Recreation Management Decisions: What Does Science Have to Offer?

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Introduction: Science and Resource Policy

The appropriate role for scientists and scientific knowledge in natural resource management decisions is hotly debated today (Tauber 1999). Some are calling for more science-based management, with a central and powerful role for scientists (Havens and Aumen 2000; Mann and Plummer 1999; Paul 2000). Scientists are often skeptical or critical of the public's knowledge of resource problems and processes and feel a need to educate and lead in problem resolution (Mackey 1999).

On the other hand, many scholars and managers have voiced concern about turning toward science for answers, arguing that privileging scientists (and/or a scientific process) in policy decisions denies the valid knowledge of other stakeholders or, what is worse, is undemocratic or deceitful (Sclove 1998; Dietz and Stern 1998). Despite their seemingly technical nature, resource problems are "social and political constructs" (Hisschemoeller and Hoppe 1995:43) that invariably involve judgments about what is desirable or appropriate. They involve questions of values, not only in selecting among alternative management regimes but also in the very process of deciding what to study and how to study it. According to Behan (1997:414), "management is as much a political enterprise as it is scientific." In recent years, many analyses have clearly exposed the myriad value judgments that underlie even the most seemingly "objective" scientific enterprises (e.g., Martin and Richards 1995; Tauber 1999; Wynne 1996, 1999).

Given the debates over "science policy" (as it is commonly termed) in natural resources generally, it is no surprise to see the same questions being debated in the context of carrying capacity or other recreation management decisions. It is important that we give careful attention to the question of how science should be used in reaching decisions about whether and how to manage recreation use. Many scholars offer advice about the place of science in resource decision-making. For example, Behan (1997:414) asserts that "science is necessary but not sufficient" for making effective decisions. Adams and Hairston (1996:27) echo this, arguing that "scientific information can be an essential part of the decision process, but alone it is insufficient to deal with complex and dynamic public issues." Unfortunately, many of these articles do little in terms of providing concrete advice about what specifically science is good for. In this paper I describe the characteristics of problems for which I think science is well-suited.

Before discussing the role of science, it may be useful to define what we mean by science. In this paper, I use "science" in its most traditional usage: as an endeavor to discover or articulate knowledge that is based in empiricism (and therefore strives for objectivity), rationality and logic, quantification, reductionism, and specialization (Behan 1997; Ozawa 1996). Whether (or how well) this description fits the reality of scientific enterprise is a matter of debate and disagreement (Tauber 1999), but nevertheless it is a definition with which we are quite familiar and with which most scientists still identify.

What is Science Good For?

Like others, I am convinced that science is critical to making management decisions that have some chance of succeeding in achieving their desired ends. Despite some notable failures, science has a proven track record in generating tangible outcomes and products that are unlikely to have been achieved through any other form of inquiry. In the pages below, I argue that the most appropriate and effective roles for science involve description, prediction, explanation, and assessment. I am certainly not alone in articulating a distinction between description and evaluation and arguing that the former, but not the latter, is the proper domain for science. For example, Freyfogle and Newton (2002:864) argue that the fundamental "aim of science is to describe nature and how it functions, rather than to pass normative judgment upon it."

Description. One important role for science is the discovery of knowledge that generates a new perspective on a phenomenon (Ozawa 1996). Because of their inquisitive nature, analytic skills, and access to technological equipment, scientists can develop understandings of phenomena that occur at spatial and/or temporal scales that exceed human sensory and perceptual abilities. A classic example is the discovery of the ozone hole (Ozawa 1996). In recreation, examples might include identification of noxious weeds carried by recreational visitors into remote wilderness areas or the description of improved human cognitive functioning after exposure to natural environments. In such cases, scientists may discover knowledge during the course of their basic research and not in response to any identified need on the part of managers. Of course, this knowledge may later be brought to bear on specific management issues.

Scientific research is particularly good at describing baseline conditions and the natural variability in phenomena that are of interest to managers and the public (Mackey 1999). Often, recreation decisions involve disagreements about the extent of some phenomenon. If all stakeholders agree about the nature of the data that would answer the question, science can help reach an acceptable resolution. For example, questions often arise about the effect of recreational use on water quality. Managers and scientists generally agree about the types of data that can be used to describe the extent of effects (fecal coliform, streptococci, nutrients), and scientific research is appropriate and often decisive in such cases. (It is important to point out, however, that deciding what levels of impact are acceptable remains a value judgment outside the sole purview of science.) Many mundane, but important, questions conform to this type—managers need information about recreational visitors and their impacts (How many are there? Who are they? What are they interested in? What do they know? Where do they go? What do they do?), which are questions science is well-suited to answer. Understanding baseline conditions through reliable, clearly articulated methods, along with estimates of natural variability, permits science to track changes over time in ways that are more accurate than reliance on human memory or intuition.

