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Working with knowledge at the science/policy interface: a unique example from developing the Tongass Land Management Plan

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Abstract

An innovative, knowledge-based partnership between research scientists and resource managers in the U.S. Forest Service provided the foundation upon which the Forest Plan was developed that will guide management on the Tongass National Forest for the next 10-15 years. Criteria developed by the scientists to evaluate if management decisions were consistent with the available information base were applied to major components of the emerging final management strategy for the Forest. While the scientists remained value neutral on the contents of the Forest Plan and the management directions provided in it, their evaluation indicated that the decisions it contained for riparian and fish sustainability, wildlife viability, karst and cave protection, slope stability, timber resources, social/economic effects, and monitoring achieved a high degree of consistency with the available scientific information. The Forest Plan, revised to conform with existing scientific knowledge, represents a management strategy designed sustain the diversity and productivity of the ecosystem while producing goods and services commensurate with the agency's multiple-use mandate. Execution of this research/management partnership highlighted the role of scientific knowledge in forestry decision-making and provided a new mechanism to input such information into the decision making process. The partnership continues as the scientists are addressing high priority information needs generated by the planning effort in order to have additional information available for plan implementation and revision through adaptive management over the next 3-5 years. Published by Elsevier Science B.V.

Keywords: Risk assessment; Forest planning, Southeast Alaska; Consistency evaluation; Decision making

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1. Introduction

Plans for management of National Forests in the U.S. have traditionally been based on selection by a policy-level decision maker of a preferred alternative from an array of options developed by an interdisciplinary team composed of specialists in different resource areas. In developing the alternatives the team would seek detailed public input and utilize available information, as they felt appropriate, to allocate land and resources to various uses (USDA Forest Service, 1982). In this approach there was no defined role for research scientists, who work in a different arm of the Forest Service than the traditional team members who came from the National Forest System arm of the organization. Furthermore, the level of risk to various resources embodied in the different alternatives was not necessarily evaluated uniformly or clearly articulated.

In contrast to this traditional approach, we believe that there needs to be a clear understanding of the different roles that science and management can play in natural resource decision-making; such as scientists establishing criteria for assessing the consistency of management decisions relative to the available scientific information. Scientists can provide managers and policymakers with the foundational information for making reasoned decisions, but policy considerations, not science, dictate the decisions. Scientists objectively follow rigid scientific protocols in developing new information, integrating and synthesizing existing and new information, assuring that information is interpreted correctly, and assessing the probable consequences associated with various proposed management actions.

Managers and policymakers, on the other hand, use scientific information, legal mandates, societal desires, political objectives, and other factors to make decisions. All policy decisions concerning the use of natural resources contain some level of risk to resources as a result of long-term implementation. Potential risks associated with decisions can be numerous and might affect, for example, community stability, wildlife viability, or long-term sustainability of resources (Shaw, 1999). When making decisions, managers strive to balance the array of risks associated with their decisions with the values of goods and services flowing to society from the managed lands. Such management decisions almost always include trade-offs and compromises for one or more resources.

In management of the National Forests, the appropriate level of risk to accept is a policy decision that should be determined and articulated by resource managers during their decision-making. It is not an issue that can be answered by the scientific method. If scientists attempt to participate in or personally influence such decisions, then their objectivity may be compromised as they bring their personal values regarding levels of acceptable risk to bear on the decision (Shaw et al., 1999). Instead, the value of science and the knowledge it provides is in identifying and quantifying the types of concerns and associated levels of risk.

To provide insights into development of potential Decision Support Systems to assist in ‘The Application of Scientific Knowledge to Decision making in Managing Forest Ecosystems’, we describe a new, structured process where scientific knowledge was formally used to audit forest management decisions (Everest et al., 1997).

