Science, values, and biodiversity

Conflicts over biodiversity policy are fierce. Every proposal to protect habitat from development or to develop existing habitat has strong opponents and proponents. Some will argue that the economic costs of excluding development are too high; others will say that too much habitat has already been degraded and what habitat remains must be preserved. Scientists become frustrated when knowledge is ignored or displaced by rhetoric in public policy disputes. Why has the role of science been circumscribed? What can be done to make science more influential in public policy debates?

Some participants in these debates reject scientific analysis because it does not support their preferred policy option. Others disregard scientific results because the conclusions are uncertain. But much of the heat in biodiversity conflicts results from the way in which science is applied to policy and from unreasonable expectations about how much science can aid in making wise decisions. A new generation of scientific analyses of biodiversity issues raises anew the problems of how to best apply science to policy and how to design decision-making processes to use science most effectively.

In biodiversity disputes, the choice is usually about how to use a tract of land or how to manage an aquatic resource. Good science can suggest what will happen under alternative scenarios and thus provide critical insights for decisions about biodiversity. But to make a decision, policymakers need to know more than just what will happen; they must weight various outcomes—for example, job loss versus habitat preservation. Such tradeoffs are always based on values. Personal decisions require a comparison of personal values—weighing the various things that are important to the individual against each other (Stern and Dietz 1994). When a policymaker makes a decision for society, she or he is weighing the values of society as a whole.[1]

Several approaches aim to achieve scientific rigor in assessing the societal value of biodiversity. These methods try to push science further—that is, to quantify the values at risk in biodiversity policy. One approach is to estimate a monetary value for ecosystem services (Costanza et al. 1997, Daily 1997), considering both society's instrumental dependence on such services (e.g., for pollination, climate regulation, and nutrient cycling) and society's moral, spiritual, aesthetic, and scientific engagement with ecosystems. Another approach is to quantify "ecological risks"—that is, to estimate the probabilities of various adverse consequences to ecosystems and sometimes to combine them into a single risk indicator (Harwell et al. 1990, EPA 1992, 1996). In addition, there have been increasing calls to use benefit–cost analysis to assess the monetary value of policy options to society and thus suggest what choice to make (Arrow et al. 1996). Such benefit–cost analyses would translate all possible impacts into money, weight each impact according to the probability that it will actually occur, discount future benefits and costs relative to current ones, and then compare the overall aggregate benefits and costs of each policy option. This approach suggests that the ratio of benefits to costs is an appropriate metric for evaluating alternative policies. The hope for all of these efforts is that rigorous analysis will provide a sounder basis for integrating scientific information and values.

Such efforts can be informative. But they will not ultimately resolve conflicts because the analyses are grounded in judgments on which reasonable people may differ. Such judgments have to do with the nature of the policy question being considered (e.g., is it necessary to analyze a pesticide's effects only on human health, or should its effects on ecosystems also be analyzed?); with the most reasonable analytical assumptions to make when knowledge is incomplete; with the appropriate weights to give to different kinds of risks, benefits, and costs; and with the best way to interpret uncertain or conflicting scientific information.

In one view, such judgments are best made by scientific and technical experts; in this view, the judgments of nonscientists are irrelevant or distort analysis. Input from nonscientists becomes relevant only after the analysis is complete, for deciding how much risk to take or how much to pay for a benefit. However, this view misunderstands the nature of environmental conflict and places an inappropriate burden on scientific judgment. Indeed, five key characteristics of environmental policy problems make it advisable to use broadly based deliberative processes to guide and interpret scientific analysis. These characteristics are the following:

• **Multidimensionality.** Environmental changes and policy outcomes have

by Thomas Dietz and Paul C. Stern

[1]The relationship between personal values and societal values has long been the subject of scholarly debate. Standard economic theory defines societal value as the sum of the values to each individual, suggests that market prices reflect societal values under certain equilibrium conditions, and asserts that market prices and monetary values can be used as a means of making tradeoffs. But there are many criticisms of this view. For a lucid explication of the economic theory, see Freeman (1993) or Gouldner and Kennedy (1997). For introductions to the debate on these issues, see Dietz (1994) or Freeman (1992).

many effects, and the resulting impacts on things people care about are not distributed so that everyone gets an equal share of costs and benefits. To translate diverse potential outcomes into a common metric, such as money, assumptions must be made—but assumptions are always subject to debate. Furthermore, every policy produces losers who feel that their interests were undervalued in the analysis. If a tract of land is developed and biodiversity is lost, for example, those who profit are usually not the same as those who mourn the loss of wilderness, and what the winners gain is usually qualitatively different from what the losers lose.

