

# Science-Based Natural Resource Management Decisions: What are they?

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## Abstract

While many people interested in natural resources management propose science-based decisions, it is not clear what “science-based” means. Science-based decisions are those that result from the full and complete consideration of the relevant science information. We offer five guidelines to focus the scientist’s contributions to science-based decision-making and use the experience of using science in the development of natural resource management decisions for the Tongass National Forest and for the federal lands in the interior Columbia River basin as examples to illustrate our guidelines.

## Introduction

Natural resource decision-making is contentious and increasingly complex. Part of this is driven by our improved understanding of the consequences of

management actions, but much of it also is the result of strongly held and dramatically different values sought from our natural resources by different segments of the public (Lackey 1999).

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The public increasingly understands that many decisions previously portrayed as professional resource management decisions are in reality the result of a value-based trade-off between quite different options with significantly different outcomes. Additionally, the public demands that information about the complex natural and social systems that they cherish be carefully considered

and fully revealed as the decision is being made.

The public and decision-makers are, in turn, demanding that the best scientific information available be considered as choices among competing options are made. There also are increasing demands that the science information be brought to, validated by, and interpreted in the decision process by a knowledgeable and objective source that is independent of the decision. Scientists often are asked to play that role because of their credibility, objectivity, and independence from the decision-making or advocacy for a particular position.

Because science offers insights and objectivity, the demand for “science-based” decisions has intensified (e.g. Committee of Scientists 1999). Science-based decision-making has strong appeal for decision-makers who are mired in endless debate and conflict between passionate advocates of mutually exclusive positions. Science increasingly is a necessary ingredient of decisions that can withstand scrutiny of both the court of law and the court of public opinion.

What constitutes a science-based decision? Some believe that it is a decision made by scientists or directed by science information. Some believe that it only requires consideration of that portion of the science information that supports their position. Some even appear

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to believe that simply having science information available, whether used or not, produces a science-based decision. We disagree with each of these interpretations and instead outline four roles that science and scientists should play in contributing to science-based natural resource decisions. We also identify one role they should avoid.

#### Guidelines for Science-Based Decisions

Our basic premise is simple. To be science-based, a decision must be made with full consideration and correct interpretation of all relevant science information, and the scientific understanding must be revealed to all interested parties. The decision, however, must be left to the appropriate decision-maker(s) with authority to make the decision. The scientist clearly should advocate that available science information be fully considered in the decision but should not advocate any particular solution.

Based on this premise, we offer five guidelines for the contributions that scientists can make to successful science-based decision-making:

- (1) Focus the science on key issues and communicate it in a policy-relevant form.
- (2) Use scientific information to clarify issues, identify potential management options, and estimate consequences.
- (3) Clearly and simply communicate key science findings to all participants.
- (4) Evaluate whether or not the final decision is consistent with the science information.
- (5) Avoid advocacy of any particular solution.

The premise and guidelines are especially applicable to contentious, broad-scale, and multi-dimensional decisions. They also apply to lower-profile, less-

contentious decisions, but failing to follow them in these circumstances carries few consequences.

#### Two Case Examples

The five guidelines are illustrated by describing how they were applied to two large-scale and contentious natural resource decisions: the development of the Tongass National Forest Land Management Plan (TLMP) and the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

The Tongass National Forest in Alaska is the largest relatively unaltered coastal rainforest in the world. The forest consists of 16.9 million acres of land

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distributed across more than 22,000 islands and a narrow strip of mainland, extending about 540 miles north from the southern end of the Alexander Archipelago (Swanston et al. 1996). The lakes, streams, and surrounding marine waters support one of the most diverse and productive fisheries for wild anadromous salmonids in the world. The economy of the area is diverse but depends heavily on tourism and recreation, and the fish, mineral, and timber resources of the Tongass. Subsistence still is a significant component of the lifestyle of

many residents. There are widely differing and strongly held beliefs about how this vast area should be managed.

