New Roles for Science in Environmental Decision Making: Discussion Paper

Prepared by The Keystone Center and the Center for Science, Policy, and Outcomes
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I. Introduction

This discussion paper emerged from a one-time meeting of the Study Group on Science and Environmental Decision Making in July of 1999. Funded by a grant from the Richard Lounsbery Foundation, the meeting was organized and moderated by The Keystone Center in collaboration with the Center for Science, Policy, and Outcomes.

The meeting was convened and the paper written in an attempt to focus attention on understanding and improving the role that science and scientists can and should play in society's efforts to protect and improve the environment. The limitations of science as well as the larger context in which environmental decisions are made were also an explicit part of the discussion. While the participants were selected with an eye towards involving a diverse set of perspectives and experience on the topic, with a particular focus on on-the-ground decision makers, all the participants were there as individuals and not as official representatives of their organizations. The groundrules for the meeting recognized this fact, and further specified specific comments or ideas would not be attributed to any one individual.

This discussion paper is the work product of Dan Sarewitz of the Center for Science, Policy, and Outcomes and Kevin Curtis and Paul De Morgan, both formerly of The Keystone Center. While it draws heavily from the discussion at the meeting, it also draws upon the expertise of the authors as well as discussions with several of the participants and invitees before and after the meeting. As such, this paper is not a meeting summary much less a consensus report approved by all the participants. Rather, it is an attempt by the authors to capture several of the ideas that arose out of the Study Group's deliberations that could lead to further action on this topic. Any

concerns or criticisms of the paper should be directed towards its authors, not the participants in the meeting.

The meeting itself was lively and the energy and insights of the participants demonstrates the importance of this topic and the desire of all to continue to improve the role of science in support of environmental decision making. We wish to thank the Richard Lounsbery Foundation for their support of the project as well as the participants for their contributions. Finally, we hope this paper conveys the spirit of the meeting and contributes to this very important dialogue.

II. Discussion Paper

A. The Changing Framework for Science in Environmental Protection

Over the past 30 years or so, the United States has implemented a comprehensive statutory and regulatory framework for protecting and preserving the environment, and for protecting the public against the impacts of environmental degradation. The rationale for this framework derives from many sources, but one of the most important -- and most legitimating -- is science.

Environmental protection in the United States is evolving in important and fundamental ways. Yet, the proper role for science in this evolving framework has yet to be defined. Previous reports dealing with federal environmental science have focused on three issues: 1) reforming administrative structure; 2) assuring scientific quality; and 3) delivering information products (for example, see Carnegie Commission, 1997 and 1992; National Research Council 1993; National Commission on the Environment, 1993). Here we address a different, but equally important issue: the need for compatibility between federal science agendas and the diversity of approaches -- many of them decentralized and adaptive -- that are emerging at the forefront of the next generation of environmental protection.

In support of its environmental framework, the Federal Government has created a significant, although highly disseminated, scientific enterprise. The federal research agenda is administered by several federal agencies including the Environmental Protection Agency, Department of Energy, National Oceanic and Atmospheric Administration, U.S. Geological Survey, National Science Foundation, and others, while the research activities are carried out at federal laboratories, universities, and the private sector.

Implementation of environmental statutes is traditionally done through centralized standard-setting; formal, agency-initiated implementation procedures; and judicial conflict adjudication processes. Much of the federal science effort has been organized to support this predominantly top-down system. Examples include determining health impacts of various air and water pollutants as a basis for national regulatory standards; evaluating ecosystem health by monitoring indicator species in support of the Endangered Species Act; and evaluating the acceptability of disposal sites for nuclear and other toxic wastes. Overall, the principal constituent for this science has been federal regulatory agencies, although the science also can play a central role in judicial proceedings.

This science-supported, centralized approach to protecting the environment and the public health has yielded considerable gains. Although robust, long-term indicators of progress are unfortunately not available, there is little debate that, absent the current framework, environmental conditions in the U.S. would be considerably worse than they are today.

Over the past 15 years or so, however, systemic weaknesses in the current framework have become increasingly apparent. Weaknesses are often attributed to lack of flexibility in the regulatory framework -- especially in its capacity to be responsive to new information, and to environmentally, culturally, and economically diverse conditions at the local level -- combined with the absence of extra-judicial remedies for dispute resolution. Indeed, the combination of regulatory rigidity and divisive litigation has often contributed to a breakdown in dialogue among those with a stake in a particular issue, and to political gridlock at the local, regional, and national level.