- **Scientific uncertainty.** Science will always be uncertain. Indeed, scientists often face meta-uncertainty—we do not know how unsure we are or what we need to know (Dietz et al. in press). Although rapid advances in our understanding of ecosystem dynamics are being made, the current understanding is still primitive when compared with what is necessary to know to inform decision making.
- **Value conflict and uncertainty.** People differ in their values and therefore in the importance they attach to the different effects of a policy. One person's pristine wilderness is another person's vermin-infested swamp. Moreover, the criteria used to judge policies might shift as people learn about and reflect on how policies affect things they value (Fischhoff 1991, Payne et al. 1992, Dietz and Stern 1995).
- **Mistrust.** The government and corporations have a long history of error and even malfeasance around environmental issues. They are mistrusted and so, therefore, are their analyses (Freudenburg 1993, Slovic et al. 1993). The more complex and opaque the analysis, the more it will be mistrusted.
- **Urgency.** Waiting until scientific uncertainties decrease or until disagreements about values are resolved is not feasible in most biodiversity conflicts. Not taking action is a highly consequential choice. For example, delays in deciding whether to develop a tract of land may preserve biodiversity in the interim, but the delays have economic costs.

When conflicts have any of these characteristics, science alone—even aided by techniques for quantifying economic value—will not resolve conflicts. Decisions should be informed by processes that use the inevitable conflicts of judgments and values to help guide scientific analysis—that is, by procedures that encourage open examination and debate about value conflicts and uncertainties rather than burying them in methodological assumptions made by specialists, as often happens with cost–benefit analysis and ecological risk assessment.

We have long advocated approaches that combine scientific analysis with deliberation (Cramer et al. 1980, Dietz 1984, 1987, Stern 1991), and such approaches are recommended in several recent examinations of risk policy (Commission on Risk Assessment and Risk Management 1996, National Environmental Justice Advisory Committee 1996, NRC 1996, Maki 1997). We believe that these approaches have great promise in biodiversity disputes as well.

Analytic deliberation is structured discussion among scientists, decision-makers, and parties with an interest in a policy. The goals of the discussion are to define the problem to be understood, to identify the values and outcomes of concern, to distinguish disagreements that must be addressed through compromise and tradeoff from those that might be resolved with better information, and to agree on appropriate ways to collect and interpret the needed information. Analytic deliberation emphasizes people's ability to process language and develop mutual understanding and thus differs from the focus on efficiency in economic analysis (Dietz 1994). The appropriate design of the analytic–deliberative process is situation dependent, but a number of general principles can make it fair and competent (Renn et al. 1995, NRC 1996, Maki 1997). A brief summary of the main principles can illuminate the nature of analytic deliberation.

First, the deliberation should involve all perspectives that can offer insights into the policies under consideration. Scientists will have the best understanding of ecosystem structure and dynamics. However, environmentalists, business interests, and local residents may ask questions that require analysis but that have not occurred to scientists; they may also have special knowledge of local conditions or human habits that is essential for doing a credible scientific analysis. A good policy analysis needs both scientific expertise and community expertise—neither alone is sufficient (Dietz 1988).[2]

Second, the deliberation should begin early—when the policy and scientific questions are first being formulated—and continue in iteration with other forms of analysis until a decision is made. Conflict often arises because in the view of some stakeholders, the list of options being considered is too short, issues of great concern have not been adequately researched, or analysts have made assumptions that are unreasonable for local conditions. A continual feedback between research and deliberation ensures that the science addresses all issues of concern, that value discussions are well informed by the science, and that the science is accepted as relevant to the decision.

Third, the deliberative process must be carefully structured so that it promotes discussion, not posturing. Several methods can increase the ratio of light to heat in a deliberative process and encourage the emergence of clarity and trust. Although the specific process used must be designed with attention to the policy problem being considered, analytic deliberation builds on knowledge of small-group psychology and conflict dynamics to facilitate the interaction of scientists with stakeholders and others.