Science can describe the strength and nature of relationships among variables, assuming those relationships are amenable to quantification. A good example comes from work on recreational trampling effects on vegetation. Science has shown that the relationship is curvilinear and has identified the morphological and phenological characteristics of species that are susceptible or resistant to degradation. Such insights have been used by managers to justify recommendations about campsite management strategies. In another example, research in environmental psychology has shown that there are strong and consistent relationships between environmental characteristics (such as vegetation, terrain, or the presence of water) and visitors' aesthetic preferences or responses. Such findings have helped recreation managers design recreation sites and predict where visitors are likely to congregate.

Physical phenomena and processes are not the only things science can describe. Science can also be helpful in giving clarity and structure to identified problems and identifying areas of uncertainty and disagreement (Adams and Hairston 1996; Dietz and Stern 1998). Science can identify elements of a problem that has already been defined as problematic by stakeholders. In the example of vegetation impacts, if managers have targeted vegetation loss as an issue in need of attention, science can help identify aspects or dimensions of the problem, such as changes in species composition, alterations in soil chemistry that might perpetuate changes in vegetation, and so on.

Prediction. If we understand how variables interact, then we may gain insight into how systems will respond if variables are manipulated or change. Thus, scientific research can aid in the prediction of future events. Dietz and Stern (1998:441) point out that "good science can suggest what will happen under alternative scenarios." That is, it can define "paths and outcomes" (Adams and Hairston 1996:28). For example, recommendations for the appropriate management of human waste and sanitation on rivers and in wilderness areas have been based on prediction of the outcomes of different management alternatives given understandings about use density. Another case in point relates to predicting how visitors will react under different management regimes. Simulation modeling of recreational use patterns, based on an understanding of the variables that enter into a visitor's decision-making process, permits managers to model aggregate behaviors under different management scenarios. Many scientists feel this is an important role and are more comfortable evaluating the likely outcomes of management alternatives than in proposing or defending the alternatives themselves.

Explanation. One can predict without being able to explain why events occur. Science is, at least potentially, capable of both prediction and explanation. It can be used to design critical tests of competing explanations for observations, as long as parties agree on the criteria to be used, the design of the tests, and the interpretation of data (e.g., Havens and Aumen 2000). For example, in recreation management, there is argument about why visitors in crowded wilderness areas feel satisfied with their experience. Managers know that wilderness visitors seek solitude, and crowded conditions should be antithetical to achieving solitude. One possible explanation holds that people who are sensitive to crowding have been displaced, so that those who remain are simply those who are satisfied. However, an equally plausible explanation argues that people are satisfied because they don't care about crowding. Scientific research is perfectly poised to answer this question through visitor studies. Turning to a biological example, science can describe and predict what types of vegetation are impacted by trampling, but it can go further to explain the mechanisms by which such effects occur.

Causation. Typically, explanations of phenomena involve explicating causal relationships. Often, these are suggested on the basis of correlational designs, and therefore must be accepted with caution. However, if research is conducted through experiments, with controls and randomization, science can make definitive statements about how variation in certain factors leads to changes in other factors. This is an extremely powerful contribution to management. However, it is typically rare that we can create the circumstances necessary to establish causation in recreation research.

Implementation and monitoring. Because of its power to predict and/or explain, one of the most important roles for science pertains to the implementation of decisions (Freyfogle and Newton 2002). Science is appropriate for evaluating the implementation and effectiveness of management actions (Adams and Hairston 1996). If there is agreement about desired end states, science can often determine (or at least determine with more certainty than other ways of knowing) which actions will lead to which end states (Mackey 1999). An increasingly important role for science in resource management relates to monitoring. Science is particularly well suited for this because it generates useful information (i.e., is quickly responsive to managers' concerns); is credible if carried out in systematic, transparent ways; and is efficient, in that it can identify the most cost-effective evaluation techniques. In recreation management, perhaps the most well-known examples are programs designed to monitor the condition of trails and campsites, or the National Park Service's long-term project to monitoring the satisfaction of park visitors across the United States.

What are Scientists Good For?

Apart from bringing scientific knowledge to bear on resource management questions, scientists as trained professionals also bring certain qualities that may facilitate resource management decisions. Scientists are trained to maintain a skeptical, questioning perspective and to employ logical analysis to scrutinize propositions. They can point out the limitations of existing knowledge (Freyfogle and Newton 2002). These are important qualities in policy debates. Humans have a natural proclivity to be uncritical of things with which they agree and to accept arguments from sources to whom they are attracted. To the extent that scientists can overcome such tendencies, they may help in decision-making. Of course, there is no guarantee that that they maintain such perspectives, or that their views will be treated any differently from those of other vested stakeholders (Mattson 1996). Furthermore, this skeptical attitude may be contrary to managers' need to make decisions in the face of limited and uncertain data.

