Translating Science into Management:

Challenges and Opportunities for the Coastal Community

Coastal States Organization
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COASTAL STATES ORGANIZATION (CSO) – SCIENCE TO MANAGEMENT INITIATIVE

This paper is the first in a series of three reports which examines the relationship between science and management in the coastal zone. This paper was undertaken as part of a multi-year project: the *CSO Science to Management Initiative*. The purpose of the Initiative is to bring together the ocean and coastal scientific and management community for the purpose of identifying and fulfilling research needs, sharing scientific findings, and improving communication.

This report examines the challenge of integrating scientific knowledge into public policy-making and outlines several factors to consider when linking science and management. The second report in the series, *Best Practices in Translating Science into Coastal Management,* documents practical examples and best practices on how science is being used to influence ocean and coastal management, and the final paper examines ways to improve the federal government's effectiveness at disseminating research to coastal managers. Electronic copies of each report can be found at www.coastalstates.org.

Since 1970, the Coastal States Organization has represented the interests of the Governors of the thirty-five coastal states, territories, and commonwealths on policy issues related to the sound management of the nation's coasts, oceans, and Great Lakes.

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INTRODUCTION

Science that provides insight into the causes, effects, and solutions to environmental problems is at the heart of adaptive ocean and coastal management and policy-making. While the past forty years have seen advances in the ways science is used to support public policy decisions, a number of inherent and discordant qualities between the scientific and policy-making processes and between the needs of scientists and resource managers have impeded the ability of science to fully inform decision-making.

Based on a review of recent literature and interviews with coastal resource managers, this paper examines five factors to consider when integrating scientific knowledge into public policy-making. The factors are:

- the limitations of science;
- scientific uncertainty;
- the importance of communication; and
- the role of politics and stakeholders.

LIMITATIONS OF SCIENCE

Today's perception of science underscores much of why science and policy often fail to intersect. Popular perception is that *science provides the best way to get at cause-and-effect relationships* so that we may understand the world well enough not only to make predictions about it, but to control and manipulate it (Steel et al 2004). In the *Nature of Scientific Thought*, Walker (1963) refers to a "philosophy of scientism," which asserts that all phenomena can be explained from a few basic natural principles. The problem with this perception is that it fails to recognize that science is a process without endpoints, a means by which each successive explanation of the world is subjected to further testing and refinement, where old theories are discarded and new ones accepted.

In fact, fewer than 25 percent of all Americans understand the true nature and limitations of science as a mode of inquiry (National Science Board 2000). A vast majority fail to recognize that: (1) science is limited to what is observable, measurable, reproducible, and universal; (2) science is limited by the structure of hypothesis testing (i.e., just because a hypothesis is proven not wrong does not necessarily make it right); (3) science strives to minimize, but can never wholly eliminate, bias on the part of the researchers; (4) science is in incapable of making value judgments; and (5) constant reexamination and reevaluation are the building blocks of science.

The scientific method is further limited by the scientists themselves, who must be objective not only about interpreting data but also about themselves, their values, their goals, and their intellectual methods ((White 1979) in (Thompson 1981)). Ironically, the debate over the function of science itself becomes philosophical when asked whether science alone has the authority to answer every question that might be asked "to the exclusion of all other areas of human thought and endeavor" (Thompson 1981).

Playing on popular perception, the needs of our system of public policy place a heavy burden on science. Public policy debate is typically shrouded in uncertainty and a lack of reliable information. Science is called upon to fill knowledge gaps and minimize or alleviate uncertainty. In the realm of environmental management, for example, science is needed to confirm perceived environmental problems, identify the causes of these problems, separate the sources, and provide the economic, statistical, and sociological justification for solutions. But such an objective reality, in which all aspects of an ecological system and the pathways to system recovery are completely understood, is nearly impossible to achieve.

Failure to understand and acknowledge the limitations of science can hinder consensus building, threaten credibility, raise apprehension and emotions, and generally make matters more difficult for both scientists and resources managers.