Fourth, deliberation does not need to produce a consensus or resolve all of the conflicts. The goal of analytic deliberation is to ensure that all relevant information and points of view are given fair consideration and to reveal areas needing more research. This research will sometimes, but not always, resolve conflicts; however, it

[2]And, of course, all parties to the discussion bring important perspectives on values. Scientists who have intimate familiarity with the species and ecosystems that they study have unique perspectives to add to the value discussion. For example, Kiester (1996/1997) has suggested that scientific understanding may lead to a connoisseurship of biodiversity that can greatly inform policy.

can usually clarify what the conflicts are about.

In analytic deliberation, science retains its essential role in building understanding. Science illuminates how each policy option may affect ecosystems and other things that people value, characterizes scientific uncertainties and scientific disagreements about these matters, and provides new information to reduce uncertainties and disagreements. Analysis and deliberation interact to ensure that science is directed toward decision-relevant questions and that deliberation is grounded in knowledge as well as in values. A major goal of the analytic–deliberative approach is to ensure that the best science is viewed with trust and understanding rather than with skepticism.

The analytic–deliberative approach therefore embodies a new relationship between policy science and its users. It recognizes that to make science useful for policy, many potentially controversial judgments must be made, and it calls on nonscientists to share the responsibility for making these judgments. It acknowledges that decisions about biodiversity must be informed by scientific research but cannot be determined unequivocally by analysis alone. It uses broadly based deliberation to guide analysis in situations in which judgment is necessary. It also uses deliberation to consider explicitly the value tradeoffs involved in decisions about biodiversity, thus leaving scientists less vulnerable to criticism on the grounds of overstepping their expertise.

Explicitly combining scientific analysis and deliberation is more realistic than relying on scientific analysis alone to inform policy. An integrated approach acknowledges that value and equity questions are as central to understanding policy choices as they are to actually making the choices. It recognizes that formulating and understanding a policy choice may require attention to several different perspectives and that self-conscious reflection and broadly based discussion can make scientific analysis more decision relevant and useful.

The analytic–deliberative approach seeks to gain for policy analysis two of the benefits of both normal scientific debate and the democratic political process: the ability to accommodate disparate points of view through civil, open discussion and the increased legitimacy that flows from such discussions. Of course, such deliberation may be criticized for also inviting the dissatisfactions of democracy—partisanship and delay. But most environmental policy, including biodiversity policy, is already fraught with these problems, without the complementary benefits of accommodation and legitimacy.

Many experiments with analytic deliberation are already under way. For example, some negotiated rule making in the Environmental Protection Agency and a variety of projects to manage local and regional ecosystems use combinations of analysis and deliberation to inform the decision-making process (e.g., Cortner and Shannon 1993, Harwell et al. 1996, NRC 1996). Of course, as with efforts to assess the value of ecosystem services, there are many questions yet to be answered: Who should participate? What constitutes adequate consensus in a deliberation? What should be done when the best approach seems to fall outside the authority of the agency conducting the deliberation? How can deliberation be shielded from social inequities in power?

It is not surprising that there are many open questions about how to implement analytic deliberation. Benefit–cost analysis has been the subject of research for over 50 years, risk analysis for almost that long. By contrast, analytic deliberation is in its infancy. Systematic experimentation with the approach can answer the outstanding questions and can aid in developing an important supplement to current tools for valuing biodiversity and making better decisions.

Acknowledgments

This work was supported in part by a grant from the US Environmental Protection Agency.

References cited

Arrow KJ, Cropper ML, Eads GC, Hahn RW, Lave LB, Noll RG, Portney PR, Russell M, Schmalensee R, Smith VK, Stavins RN. 1996. Is there a role for benefit–cost analysis in environmental, health and safety regulation? Science 272: 221–222.

Commission on Risk Assessment and Risk Management. 1996. Risk Assessment and Risk Management in Regulatory Decision Making. Washington (DC): Commission on Risk Assessment and Risk Management.

Cortner HH, Shannon MA. 1993. Embedding public participation in its political context. Journal of Forestry July: 14–16.

Costanza R, et al. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253–260.

Cramer JC, Dietz T, Johnston R. 1980. Social impact assessment of regional plans: A review of methods and a recommended process. Policy Sciences 12: 61–82.

Daily GC, ed. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Washington (DC): Island Press.

Dietz T. 1984. Social impact assessment as a tool for rangelands management. Pages 1613–1634 in National Research Council, ed. Developing Strategies for Rangelands Management. Boulder (CO): Westview Press.