In this process, several scientists from the Pacific Northwest Research Station (PNW) of the USDA Forest Service, working side-by-side with personnel from the Alaska Region of the National Forest System arm of the Forest Service, charted new ground in the application of scientific information to natural resource decisions in development of the Tongass Land Management Plan (USDA Forest Service, 1997a,b,c). The PNW scientists joined the planning team as full members, but maintained separate and distinct roles from National Forest System members (Mills et al., 1998); for example, they reported to the PNW Station Director in the Research arm of the Forest Service rather than to the Regional Forester who oversees the National Forest System arm of the Forest Service in Alaska. They worked in cooperation with other resource experts from the Forest Service, the State of Alaska and other Federal agencies, and universities to assemble and interpret the most complete base of information ever developed for forest planning on the Tongass National Forest.

2. The Tongass National Forest

The 6.8 million ha Tongass National Forest is the largest remaining, relatively unaltered coastal temperate rainforest in the world. It is a rich patchwork of forested land bordered by muskeg, alpine meadow, rock, water, and ice that is distributed across some 21000 islands and a narrow strip of mainland that spans 870 km northward from the southern extent of the Alexander Archipelago. The Tongass has been a focus of often intense social, political, and ecological debate for over 40 years as it contains abundant timber, wildlife, fish, mineral, and scenic resources (Servid and Snow, 1999). Extensive clearcut logging of the most productive and ecologically complex old-growth forest heightened concerns about the viability of many old-growth associated species (including various endemic taxa) and the sustainability of the anadromous fisheries resource which is among the most diverse and productive in the world. Finding management solutions that meet the diversity of society's emerging expectations, from recreation and subsistence to timber production and mining, while also being sustainable for all resources (consumptive and nonconsumptive) have represented significant challenges to land management planners for over a decade.

3. The information base

The scientists were asked to assure that credible, value-neutral, scientific information was developed independently without reference to management decisions. Emphasis was placed on identification, acquisition, assessment, and synthesis of available information. Examples of documents produced during this process include information on: regional and community economics (Allen et al., 1999); karst landscapes (Baichtal and Swanston, 1996); timber volumes, (Julin and Caouette, 1997), timber outputs (Brooks and Haynes (1997), and the suitability of forested wetlands for timber harvest (Julin and Meade (1997); conservation status of the marbled murrelet (DeGange (1996), northern goshawk (Iverson et al., 1996), and Alexander Archipelago wolf (Person et al., 1996); a conceptual approach to maintaining wildlife habitat (Iverson and Rene, 1997); wind as an agent of disturbance (Nowacki and Kramer, 1999); and slope stability (Swanston 1997). More recently, a popular summation and synthesis of the above information has been developed for the general public (Julin and Shaw, 1999). Many of these hard copy publications are also available electronically at: www.fs.fed.us/pnw.

Besides preparing these specific resource assessments and a summary of their key findings (Swanston et al., 1996), the scientists also displayed options and the likely levels of risk to resources and society associated with various decisions. This risk assessment was primarily accomplished through conducting two sets of risk assessment panels designed to elicit informed professional judgments from knowledgeable experts in a structured format (Shaw, 1999). These panels focused on the likelihood that various management alternatives would impact the viability of an array of wildlife species, the sustainability of the fisheries resource, the subsistence use of fish and game, and socio-economic conditions.

Both scientists and managers working on the Plan made extensive use of a state of the art Geographic Information System (GIS) to portray in digital and map format the effects of decisions regarding land allocations and standards and guidelines in the draft alternatives. The GIS was also useful in displaying how information from the assessments noted above could be applied in management decisions. For example, information in the assessments indicated a strong preferential use by goshawks and deer of the lands within 330 m of an ocean beach. The GIS allowed for clear, visual display of the effects of implementing a decision to remove these areas from the suitable timber base across the numerous islands of the forest.

4. Evaluation criteria

One of the scientists' responsibilities as members of the planning team was to examine how the available scientific information was used in making management decisions and to evaluate whether the decisions were consistent with that information (Everest et al., 1997). To fulfil this responsibility, the scientists developed and used a specific set of criteria to evaluate the consistency of management decisions with scientific information. The evaluation of how scientific information was used began while the emerging final alternative was still in the formative stages.