These problems are not unconnected from the way science is conceptually and organizationally linked to the top-down environmental framework. For example, the media-specific and hazard-specific nature of many federal regulations tends to be supported by disciplinary scientific programs aimed at providing an objective basis for decision making. Not surprisingly, disciplinary science has often been central in the political and judicial battles associated with implementation of regulations (for example, hydrologic modeling and nuclear waste disposal; species ecology and endangered species preservation; epidemiology and air standards for particulate matter). More broadly, science has been seen as a predictive tool that can guide management of complex systems as diverse as a forest, a marine fishery, or a toxic waste site. Yet frequently -- perhaps predominantly -- top-down management schemes for complex systems have failed to achieve desired goals (e.g., sustainability of forests or fisheries; certification of waste disposal sites; preservation of biodiversity), in part because of the inability of disciplinary science to provide generalizable rules for systems management. The point is not that science is responsible for failures of the framework, but that disciplinary science combined with top-down regulation and management approaches is not always a formula for success.

As problems with the framework have become increasingly apparent, alternatives have begun to germinate. These alternatives typically focus on creating enhanced flexibility and open political dialogue at the local level, by fostering the participation of diverse stakeholders with local interests and expertise in the problem-solving process, and by dispute-resolution processes that are less divisive, expensive, and formal than judicial procedure. The rise of civic environmental mechanisms such as regional watershed councils throughout the West are a concrete manifestation of these developments, as is the increased federal focus on ecosystem-based management efforts such as the Everglades, and Greater Yellowstone region. Overall, new approaches to managing environmental protection are focused around the challenge of developing workable political and administrative processes at the local and regional level (Knopman and Fleschner, 1999; Landy, Susman, and Knopman, 1999; and Knopman, 1996), rather than simply implementing federal regulations. A stark indication of the promise that such approaches may hold is the relatively positive response of stakeholders in the Puget Sound region to the endangered species listing of the Chinook Salmon. (For example, the Mayor of Seattle is reported to have said, "We're not here to save the salmon, the salmon is here to save us.") Such positive resolve contrasts markedly with, for example, the experience of the Pacific

Northwest in addressing preservation of the endangered Northern Spotted Owl, which has been corrosively divisive from the outset.

Other alternative approaches focus on increasing the flexibility various industrial sectors are afforded in complying with federal and state environmental laws. These approaches attempt to integrate multiple statutes and regulations, while providing a more comprehensive or holistic approach to monitoring and regulating compliance (e.g., EPA's Common Sense Initiative). Whether these programs also encourage a concomitant integration of potentially relevant scientific disciplines is still unclear.

Overall, the need for systems-level scientific understanding, rather than rigid, disciplinary approaches, is broadly accepted, at least in principle, by leaders of the environmental research community. Similarly, the idea that science can more successfully support adaptive, rather than rigidly prescriptive, approaches to environmental management is also gaining increased acceptance. However, the current federal environmental science enterprise, whose intellectual and bureaucratic structure grew up in response to a top-down, media-specific regulatory mentality -- may not be suitably organized to sufficiently achieve systems level understanding in support of flexible, adaptive, and devolved approaches.

B. A Brief Illustration: The Chesapeake Bay

The challenges now facing science in support of environmental regulation are vividly illustrated by the ongoing effort to restore and protect the Chesapeake Bay. The declining environmental health of the Bay has been known for decades, as documented both by scientific understanding and the direct experience of those who live near the Bay and depend on it for economic, recreational, esthetic, and spiritual sustenance. Deterioration of the Bay ecosystem has variously been attributed to thermal pollution, pesticides and other toxic effluents, and nutrients (nitrogen and phosphorus). In response, a succession of science-based regulatory approaches have been adopted, culminating in the First and Second Chesapeake Bay Agreements. A third, still more comprehensive Bay Agreement is now being forged, due in large part to the fact that the forty percent reduction of nitrogen and phosphorus committed to in the Second Agreement by the three signatory states (Pennsylvania, Maryland, and Virginia) is now widely recognized as not being sufficient to truly restore the Bay's water quality to levels necessary for living resources.