Scientists lend credibility to many proceedings and deliberations (Ozawa 1996). Science is a powerful, authoritative institution in the modern world. Following the accepted strictures of science, especially done while maintaining some independence, lends powerful credibility to an endeavor. Scientists are not always convincing to everyone, but science as an institution does enjoy widespread social support. This authority of course brings responsibility—it is rather easy to fall into using science as a shield, to "create the illusion that science is arbitrating between multiple policy viewpoints," when in fact it is not scientific knowledge, but value commitments, that do the arbitration (Ozawa 1996:224).

When Does Science Offer the Most?

To summarize the above points, science appears to be most useful when (1) problems have limited numbers of dimensions; (2) the questions lend themselves to quantification and reduction; (3) when the value questions have been resolved—either stakeholders have shared values or their values conflict, but at least are certain; (4) when there is adequate time, as science requires time for study; and (5) when the entities under study behave in uniform ways under similar conditions.

A Graphic Model of Problem "Types"

Hisschemoeller and Hoppe (1995) offer a conceptual model to help understand the role of science in decision-making. They identify two axes that shape the nature of the problem and therefore the role of science: (1) consensus on relevant norms and values; and (2) certainty about relevant knowledge (Table 1). Structured problems are those in which all players agree about the desired end state (values) and about the types of knowledge that will help attain that end state (relevant knowledge). Science is of most utility in these structured problems. For instance, stakeholders often agree that restoration of natural vegetation is a desirable end state (values), and it is clear that information on species-specific responses, soil amendments, and similar things is needed to help achieve these ends. Scientific research is the dominant force in guiding such efforts.

Some problems are structured to the extent that stakeholders share views on desirable end states, but not on what types of information are needed to achieve them. Hisschemoeller and Hoppe (1995) describe these as problems that are "moderately structured (ends)." Science is helpful in such prob-

Table 1. Types of resource management problems (based on Hisschemoeller and Hoppe 1995)

		Consensus on relevant norms and values	
		No	Yes
Certainty about relevant knowledge	No	Unstructured (messy, wicked)	Moderately structured (ends)
	Yes	Moderately structured (means)	Structured

lems, but not so much as in fully structured problems, because of disagreement about how to obtain needed knowledge and/or what to obtain. An example may be found in the eradication of noxious weeds from wilderness areas. Many (though not all) share such a goal, but there is disagreement about the proper means to attain it. Another example might pertain to ensuring solitude in wilderness; all agree about need to provide it (the ends), but there is considerable disagreement about what data should be brought to bear to determine whether solitude is being ensured.

Some problems are moderately structured in terms of having agreement about the types of data that are relevant, but disagreement about the desired end states. For example, wilderness managers appear to agree that data on vegetation loss at campsites are needed to manage recreational impacts. But how much vegetation loss is too much? Science can quantify the vegetation loss with relatively little controversy and can help managers understand implications of different value choices. However, science itself does not specify what the threshold level of impact should be. Similarly, many recreation managers believe that they need survey data to describe the characteristics, values, attitudes, and preferences of their visitors. However, there is often disagreement about which visitor segment should be privileged in making decisions, i.e., the relevant values.

Finally, there are unstructured problems (sometimes called "messy" or "wicked" problems), which are characterized by strife over both means and ends. Dietz and Stern (1998) describe such problems as multidimensional (outcomes may have many, unequally distributed effects), uncertain at a meta-level (we are uncertain about our level of uncertainty), fraught with mistrust, and urgent (failure to act has significant consequences). In such conflicts, placing faith in science or scientists will not lead to an accepted resolution. Unfortunately, many important resource management issues, including many in recreation management, fall into this category, and even the descriptive data themselves paint an uncertain picture (Mattson 1996). For example, in wilderness management there is debate over which value (access or preservation) should be privileged and over how we would know when we got there. There is also disagreement about whether wilderness should be managed for wildness or naturalness, and what criteria to use to identify one or the other. Many scholars strongly advocate alternative decision processes for such messy problems.

Conclusions

This review may seem to draw a narrowly circumscribed line around the territory of science. I have contended that science is a powerful tool to describe, predict, and explain, but not to arbitrate values. Thus, I want to conclude by emphasizing that, within the boundaries I have described, science has done a tremendous amount to improve resource management. Science is indeed an essential component to resource and recreation management; it is just not the only one.

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