The following criteria were used to address how scientific information was used by managers making decisions during revision of the Tongass Land Management Plan (Everest et al., 1997):

1. A management decision was considered to be *consistent* with available scientific information if the following three conditions were met:
    1.1. All relevant scientific information made available to managers was considered cited in the decision.

1.2. Scientific information was understood and correctly interpreted.
1.3. Resource risks associated with decisions were acknowledged and documented.

All three criteria had to be met before a decision could receive a rating of ‘consistent’ with available scientific information.

2. A management decision was considered to be *inconsistent* with available scientific tire information if *any* of the following circumstances occurred:
    2.1. Managers misrepresented or reinterpreted information in ways not supported by the original information.
    2.2. Managers selectively used information such that a different decision was reached than would have been made if all available information had been used.
    2.3. Decisions were stated and documented in such a way that implementation effects could not be predicted.
    2.4. Projected consequences of management actions were not consistent with scientific information.

Failure to meet any of these criteria resulted in a summary rating of ‘inconsistent’ with available scientific information.

5. The decision evaluation process

Decision makers had indicated early in the planning process that key areas of concern included fish sustainability, wildlife viability, karst and cave protection, slope stability, timber resources, social and economic impacts and monitoring protocols. Information specific to these topics, along with a scientific interpretation of it, was provided by the PNW scientists to the managers responsible for deciding the content and direction of the Tongass Land Management Plan. Managers considered this information as they guided development of an array of draft alternatives and, subsequently, a draft preferred alternative for management of the Tongass. After further analysis and review of public comment, the managers modified the draft of the preferred alternative into the Forest Plan (Fig. 1).

Management decisions were evaluated as they were made in an iterative process that resulted in more than 20 drafts of Everest et al. (1997), and a like number of changes in management decisions, before the emerging preferred alternative was finalized (Fig. 1). An important step in this process is that the scientist’s evaluation was subjected to peer review like that applied to other scientific papers (Risser and Lubchenco, 1992; Shaw et al., 1999). Further discussion and description of ‘lessons learned’ from this process appear in Mills et al. (1998).

6. Example: protection of brown hear feeding areas

The following example addressing brown bear habitat illustrates how the above mentioned criteria were used by the PNW scientists to assess consistency of decisions with available scientific information.

Radio-telemetry data from a brown bear study indicate that areas along principal salmon spawning streams are key brown bear feeding habitat and that bear use of these zones extends about 150 m on either side of the streams. The long-term health of bear populations is tied to maintenance of old-growth forest habitat in these areas, which provides hiding cover from humans and isolates feeding and resting bears from each other. In this example three possible approaches for management of brown bear feeding areas along salmon spawning streams are considered.

1. Managers develop standards and guidelines for managing brown bear feeding areas along salmon spawning areas that protect about 150 m riparian zones of forest habitat along each side of the streams. They acknowledge, and risk assessment panels (Shaw, 1999) verify, that the risk to bear populations would be low using this management approach. This decision would be considered to be consistent with available scientific information because managers were provided relevant information, it appears that they understood it by developing management directions that fully protected this key bear habitat, and they documented the risk to bear populations.