Evolution of the Bay restoration effort is characterized by increasing recognition that the problems of the Bay reflect complex interactions among cultural and natural processes that cannot be addressed by focusing on specific sources, localities, or pollutants. The breadth of participation in decision making has also widened progressively and now includes most of the major constituencies in the Bay watershed, from environmentalists to industrialists, farmers to oystermen, politicians to scientists to developers. Despite these changes -- and Chesapeake Bay is among the most -- if not the most -- battle-tested, long-term, science-based restoration efforts in the nation, the regulatory focus is still on reduction of single pollutants, and scientific perspectives still treat the system as one that can be modeled and prescriptively managed based on predictive research.

Continued problems with this approach are reflected, for example, in the challenge facing farmers who must comply with the nitrogen and phosphorus reduction requirements, while also

maintaining profitability. Achieving this balance can result in farmers increasing the size of their operations in order to gain economies of scale, which in turn increases material consumption throughputs that can undermine environmental and economic sustainability. Similarly, if farmers find their livelihoods jeopardized, they may oppose further restoration action, or even sell their operations to developers -- which leads to an entirely new set of environmental challenges. In this sense, monitoring and regulating a nutrient like phosphorus is a problem, not a solution.

The Chesapeake experience tells us that the nation's environmental challenges occur in a culturally, economically, and naturally dynamic system that cannot be directed in predictable ways by any single, top-down strategy, nor comprehended by any single disciplinary research program. The behavioral dynamics of farmers, for example, is an integrated component of the Bay ecosystem. The Bay experience highlights the value of including the broad array of stakeholders in the process of problem definition and environmental action, and the need for science to look at the Bay ecosystem in the most expansive possible light.

The role of science in this new view of environmental action cannot be to dictate a rigid trajectory of action, because such a trajectory cannot be foretold. Rather, science is a tool for assessing conditions and ideas, defining boundaries of "reasonableness," measuring progress, and charting alternative futures. In the words of University of Maryland environmental scientist Donald Boesch, "Science is a creative force that challenges us to be better."

The essential question, therefore, is this: how can federal science support environmental protection that is more flexible, more decentralized, more adaptive, more responsive, and ultimately more suited to the realities of a complex, pluralistic society whose vitality and future are intimately linked to the vitality and future of the environment that surrounds and sustains them?

C. In the Beginning, There was: The Problem.

The manner in which a public policy problem gets framed strongly determines future courses of action, the population of interested stakeholders, the range of relevant science, and the prospects of achieving desired and desirable outcomes. The U.S. experience in environmental policy indicates that problems have typically been framed too narrowly. Moreover, the disciplinary nature of much environmental science has contributed to this narrowness. Thus, Chesapeake Bay restoration is a problem of nutrient reduction; global climate change is a problem of carbon dioxide reduction; asthma in children is a problem of small particle reduction.

Hypothesis: We have been defining problems too narrowly. If an environmental problem is framed broadly, through discussions among potentially interested parties at an early stage in the political process, and including scientists, then problem definition will be more likely to encompass the perspectives of diverse stakeholders, view the problem in terms of an integrated systems, prevent the alienation of stakeholders later in the political process, and define a role for science that supports systems-level, adaptive approaches, rather than narrow, prescriptive approaches (cf. Commission on Behavioral and Social Sciences and Education, 1996).

Idea for Further Discussion: *Create an Independent National Forum to Define Emerging Environmental Problems.* As new environmental problems emerge, convene a nongovernmental

forum of relevant stakeholders to try to formulate an integrated problem definition. This definition will help inform political debate, policy action, and scientific research. The key here is to create a *formal* process. This contrasts diametrically with the current approach, which often moves from informal, political agitation to scientific programs aimed at problem definition (for example, U.S. Global Climate Change Research Program; National Acid Precipitation Assessment Program). A prime candidate for this process today is urban sprawl.

Idea for Further Discussion: *Consider implementing a quiet time for science during the problem definition and policy formulation process.* Policy makers and the public alike tend to view science as a source of definitive, authoritative answers that can provide a predictive foundation for action. Yet complex environmental problems rarely allow science to achieve such stability (Gunderson, Holling, and Light, 1995; Lee, 1993), and science often becomes embroiled in political debate that undermines its legitimacy and value. While science often brings public attention to environmental problems, once an issue becomes highly contentious it may be beneficial to explicitly minimize the role of science in the political process until a clear problem definition emerges and an adaptive approach to addressing the problem is accepted. Adaptive approaches do not require scientific certainty prior to taking action—in fact, they assume that such certainty cannot be achieved. Rather, adaptive approaches define a central role for science in monitoring progress toward predefined goals, redirecting action based on such monitoring, and refining goals based on interim results. Thus, in addressing complex environmental problems, it may often be preferable to designate a quiet time for science until *after* the problem is well-defined and *after* desired goals are identified through political means.