SCIENTIFIC UNCERTAINTY

The majority of environmental problems are so complex in origin that perfect knowledge is an impractical expectation. Inherently, incomplete knowledge leads to uncertainty in the decision-making process, and resources managers must have tools for managing this uncertainty.

One important task managers should undertake is working closely with scientific experts from related disciplines to keep abreast of the latest research findings and to avoid misinforming policy-makers and the public. When associated implementation costs are high, it is especially important that the resource manager or scientist consider how best to inform policy-makers about the limits of scientific knowledge and to communicate issues in the context of balancing risks.

One emerging tool for addressing uncertainty is the application of the precautionary principle and its basic tenets of transparency, inclusiveness, and accountability. The precautionary principle has become the hallmark of science in matters of public health and, increasingly, in matters of environmental health. The precautionary principle exists to protect people and the environment from future adverse impacts, emphasizing safety considerations when clear evidence of cause-and effect is unavailable. *Transparency* calls for science to be as unbiased as possible and to be forthright about what is known and unknown. *Inclusiveness* requires that all critical information be revealed and considered and that the costs of inaction be measured against the costs of action. *Accountability* insists that the risks to all classes and all races of society are exposed.

Under the high standards of proof of both science and public policy, precaution is not always possible (Tickner 2002). But under the right circumstances, the precautionary principle can prevent harm, even though the source and extent of harm are unproven.

THE ROLE OF SCIENTISTS IN RESOURCE MANAGEMENT

Scientists agree that every discipline has its own set of theories, methods, rules, etc., that must be followed, but there is a lack of consensus as to what role scientists should play in decision-making and resource management beyond conducting research, documenting and verifying results, and drawing conclusions based solely on those results. Concerns about scientific bias and the appropriateness of science-advocacy are at the root of the conflict.

Bias is defined as an inclination, predisposition towards, or prejudice (Oxford English Dictionary 1989); there are two aspects to bias that are relevant to scientists and their ability to contribute to management and policy decision-making. First, the choice of any profession is itself value-laden (DeStefano & Steidl 2001, Nielsen 2001). That scientists must financially support themselves imparts some bias into their day-to-day work (Norgaard 2002), and introduces the possibility that some scientists will inflate an issue to "get government grants or sell books," (Ehrlich 2002).

Second, there are biases that affect professional judgment. All scientists are conditioned by social influences and nonscientific values that "lead them to favor certain assumptions over others, and underlie the way they study ecosystems," ((Boyd et al 1991) in (Benda et al 2002)). Nielsen (2001) believes that scientists pursue truths, and they will never take a position on a scientific issue unless they are certain it is true. "In other words, scientists would rather be silent than wrong—they have a bias for inaction," (Nielsen 2001). Advocates, on the other hand, would rather be wrong than silent—they have a bias for action.

The issues surrounding science-advocacy are difficult to sort out, mostly because the meaning of the word 'advocacy' and the function of an advocate are interpreted in different ways. An *advocate* is defined as "one who defends, maintains, publicly recommends, or raises his voice in behalf of a proposal or tenet,"(Oxford English Dictionary 1989). According to this definition, the basic function of a scientist—to research, document, verify, and draw conclusions—does not cross into the realm of advocacy. But most scientists and resource managers believe that scientists also must play a role in the decision-making process. What that role should be and whether it crosses the line into advocacy and poses a threat to scientific credibility is debatable.

There are scientists who believe that they have a professional obligation and ethical responsibility to use their knowledge to prevent environmental harm (Blockstein 2002, Ehrlich 2002, Lovejoy 1989). Some say scientists should be free to speak their mind on relevant issues, as long as their opinion is "based on data, experience, and insight," (DeStefano & Steidl 2001), drawing the line at opinions formed from bias, emotions, or agenda. Scientists need to be clear about whether the information they offer is widely accepted in the scientific community or whether it stems from personal opinion (Ehrlich 2002, Nielsen 2001).