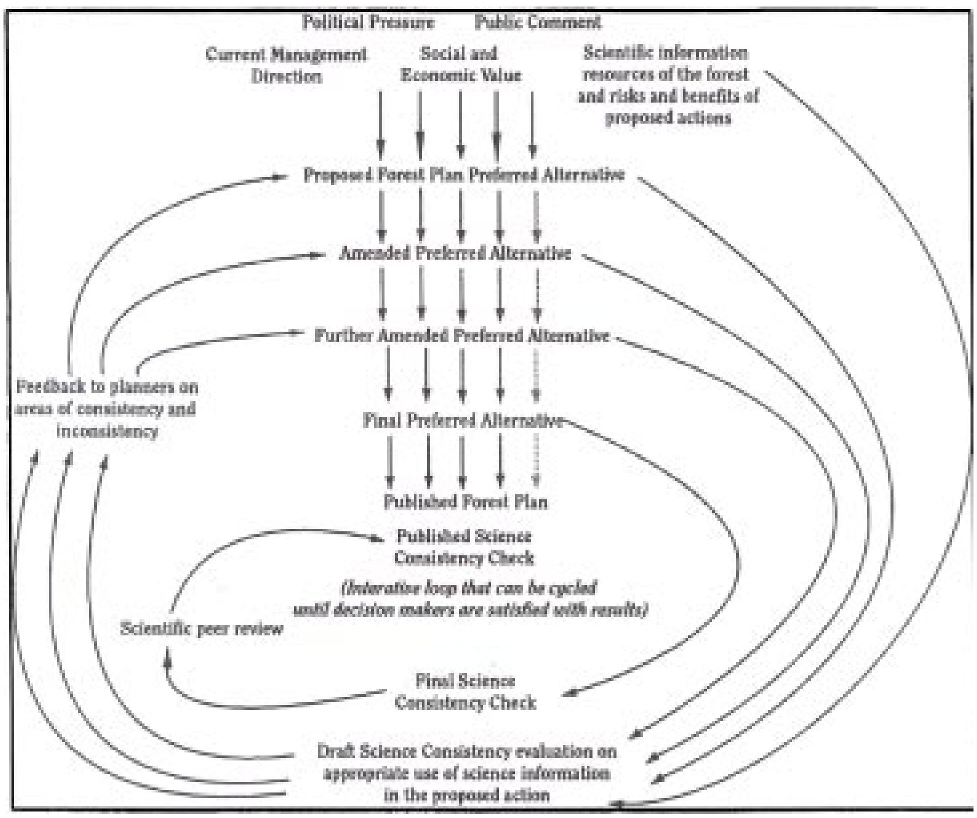

Fig. 1. Schematic diagram of the process used in developing the Tongass Land Management Plan. The scientists' role in developing scientific information, interactively evaluating its use in management decisions and having their efforts peer reviewed by other scientists (Left side of schematic diagram), ensured that science based information was considered throughout the decision-making process.

2. Managers develop no standards and guidelines that specifically protect brown bear feeding areas along salmon spawning streams. Managers, however, document in the final environmental impact statement (FEIS) that research indicates key brown bear feeding areas extend about 150 rut on each side of principal salmon spawning streams. They also state that they consider riparian standards and guidelines prescribed for these streams, which protect an average 90 m width along each side, provide an acceptable compromise between maintenance of bear habitat and timber production. They acknowledge that the risk to bear populations could be increased by this decision and commit to further studies to assess the extent of risk. This decision also would be considered to be consistent with available scientific information. The managers based their decision on a reasonable interpretation of relevant scientific information, with consideration of public desires for resources and, perhaps, legal mandates. Managers acknowledged and documented that some increased risk to brown bear populations will result from their management direction.
3. Managers develop no standards and guidelines specifically to protect brown bear feeding areas along salmon spawning streams. They state in the FEIS that they consider riparian standards and guidelines prescribed for these streams, which protect an average 90 m width along each side, adequately protect the principal brown bear feeding areas along salmon spawning streams. This decision would be considered to be inconsistent with available scientific information. While all relevant scientific information was provided to managers, they failed to acknowledge its existence or to incorporate it into their decision, and they also failed to acknowledge and document the increased risk to brown bear feeding areas associated with the decision.

7. Discussion

Any sound and reasoned decisions about the management of natural resources must be informed by and based upon a solid foundation of scientific information. The complexity of natural systems and their importance to people who depend on them demand this. Though an essential consideration, science information alone does not ‘make’ decisions. Scientists provide managers and policymakers with the foundational information for making reasoned decisions, but policy considerations, not science dictate the decisions. