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SCIENTIFIC INPUT TO COASTAL MANAGEMENT AND POLICY: THREE MODELS OF COMMUNICATION

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Introduction

Environmental policy-makers need scientific information to aid them in the decision-making process. Decisions concerning natural resource management and use should be based upon a clear understanding of the dynamics of natural systems, to ensure their effectiveness in the long-term (NRC, 1992). This is especially true for coastal ecosystems which are characterized by complex biological and physical interactions and subjected to increasing human pressures as coastal populations grow (NRC, 1995). Scientists have a responsibility to ensure that policy makers and resource managers have access to the best coastal science information available (Baird, 1996). That means not only supplying information but also communicating the relevance and implications of scientific findings to non-science audiences.

In the past, resistance from both sides has limited the use of scientific information in decision-making. Scientists and mangers worked within cultures that had very different concepts and understandings of natural systems. Management decisions were often based on deterministic models of nature that assumed direct, linear relationships between human impacts and natural responses. Research that suggested greater complexity was seen esoteric, irrelevant, and not applicable to the 'real world' in which managers worked (Boesch and Macke, 1995; Baskerville, 1997). Most scientists, on the other hand, had little interest in studying human-impacted systems and sought out 'pristine' environments in which to conduct their research (Pulliam, 1997). They regarded applied science as some sort of lesser intellectual endeavor that reaped few interesting insights or rewards (Boesch and Macke, 1995).

These views have been changing in recent years. As managed resources continue to decline worldwide and standard management practices have had limited success in stemming this trend, many managers and policy makers are looking for ways to use scientific understanding in the design of management tools. This new interest in science and especially in research is reflected in the development of strategies such as ecosystem management, sustainable development, and adaptive management, and the recent focus on cumulative impacts. Scientists are changing their attitudes as well. Today there are few, if any, natural systems that remain completely untouched by human influence and thus, the study of human-induced change has become a fact of life for many scientists whether intentional or not. In many disciplines, this reality is driving a shift towards a paradigm that considers humans as part of, not apart from, natural systems and new techniques are being developed that reflect this understanding. Finally, after complaining for many years that the debates over environmental issues were not scientific enough, more and more scientists are looking for ways to become involved in these important public policy issues.

The polarized attitudes of both policy makers and scientists have also been changed by the important insights and societal awareness that have come from applied efforts such as monitoring and from basic research results that have led to unforeseen practical applications of societal benefit. The long-term records of atmospheric carbon dioxide that have furthered our understanding of climate change are an excellent example of the former, while the basic research on ozone that unexpectedly led to a global ban on chloroflurocarbons (CFCs) illustrates the latter.

The Scientific Process

The integration of science into policy means more than just injecting scientific information at various points in the policy process. Science can play an important role in shaping the policy process itself (Knecht, 1995). Policy and management can also have an important role in the scientific process, although interactions between scientists and policy makers appear to be more effective during some stages of the process than others. For the purpose of this discussion, we can identify three stages in the scientific process. First, the question is defined. This should usually involve understanding the management and policy issues at hand, identifying gaps in the existent knowledge base, and designing a research program to address those questions. Next, research is conducted and data are collected and analyzed. Third, the information is communicated to others.

The second stage comprises the actual research effort. Although changes in stages one and three might affect what research is done and how the results are presented and utilized, it is our contention that the scientific community should carry out stage two, through tried and true scientific methods, without significant interaction with managers or policy makers. Political or social relevance is not an excuse to diminish the rigors of scientific scrutiny; including peer review, competitive approaches, and dissent. On the contrary, as environmental policy debates become more political and polarized, it is crucial that the science upon which it is based is clear, objective and of the highest quality possible.

The first and third stages, however, represent the input to and output from the research process. These stages comprise the interface between science and the non-science community, and therefore, offer the most promising opportunities for interactions between science and policy. In the first stage, scientists, policy makers and the public can work together to identify critical issues, prioritize information needs, and define appropriate scientific questions to address those needs. During the third stage, scientists can facilitate the incorporation of science into environmental policy by communicating their results to a broad audience, making clear the implications, limitations, and uncertainties of their findings.

Models of Communication

The effectiveness of the communication of science to decision-makers and its translation into policy appears to be influenced by both the nature of the questions being asked and by interactions among the scientists, managers, and the public. These factors, in turn, are influenced by the means by which the relevant information is delivered to stakeholders outside of the scientific community. Based on almost a decade's experience of attempting to provide the highest quality science to policy makers in time for important coastal management decisions, we at the Coastal Ocean Program (COP) have identified three models which describe the ways that science informs those decisions: the packet model, the diffusion model, and the triangulation model.

The Packet Model

The most common form of information transfer occurs through the packet mode. It is a method whereby scientific information is gathered into a 'packet' and distributed to interested parties after the relevant research has been completed. The packet model is characterized by an information product, typically a report or a CD-ROM. It is the most common means of scientific communication, in part because it is the easiest and least costly method of distributing information. Another reason for its popularity is that it is the mode that scientists use to communicate amongst themselves, and thus it is the mode with which most are familiar and comfortable. To effectively employ this method to communicate with policy makers and the public, however, it is important to present the material in a form that is accessible and relevant to a non-technical audience.

COP has employed the packet method with its Decision Analysis Series (DAS). This Series consists of reports that synthesize existing information on topics that have been identified as high priorities for coastal managers. The development of DAS reports occurs through a three-step process. First, a list of critical topics is compiled through a survey of coastal resource managers, and a multi-disciplinary panel of technical experts prioritizes the subjects. Next, proposals are solicited to conduct the research for the reports and principal investigators are selected through a rigorous peer-review process. Finally, the resulting summaries are peer-reviewed and compiled into a format that is accessible to scientists and non-scientists alike. To date, COP has published ten DAS reports on topics ranging from techniques for the economic evaluation of coastal resources (Lipton, et al., 1995) to the prevention and mitigation of harmful algal blooms (Boesch et al., 1996). These reports were prepared in response to an identified information need and thus they have been very well received. Over eleven thousand copies have been distributed, primarily in response to individual requests. Most of the titles have been reprinted, some for the fourth or fifth time.

The Diffusion Model

The diffusion model describes the exchange of information that occurs among scientists, policy-makers and the public within an ongoing management context, such as a regional council established to manage fisheries or watershed resources. It is characterized by a process. Under this model, the exchange of information is not an end in itself, nor is it unidirectional. Instead, information is transferred among the parties throughout the process, via a dynamic and ongoing 'conversation'. Because scientists and policy makers are engaged in a continuous dialogue, science both informs and is shaped by the policy development process. This leads to co-evolution of the science and management of the system.

The Coastal Ocean Program is exploring this model by including more stakeholders in its research management. COP projects tend to be fairly large-scale, with 5-6 year life cycles. To increase the flow of information from science to policy during that life cycle we have tried to create innovative project management structures that encourage and facilitate effective interaction. These structures bring scientists, managers, and other stakeholders together to define critical issues, prioritize information needs and define appropriate scientific questions.

The science and management of the fisheries on George's Bank offers an example of this process. Dramatic changes have occurred in the George's Bank ecosystem. Over the last decades, this system has gone from one dominated by commercially important cod and haddock to one dominated by skates and dogfish. After the closing of the commercial cod and haddock fisheries, managers recognized a need to look beyond traditional single-species approaches in developing the recovery plan. Science played an important role in that realization and in the development and adoption of the multi-species called for in Amendment 7 of the New England Fishery Management Plan. A significant portion of the scientific information which encouraged that transition 'diffused' from fisheries research supported by the NOAA COP because, at least to some extent, of the structure of the research/management approach. COP-funded researchers working on George's Bank are directly involved in the New England Fishery Management Council (NEFMC) which is responsible for managing the groundfish recovery. As those scientists were developing multi-species models as part of the COP project, they were also advising the Management Council and the insights they were gaining just naturally flowed from the research side to the management side.

We are experimenting with other ways to involve a broader range of stakeholders in the routine aspects of research and research management. In a coastal habitat project in Oregon and Washington, a representative from Oregon's Coastal Zone Management Program has been included on the management team in hopes that greater interaction between the researchers and managers will encourage communication between the two communities. In the Chesapeake Bay, COP is supporting a cumulative effects project with investigators that are intimately involved in the science advisory structure of the Chesapeake Bay Program. Along the Georgia/South Carolina coasts, COP is initiating a land-sea interface project that brings together academic and state scientists with state coastal managers in both program design and implementation.

In each of these cases, the actual research continues to be peer-reviewed and high quality. But, in addition, the projects involve research and research management structures designed to increase the interaction among stakeholders and enhance the diffusion rate as a routine part of doing business

The Triangulation Model

At times, issues emerge from research and modeling that the managers and policy makers don't hear, or simply can't find the time or resources to address. In these cases, direct communication, whether through packets or diffusion, doesn't make the appropriate impact. In this mode, information is communicated to policy makers and managers via a third party - the public.

The triangulation model is characterized by an issue. In the course of their research, investigators discover some environmental problem that catches public attention. The public demonstrates their interest and concern by bringing the information to the attention of policy makers, creating the need for an appropriate policy response. It is the demonstration of the public's interest and concern that makes an actionable environmental issue out of the relevant scientific findings. Concerned scientists can facilitate this process by communicating their results directly to the public, increasing the likelihood that their information will be heard and understood.