Contrary opinion asserts that all advocates are driven by emotion and passion about an issue that prevents them from remaining objective, and that there is no role for scientists as advocates (Kaiser 2000, Nielsen 2001). Those who hold this view tend to draw distinctions between advocacy and professional opinion and between advocacy and science that others do not. Nielsen (2001) explains that because of science's cautious approach towards finding truths, it "will seldom be a good basis for advocacy."

There are other factors to consider regarding how values and ethics limit a scientist's role in the decision-making process, but a more complete analysis of these issues is beyond the scope of this paper. The main message is that part of science's ongoing challenge is to minimize bias and to refrain from any sort of science-advocacy that jeopardizes its credibility, but still find meaningful ways to contribute to the decision-making process.

Adding to the challenge is the fact that no matter how impartial and factual scientific information may be, there is always the risk that the media will derail its credibility by skewing values and ignoring context for the sake of a more interesting story (Gregrich 2003, Marshall 1992).

Steel *et al.* (2004) recently published the results of a survey intended to ascertain various attitudes about science and the role scientists should play in the environmental policy-making process in the Pacific Northwest. This research found that scientists and research managers, above all others surveyed, were most critical about the scientific process and the perception of science as "all knowing" and they were less supportive of an advocacy role for scientists in decision-making. Scientists expressed skepticism about the policy implications of their own research and the role they should play in the policy process. The researchers learned that part of the reason why scientists are skeptical about their role in decision-making is because they fear their work coming under close public scrutiny and that, in turn, their role as "generators of 'objective' knowledge will be called into question."

Respondents from the general public and special interest groups, on the other hand, expressed greater confidence in the certainty of science and that science and scientists should play more formidable roles in policy decision-making. These findings reinforce the point that those who understand less about the true nature of scientific inquiry regard science as highly objective and are more inclined to believe science should be central to environmental decision-making. At the same time, these findings reinforce the general fact that scientists have credibility with the public.

COMMUNICATION IS KEY

As decision-makers, natural resource managers should monitor scientific trends and connect with scientific experts who can answer questions relevant to public policy debates in which they engage. Likewise, there is a growing need for scientists to present their research findings beyond traditional publications and to target their research on specific public policy issues. Both the Pew Oceans Commission (2003) and US Commission on Ocean Policy (2004) reports noted that mechanisms are lacking for effectively communicating scientific information in the field of coastal and ocean management.

Three common communication problems that can arise between scientists, resource managers, and the citizens they serve are outlined below.

Language

To the layperson that struggles through scientific discourse on television or in magazines, it is obvious that scientists need to do a better job of communicating in simple terms not only the results of their research but what those results mean to every day lives. In this way, important scientific findings can garner popular support, which in turn will fuel political support.

Language barriers can easily stymie policy-science discussions. Wiltshire (2001) describes policy advisers searching relentlessly for relevant research on the Internet but to no avail because the keywords that they associate with a current policy issue do not correspond with what scientists use to describe their research. If it is assumed that the research does not exist when in fact it does, then this is a disservice to both science and public policy.

For scientists, environmental problems are generally complex and there are no simple answers. Resource managers struggle with interpreting and integrating this complex information—often from a diverse array of sources and disciplines—to establish the most effective management goals and avoid further problems (Bosch et al 2003, Gregrich 2003, Weiss 2002). While it is unlikely that scientists can simplify the results of their research, better ways of presenting scientific findings in a less complex manner are needed (Norton 1998).

Relationships and Partnerships

While the duty of a scientist is to acquire knowledge, the resource manager must apply it. Applying knowledge can be a challenge for managers because it is not always clear what scientific findings are relevant to the problem at hand or where and in what form the information might be available (Bosch et al 2003, Gregrich 2003).