D. Adaptive Science

Neither federal environmental science nor the current regulatory system are well organized to support environmental action that is locally based, systems-oriented, and able to respond flexibly to changing conditions and evolving knowledge.

In general, federal environmental science is characterized by:

- disciplinary orientation;
- individual investigator research, or large research centers;
- intramural scientists working as civil servants, or academic scientists working under the tenure system;
- isolation from other stakeholders; and,
- institutional incentives that encourage the above.

An alternative approach to federal environmental science could emphasize the organization of interdisciplinary teams who work together for finite, defined time periods in developing and applying knowledge relevant to locally defined environmental problems. Research teams must work closely with stakeholders to: a) ensure that research is relevant to the evolving problem, and b) help stakeholders understand the value and limits of the science. Such teams are most appropriately mobilized in support of adaptive approaches to problems that have already been defined through a stakeholder-driven process such as the one recommended above.

Idea for Further Discussion: *Research administrators must move resources away from individual investigators and large centers, and toward interdisciplinary, problem-oriented teams.* Implementing this recommendation will be facilitated by the following:

1. To achieve necessary workforce flexibility, research administrators should increase emphasis on contracting with outside scientists, and decrease emphasis on maintaining or expanding permanent staff.
2. Research administrators should look for scientists with a demonstrated ability to work with scientists from other disciplines, as well as with non-scientists.
3. Research projects should be aggressively competed, to ensure quality.
4. Professional incentives such as salary and promotion must be realigned to draw scientists into this team-based, systems-oriented, problem-focused approach. Team-based researchers must be given sufficient resources to attend meetings, travel, and pursue other career-enhancing activities.
5. Mechanisms must be found to devolve federal research money to states. As environmental process devolves, so should scientific research. (In fact, the opposite appears to be happening: environmental science capabilities are becoming increasingly centralized in the federal government.)

Although increased federal science budgets might facilitate implementation of this recommendation, they are neither necessary, nor forthcoming. No one can claim that the current allocation of resources for environmental science is optimal, and science administrators have considerable flexibility for reallocation, especially over a period of several years. Resources can and must be redirected to support the team approach.

E. But Can it be Done?

The evolving framework for environmental policy emphasizes flexibility and diversity over rigidity and uniformity. The operational process that incorporates these qualities is called adaptive management. Adaptive management recognizes that successful policies will develop as part of a social learning process, and accepts the need for experimentation in order to learn what works and what does not. This means that uncertainty must be accepted as compatible with action, and that error must be a politically acceptable consequence of action. It also means that the role of science focuses on monitoring and generating hypotheses to guide future experiments.

But is this a reasonable vision for environmental protection and environmental science? Most environmental statutes do not successfully build flexibility and learning into their structure. (For example, even in the case of the Clean Air Act, which grants considerable local flexibility in devising action plans, those plans are still governed by the unrealistic expectation of science-based action in the context of centrally established regulations). Indeed, good laws are written so as to minimize ambiguity and flexibility; otherwise, they may be unenforceable. Moreover, comprehensive redesign of federal environmental statutes to make them more compatible with adaptive management is simply not a practical political option in the near future. (One of the prime obstacles to this option is the highly polarized nature of political debate over the environment, which is in part a product of the original, centralized framework.) Thus, most innovation must occur within the existing framework.

Another type of problem is illustrated by the Federal Advisory Committee Act (FACA). Although in many ways FACA is a crucial tool for ensuring openness in decision making, it has also had a chilling effect on the willingness and ability of federal scientists to meet with nonfederal scientists to discuss environmental issues. If the type of team-based approach to environmental science that we advocate is to be adopted, administrative and legal obstacles to intersectoral scientific cooperation will need to be overcome.

How compatible is the current federal environmental regulatory framework with the goal of stakeholder-driven, adaptive approaches to environmental problem solving? Indeed, is the goal of effective, enforceable law consistent *in principle* with adaptive approaches to environmental protection? These questions must be carefully and comprehensively addressed as part of any process to move toward a new generation of environmental protection and science.

Idea for Further Discussion: *Convene a meeting of policy makers, lawyers, political scientists, environmental managers, and environmental scientists to investigate the formal administrative, regulatory, and statutory obstacles to, and opportunities for, adaptive and decentralized approaches to environmental protection and science.*

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