The ICBEMP consists of two major components. One is a scientific assessment of ecological, social, and economic systems on 145 million acres in the Pacific Northwest. The second is a decision over management of the 60 million acres of USDA Forest Service and U.S. Bureau of Land Management (BLM) administered land in the project area (Quigley et al. 1996). The primary issues driving the assessment and decisions driving the declines and Endangered Species Act listings of anadromous fish populations, declines in old forest structure, declining forest and rangeland health witnessed by uncharacteristic wildfire and expanding noxious weed populations, and a policy to adopt a scientifically credible, ecosystem-based strategy. Given the strong dependence of many local communities on the resources derived from the federal lands, and because of the prevalence of significant acreages of unroaded lands, the debates about the management of these lands is contentious.

Both planning efforts made extensive use of scientific information and scientists. The guidelines proposed herein were developed in part from our experience in those two efforts.

Guideline One: Focus the Science on Key Issues and Communicate it in a Policy-Relevant Form.

To be helpful in informing the decision, science must be tailored to address the relevant management issues and framed in a form relevant to those issues (Mills and Solberg 1998). While the scientist should be free to compile information and study issues unconstrained by management direction, in order to be relevant, the science must be timely and focused. The resource management goals for the area provide this focus. Although scientists might contribute to the goal-setting process, establishing management goals is cen-

tral to the normative, value-laden process of decision-making, and not part of scientific study. The compilation of scientific information might be guided by an analysis of the information to which the decision is most sensitive.

The scientist should describe the key relations that exist within the systems being managed. An understanding of natural and social systems affected by management is essential to understanding the remaining science information that is presented. It also provides context for the decision process. Just like any science-based product, the science reports should be peer reviewed and published.

In the case of the Tongass National Forest plan revision, the science assessments focused on five key policy issues that were identified by the decision-makers: fish and riparian habitat, wildlife viability, cave and karst resources, timber resources and harvesting strategies, and social issues. After conducting a few new studies to augment existing scientific information, the relevant scientific information was synthesized for each issue. Allen et al. (1998), Baichtal and Swanston (1996), and Iverson et al. (1996) are but a few of the many published scientific assessments that were prepared for the effort. The resulting science assessments were subjected to a double-blind peer review through the editor of Northwest Science to ensure quality control and independence. An additional assessment was developed in response to a congressional request and was subjected to peer review, but through a different process. Each of the science reports was published to provide a permanent record for all interested parties, and to permit full debate of the science findings.

Information provided by the scientists was examined by, interested parties on opposing sides of the Tongass management debate. The scrutiny applied to the information corroborated the belief that assessments should be:

- Completed by the most knowledgeable scientists on the subject, regardless of their organizational affiliation;
- Subjected to blind scientific peer review and formal reconciliation between the review comments and the final manuscript to assure credibility;
- Published to provide a permanent record for all interested parties; and
- Distilled into a list of key findings that are easily understood by all interested parties.

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Guideline Two: Use Scientific Information to Clarify Issues, Identify Potential Management Options, and Estimate Consequences of Decisions.

One of the most difficult aspects of any decision is being certain that the issue or problem definition is robust. This is especially the case when the issue involves large and complex landscapes. The science information can provide special insight into the relations and trends in the system that can contribute to issue clarification, as well as discovery of issues that were previously unknown. The scientist's understanding also might be valuable in creating new management options, possibly even options that provide for greater compat-

ibility among competing interests.

The scientist can help estimate the consequences of the decision options (Mills and Solberg 1998). The scientist also can provide estimates of risks associated with particular actions and uncertainty about estimated outcomes. Ignoring risks and overestimating outcome certainty are common shortcomings in decision-making, perhaps because full consideration of these factors would add complexity to an already complex situation (Messick and Bazerman 1996). Risk preference-or the acceptance of risk-is a major public policy issue. It needs to be fully revealed for informed decisions, not hidden in the implicit risk preference of individual scientists or disciplines.