Moreover, scientific research is often carried out for purposes other than addressing current public concerns or management strategies, and as a result the scientific findings are not always useful for managers or politicians. Scientists have been criticized for overlooking public interest and the needs of decision-makers and for failing to "develop techniques and studies that can usefully inform policy discourse," (Norton 1998). What both scientists and managers need are opportunities for frequent exchanges in the form of programs and organizations aimed at bringing the two together for the purpose of sharing research findings and needs.

Information Technology and Data Sharing

Most research scientists strive to deliver accurate, high quality, and formally or informally peer reviewed data and analysis. But in this age of rapid scientific discovery, increasingly complex environmental problems, and expanding information technology, both scientists and managers must be mindful that the overwhelming pace and increasing ease of information exchange can bring into question the accountability and credibility of information.

The Internet, for example, serves as both an opportunity and barrier to communication. The Internet allows users to post and retrieve massive volumes of information on any topic imaginable. Information that is questionable, incorrect, and generated by unknown sources is as readily available as it is from the most reliable sources. False and unscientific information can engender mistrust in science and can be challenging to counter once considered popular 'fact'. When a reader is confident that the information source is reliable, however, the Internet is a powerful medium for sharing information.

One tool resource managers have identified to improve Internet information exchange is a central source of reliable on-line information that combines what is known about particular topics both from public policy and scientific research standpoints. With such a resource, particular attention will need to be paid to issues surrounding the comparability of data, data records (metadata), how data is being used, and who is using it.

COMING TO CONSENSUS: THE ROLE OF STAKEHOLDERS AND PUBLIC PARTICIPATION

Public gatherings where the technical information is complex, emotions are high, and the discourse is quickly polarized by a highly-charged "with-us-or-against-us" attitude are prevalent in natural resource management (DeStefano & Steidl 2001, Streever 2002). This is especially true in situations where the "credibility of the underlying science is either in doubt or inconsistent with stakeholder concerns" (Charnley 2000). Indeed public participation—the keystone of democracy—at times can seem to be more of a hindrance to environmental problem-solving than not. With this added complexity in mind, the study of human behavior - in particular self-interest, values, judgments, and ethics - becomes important and integral to understanding the role of science in decision-making.

Politics

There are a number of obstacles to integrating science into policy decision-making. On the most fundamental level, policy-making is not a pure form of empirical problem solving like science is, but rather a democratic and normative process that is fixed on multiple interests and stakeholders (Cahn 2003). While science plays a key role in advancing knowledge and awareness of an issue, ultimately it is citizens' self-interest and political bargaining that will drive decision-making. Simply stated, "if science is rational and democracy is non-rational, then there is bound to be conflict" (Cahn 2003).

Stemming from this fundamental discord are the political obstacles to applying scientific information to decision-making. High implementation costs and demands for behavior modification can make it difficult to mobilize decision-makers to act on what might be certain and undisputed scientific evidence of an environmental problem. Consider, for example, nonpoint source pollution (NPS). While science has linked NPS to a variety of land use practices, it remains politically problematical for resource managers and planners to develop land use policies to minimize the pollution because environmental impacts are only one factor considered in land use planning (IAGLR 2002) with short-term economic factors typically assuming greater importance. At the other end of the spectrum, resource management decisions are sometimes made for cultural and ethical reasons with limited regard to ecological or economic rationale (Boesch 1999).

Incorporating Stakeholder Values, Judgments, and Ethics

Environmental problems are commonly identified as being related to technological progress. Air pollution by fossil fuels, water pollution from industrial discharge, and the loss of agriculturally productive land, for instance, are problems commonly perceived to be the result of inadequate or improper technologies. Hazell and Wood (2000) claim a fundamental flaw in this perception, saying that it is "rather like attributing traffic accidents to the poor design of cars." Science alone cannot balance the interests of the people, and the bottom line is that as a free society we have choices. These choices involve values and judgments that are themselves not technical, but can have damaging repercussions. Value judgments are embedded in decision-making, and for this reason must be central to the overall assessment and application of available knowledge to solve a problem.

