities and be prepared to blend it with their perspectives and modify it as necessary to win their endorsement.

In doing so, we should be able to convince those who allocate scarce resources that they can confidently support research that truly addresses regional and national priorities that have been developed and endorsed by both the science and management communities. We will speak with a clear and compelling voice that recommends efforts that link appropriate scales of research to comprehensive policy development and that will be cost-effective by virtue of employing effective partnerships at all levels. By acting together in this way, the community can make an enormous contribution not only to enhancing its ability to perform important work, but also to continuing the pursuit of sustaining our precious estuarine, coastal ocean, and Great Lakes resources.

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References

Boesch, D.F. and E.R. Urban, Jr., 1995: Priorities for coastal ecosystem science—a review. *Oceanography, 8,* 97–99.

Consortium for Oceanographic Research and Education (CORE), 1996: *Oceans 2000: Bridging the Millennia. Partnerships for Stakeholders in the Oceans.* Consortium for Oceanographic Research and Education, Washington, D.C.

Ecological Society of America (ESA), 1995: *The Scientific Basis for Ecosystem Management.* Ecological Society of America, Washington, D.C.

Lee, K.N., 1993: *Compass and Gyroscope. Integrating Science and Politics for the Environment.* Island Press, Washington, D.C.

National Association of Marine Laboratories (NAML), 1996: *Roles of Coastal Laboratories in the Implementation of the Nation's Emerging Priorities for Research in the Coastal Zone.* Workshop Proceedings, Horn Point Environmental Laboratory, Cambridge, MD.

National Research Council (NRC), 1992: *Oceanography in the Next Decade: Building New Partnerships.* National Academy Press, Washington, D.C.

National Research Council (NRC) 1995: *Priorities for Coastal Ecosystem Science.* National Academy Press, Washington, D.C.

National Science and Technology Council (NSTC), 1995a: *Setting a New Course for U.S. Coastal Ocean Science.* National Science and Technology Council, Washington, D.C.

_____, 1995b: *Preparing for the Future Through Science and Technology.* National Science and Technology Council, Washington, D.C.

Sea Grant, 1995: *Sea Grant's Network Plan, 1995–2005.* National Sea Grant Program Office, Silver Spring, MD. ❑