In the ICBEMP effort, scientists projected outcomes of three management scenarios to help decision-makers explore management alternatives (Quigley et al. 1998a). The science team also projected outcomes from seven management alternatives that were developed by the managers in the Draft Environmental Impact Statement (EIS) (Quigley et al. 1998b). Like the Tongass case, scientists projected the effect of alternatives on the viability of fish and wildlife species. Unlike the Tongass case however, the science team also projected other outcomes, such as fire, vegetation composition and structure, wildlife habitat conditions, and socioeconomic variables. The more comprehensive set of projection outcomes was developed to increase the credibility of the projected effects of decision alternatives. The expanded projections helped focus public debate on real value differences in the management of the basin instead of the underlying information:

Guideline Three: Clearly and Simply Communicate Key Science Findings to All Participants.

Science findings must be presented in a form and manner appropriate for the

intended audience. While publication of the science findings in technical scientific reports and journals is important, it is not enough. The scientist must be proactive in communicating the science findings in forums and formats understandable and accessible to the participants in the decision process.

Some of the science findings likely will display what are seen as undesirable consequences of a particular party's proposed solution. Those parties might, therefore, prefer that some potential consequences, not be revealed or communicated. For example, they might not favor listing the risks of certain management actions. Withholding science information is contrary to our underlying premise. Therefore, science findings should be communicated so that they can be easily understood, and to make them difficult, and embarrassing to ignore.

Key science findings can be communicated effectively by:

- Publishing a summary of the key science findings in lay terms with an engaging format;
- Distilling the most policy-relevant science findings into a few concise messages for electronic and print media; and
- Conducting conferences with interested parties to present and discuss science findings and their implications.

In the case of the ICBEMP, a simply written summary report was published (Quigley and Bigler Cole 1997) and widely distributed. Release of the summary followed a sequence of briefings to the press, staff from several agencies, representatives of numerous nongovernment organizations, and congressional staff. Numerous briefings also were provided to the resource management staff and decision-makers associated with the project. One of the highlights of communicating science findings was a three-day conference with over 500

participants. The science findings were presented in summary and in detail, as well as in forums that encouraged discussion for greater understanding. A series of articles highlighting the key science findings of the ICBEMP assessment was published in the October 1998 issue of the Journal of Forestry. A similar summary of key science findings was published for the TLMP science assessments (Swanston et al. 1996), and similar briefings were provided.

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Guideline Four: Evaluate Whether or Not the Final Decision Is Consistent With the Science Information.

Having the relevant science information available and understood is a necessary but not sufficient condition of science-based decisions. The information must be fully considered, projected outcomes of the decision must be consistent with science literature, and consequences—especially the risks—must be revealed to all parties (Committee of Scientists 1999; Everest et al. 1997; Shaw et al. 1999). A formal evaluation of the final decision to document whether or not these conditions have been met is the culminating activity of the scien-

tist in the decision process.

A formal evaluation has three key benefits. First, it is a formal step to show that the decision-maker understood and used the science information correctly. Second, it fosters discipline by scientists to avoid slipping into an advocacy role. Third, drafts of the science-consistency check provide an excellent information-transfer tool that enables the decision-makers to more completely understand and consider the science information.

The first step in a formal science-consistency evaluation is to identify key elements of the decision for which science information is available. Next, each element is evaluated using three criteria:

1. Is all of the relevant science information addressed and revealed in the decision?
2. Is the science information correctly interpreted based upon our best current understanding, and accurately presented?
3. Are projected outcomes and risks associated with the decision considered and revealed?

If an element of the decision does not meet these criteria, then the decision is not consistent with the science.

Once the science-consistency check is completed, it should be treated like any other science document. It should be peer reviewed to ensure that all of the relevant science was considered and that the conclusions are supported by the data, and published. Anticipation of publication of the final consistency evaluation lends gravity and focus to the exchange between scientists and decisionmaker during development of the decision document.