______. 1987. Theory and method in social impact assessment. Sociological Inquiry 57: 54–69.

______. 1988. Social impact assessment as applied human ecology: Integrating theory and method. Pages 220–227 in Borden R, Jacobs J, Young GR, eds. Human Ecology: Research and Applications. College Park (MD): Society for Human Ecology.

______. 1994. "What should we do?" Human ecology and collective decision making. Human Ecology Review 1: 301–309.

Dietz T, Stern PC. 1995. Toward realistic models of individual choice. Journal of Socio-Economics 24: 261–279.

Dietz T, Frey RS, Rosa EA. In press. Risk, technology and society. In Dunlap RE, Michelson W, eds. Handbook of Environmental Sociology. Westport (CT): Greenwood Press.

[EPA] Environmental Protection Agency. 1992. Framework for ecological risk assessment. Washington (DC): Environmental Protection Agency. Publication no. EPA/630/R-92/001.

______. 1996. Proposed guidelines for ecological risk assessment. Washington (DC): Environmental Protection Agency. Publication no. EPA/630/R-95/002.

Fischhoff B. 1991. Value elicitation: Is there anything in there? American Psychologist 46: 835–847.

Freeman III AM. 1993. The Measurement of Environmental and Resource Values. Washington (DC): Resources for the Future.

Freeman DM. 1992. Choice Against Choice: Constructing A Policy-Assessing Sociology for Social Development. Niwot (CO): University Press of Colorado.

Freudenburg WR 1993. Risk and recreancy: Weber, the division of labor and the rationality of risk perceptions. Social Forces 71: 909–932.

Gouldner LH, Kennedy D. 1997. Valuing ecosystem services: Philosophical bases and empirical methods. Pages 23–47 in Daily GC, ed. Nature's Services: Societal Dependence on Natural Ecosystems.

Washington (DC): Island Press.
Harwell MA, Harwell CC, Weinstein DA, Kelly JR. 1990. Characterizing ecosystem responses to stress. Pages 91–115 in Cowling EB, Breymeyer AI, Phillips AS, Auerback SI, Bartuska AM, Harwell MA, eds. Ecological Risks: Perspectives from Poland and the United States. Washington (DC): National Academy Press.
Harwell MA, Long JF, Bartuska AM, Gentile JH, Harwell CC, Myers V, Ogden JC. 1996. Ecosystem management to achieve ecological sustainability: The case of South Florida. Environmental Management 20: 497–521.
Kiester AR. 1996–1997. Aesthetics of biological diversity. Human Ecology Review 3: 151–157.
Maki AW. 1997. A framework for assessing the value of ecosystems to humans. Paper presented at the annual meeting of the Society for Risk Analysis; 8 December 1997, Washington, DC.
National Environmental Justice Advisory Committee. 1996. The model plan for public participation. Washington (DC): Environmental Protection Agency.
[NRC] National Research Council. 1996. Understanding Risk: Informing Decisions in a Democratic Society. Washington (DC): National Academy Press.
Payne JW, Bettman JR, Johnson EJ. 1992. Behavioral decision research: A constructive processing perspective. Annual Review of Psychology 43: 87–131.
Renn O, Webler T, Wiedemann P, eds. 1995. Fairness and competence in citizen participation: Evaluating models for environmental discourse. Dordrecht (The Netherlands): Kluwer Academic Publishers.
Slovic P, Layman M, Clary BB. 1993. Perceived risk, trust and nuclear waste: Lessons from Yucca Mountain. Pages 64–86 in Dunlap RE, Kraft ME, Rosa EA, eds. Public Reactions to Nuclear Waste: Citizens' Views of Repository Siting. Durham (NC): Duke University Press.
Stern PC. 1991. Learning through conflict: A realistic approach to risk communication. Policy Sciences 24: 99–119.
Stern PC, Dietz T. 1994. The value basis of environmental concern. Journal of Social Issues 50: 65–84.

Thomas Dietz (e-mail: tdietzvt@aol.com) is a professor of sociology at George Mason University, Fairfax, VA 22030. Paul C. Stern (e-mail: pstern@nas.edu) is director of the Committee on the Human Dimensions of Global Change at the National Research Council, Washington, DC 20418. © 1998 American Institute of Biological Sciences.