The triangulation model can be illustrated by the development of Gulf of Mexico hypoxia (low-oxygen conditions) into a national issue. Since the mid-1980's, researchers have documented a growing area of hypoxia that appears in the Gulf of Mexico each summer. This area, known to local fisherman as the "dead zone", threatens the viability of one of the nation's most productive fisheries. In 1989, COP launched its first field effort, the Nutrient Enhanced Coastal Ocean Productivity (NECOP) Program to study this problem. Dr. Nancy Rabelais, who has been studying the hypoxic zone since 1985, was one of the researchers funded under NECOP. Every summer she conducted research cruises across the Louisiana shelf to document the shape and areal extent of the hypoxic zone. Results from other NECOP studies have confirmed that the hypoxia is largely driven by the more than more than one million tons of nutrients that make their way into the Gulf of Mexico each year via the Mississippi River system (Rabelais et al., 1995). Early on, COP attempted to communicate the implications of NECOP research to policy makers and managers using the diffusion method. Key researchers and program managers sat on appropriate Gulf nutrient strategy teams and committees. In spite of this, policy makers and managers did not show much interest in the issue.

After receiving inquiries about her work from local environmental groups, Rabelais began to send press releases to local and regional newspapers following each summer's research cruise. This information helped to increase public awareness and understanding of the hypoxia problem. In 1993, record floods roared through the Mississippi River basin. That summer the hypoxic zone doubled to more than 7,000 square miles, and has returned to that size every summer since. This dramatic shift in the system served as a major focusing event. While the local press had been covering the annual survey of the hypoxic zone, the flood and the subsequent doubling of the area of hypoxia caught the interest of the National press and a segment of the general public. In 1995, the Sierra Club Legal Defense Fund responded to the public's growing concern. Armed with information like that from Rabelais' studies, the Fund petitioned the Environmental Protection Agency (EPA) and the State of Louisiana, on behalf of eighteen environmental, social justice and fishermen's organizations, to convene an interstate management conference to address the implications of the hypoxia problem (Samet, 1995). In December of 1995, the EPA convened a hypoxia management conference under the auspices of the Clean Water Act in December of 1995 to begin a strategic assessment of the issue.

The participation of research scientists in public fora and the publication of relevant scientific findings in both the scientific and popular literature heightened public interest in hypoxia. The persistence of Dr. Rabelais in presenting her results to the public helped to raise the issue to the level of a national priority. As a result, efforts are currently underway by the White House Committee on Environment and Natural Resources (CENR) to conduct a first-ever-integrated assessment of the causes and consequences of Gulf hypoxia. Thus, this triangulation has come full circle and opened the door to more effective use of the other models. The CENR Assessment process, an example of the diffusion model, will bring together scientists and policy makers in an attempt to address the hypoxia issue. The goal of the assessment is to synthesize current scientific information from the top of the watershed to the bottom of the Gulf into an information packet that policy makers and managers can use to evaluate options and design solutions to the hypoxia problem.

The Role of the Public

In these days of emotionally charged environmental battles and multiple stakeholders, it is critical that scientists make every effort to ensure that the best scientific information finds its way into the policy process. Because public interests are at stake and environmental policy decisions often involve the public good or aspects of the public trust, scientists must learn to communicate their research goals and findings not only to managers and policy makers but directly to the public as well. As illustrated by the triangulation model, public stakeholders, often through non-governmental organizations, play an important role in determining which scientific findings are raised to a policy. This has been demonstrated in regard to other coastal resource issues. Boesch (1995) attributes the Chesapeake Bay region's ongoing success in developing restoration strategies to the long history of scientific investigation in the bay (including basic research and monitoring) as well as strong public and political support for restoration efforts. Malone (1993) contends that public participation was an "essential ingredient" that facilitated interaction among scientists and managers in the Chesapeake Bay area. Without the participation of informed representatives of public interests, adaptive management programs designed to sustainably manage large ecosystems cannot succeed (Lee, 1993). For restoration efforts to be sustainable over the time periods needed to see results, these programs must have constituencies that support them (Olsen, 1993; Baird, 1996). Finally, Scavia (1997) noted that developing and supporting a comprehensive research agenda for coastal areas requires attracting new sources of financial support. In these days of shrinking budgets, an expanded research effort is unlikely to attract scarce financial resources without public interest and endorsement.

Conclusions

Providing scientific information and advice to managers and policy makers is becoming more important as they are called upon to deal with increasingly complex and technical issues concerning natural resources. Here, we have outlined three models for this critical communication. It is important to note that different models are effective under different circumstances. The packet mode is most useful when the target is already interested audience in need of more detailed information. It may not be an effective way to increase awareness of an issue or get quick policy action. Those situations that benefit from the continued influx of scientific information over time, such as an adaptive management regime, may be best served by the diffusion mode. Diffusion can be blocked, however, by the deaf ear of someone too busy with today's issues to deal with preventing tomorrow's. As the triangulation model illustrates, there are times when even the best science cannot move an issue forward and it takes a third party to sound the warning bell. Thus, it is important that scientists learn to communicate not only with policy-makers and managers, but with the general public as well.

There are no cookie-cutter solutions to communicating at the science-policy interface. It takes patience, a willingness to make it happen, and an understanding of which tools are needed when. When it succeeds, the infusion of timely, relevant scientific information into the policy process can have a cascade effect, creating the need and desire for further understanding on the part of policy makers and the public, encouraging research in policy-relevant areas, and leading ultimately to the development of scientifically-sound environmental policy.

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