In the case of TLMP, the formal science-consistency check of the evolving final selected alternative and Regional Forester's Record of Decision was prepared and shared in over 28 drafts with the decision-makers. Drafts of the science-consistency check also were

shared with staff of other agencies who were reviewing the decision. The final science-consistency check of the record of decision was published after scientific peer review (Everest et al. 1997). A similar science-consistency evaluation is being prepared for the ICBEMP (Quigley et al. 1998b).

#### Guideline Five: Avoid Advocacy of Any Particular Solution.

The substance of this guideline has been, and continues to be, hotly debated (e.g. Hammond and Adelman 1976). Some observers say that scientists hold and are influenced by their own values, so why pretend otherwise (Shannon et al. 1996). Others argue that once the science work is peer reviewed and the scientists have completed their job, they should be at liberty to propose policy solutions, and some scientists also state that their scientific understanding makes their recommendations relative to values particularly insightful (Burns 1999). Still other scientists argue that scientists have a moral responsibility to propose solutions to society (Noss 1993).

A contrary view is espoused by a former president of the American Association for the Advancement of Science. Lubchenco suggests that the science contract with society is simply to communicate knowledge to inform policy and management decision processes (1988). Others conclude that "scientific information does not inherently support any policy option" (Lackey 1999). Some argue that "scientific management" in forestry sought to drive decisions based largely on scientific understanding (Nelson 1999), while others argue that that does not and probably never did happen in forestry (Thomas and Burchfield 1999). Our experience and premise supports the positions offered by Lubchenco (1998), Lackey (1999), and Thomas and Burchfield (1999).

Any substantive natural resources management decision weighs trade-offs between competing values. This is

especially the case with complex, multifaceted issues such as the TLMP and ICBEMP. Integrating diverse considerations, values, and interests is a value-based, value-laden process. Those value choices are the stuff of decision-making, not science. How much risk to species viability is acceptable? Who should receive the benefits of the resource and what would they pay to receive them? What premium should be given to naturalness? What preference should be given to local communities relative to other interested parties with a legitimate stake

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in the decisions? These are but a few of the long list of value-based questions that the decision-maker must consider in order to make a decision. While the science may inform those decisions, it cannot "make" them.

Scientists clearly have personal values and opinions, but that does not make those opinions science. While we do not expect anyone to divorce themselves from their personal values, it is necessary that scientists refrain from position advocacy when providing science-based information for decision-making.

Position advocacy can undercut the credibility and independence of scientists, the science organizations they represent, and even the science information. Interested publics, especially those

whose opinions differ from what the scientist is advocating, will recognize the advocacy for what it is—and that it is not science. They also will suspect that the scientist's value-driven position advocacy biases the scientist's objectivity, independence, and neutrality. Position advocacy thereby jeopardizes the most important contribution that a scientist can make. In the middle of a contentious policy debate, a credible source of science information is usually as scarce as value-driven opinions are common. Sacrificing the scarce for the common is a poor trade.

Decision-makers that would like the shield of science might well ask the scientist to endorse or support a particular decision. Other than endorsing the outcome of the science-consistency check, the scientist should avoid endorsing a specific decision.

In the tight time-line of contentious natural resource decisions, this caution is particularly important. Since there seldom is time to conduct new research in the middle of a major policy debate, there always will be holes, sometimes big ones, in the science information. The scientists will be asked to at least hypothesize relations that might fill those holes and that will require significant personal judgement. Often, tight time frames will not permit the sort of multiple rounds of peer review that are desirable and typical in the science arena. In these circumstances, faith in the objectivity and independence of the scientists is particularly important.

#### Summary

While not easy, applying science has contributed materially to informed public debate about important natural resource policies. There appears to be a trend toward even more demand for sound science consideration in these debates. Our experience supports these five guidelines as ways to grasp the benefits of that potential while avoiding the pitfalls.

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