Ethical concerns for humanity and for other life forms motivate many people to be pro-active advocates in favor of, or against, a cause. Where do ethics come from? Ehrlich (2002) contends that the adaptation of ethical concerns is one of the most important outcomes of our ongoing 'cultural evolution', but explains that little is known about the factors that drive this evolution or how different and diverging attitudes emerge.

Schubel (1997) offers insight into the exercise of identifying an environmental problem and selecting the most meaningful course of action to solve it with a proverb that says, "If you don't know where you are going, any road will get you there." That is, only by knowing the desired endpoint, can there be greater success in environmental decision-making. But more often than not, this is not the case. Uncertain or ambiguous endpoints (or goals), he maintains, are the stronghold of politicians and bureaucrats. Determining an endpoint is an uphill battle, and the best way to get there is to uncover the environmental and social values and human uses that are deemed important (Norton 1998, Schubel 1997). According to Schubel (1997), this approach lets society, not science, set the goals. Then science can be used to help achieve those shared goals.

Other research supports the assertion that "democratic science"—science shaped by stakeholder values—provides the best means through which science can inform decision-making in the least confrontational manner (Charnley 2000). When properly implemented, stakeholder participation is a valuable tool for bridging gaps between science and policy. The key is in avoiding scientists resorting to an overly narrow science-based perspective and stakeholders to an overly narrow interest-based perspective (Cahn 2003).

Traditional Ecological Knowledge

One outcome of the 1999 United Nations World Science Conference was the need to make greater use of traditional knowledge of indigenous people in management and decision-making. This was further supported by recommendations made at the Second National Conference on Science, Policy and the Environment (National Council for Science and the Environment 2001), which advocated that traditional knowledge and western science should have equal footing in decision-making.

Traditional knowledge refers to information and beliefs held by historically non-technical societies concerning human nature's spiritual and material relationships with its environment (Kimmerer 2002). The use of traditional knowledge provides a "cultural framework for environmental problem solving that incorporates human values," (Kimmerer 2002) reducing some of the disparity among society's differing attitudes toward the environment. Unlike most scientific knowledge, traditional knowledge is generally qualitative and can frequently bring long-term perspective to the table. Kimmerer (2002) examines various benefits to incorporating traditional knowledge in the decision-making process: (1) it can provide early warning signs of environmental change and be a source of new models for predicting the impact of change, (2) examining a problem from a cross-cultural perspective provides insight into the cultural influences underlying behavior, (3) it increases opportunities for partnerships between indigenous people and scientists, and (4) it integrates both science and cultural concerns.

CONCLUSIONS

There are a variety of factors that must be considered to facilitate effective use of science in the coastal resource policy process. In particular, scientists and decision-makers should consider and must be mindful of the following.

- Scientists play an essential role in the policy process by advancing knowledge and providing objective information on issues. Be willing to accommodate science in decision-making and to become educated about the complex information that scientific research generates.

- A fundamental understanding of the limitations and uncertainty of science is necessary. Resources managers must have tools for managing uncertainty and learn to openly communicate about uncertainty and assumptions to build confidence in the decision-making process.

- Decision-makers should articulate to scientists what their research issues/needs are and what kinds of answers they hope science will provide. Ask that the science be communicated in a way that is purposeful and easy to understand.

- Scientists and managers need opportunities for frequent exchanges in the form of programs and organizations aimed at bringing the two together for the purpose of sharing research findings and management needs.

- Be certain to distinguish between the scientific and non-scientific considerations that are the basis for decisions.

- Recognize that scientific findings can be eclipsed by social, economic and political considerations; learn to communicate and balance the value judgments that must be made.

- Become familiar and make use of those organizations and programs aimed at bringing scientists and policy decision-makers together.

- Combine values, ethics, politics, and traditional ecological knowledge with other scientific information on particular issues as a means of enhancing science, grounding decision-making within the affected community, and building community support.

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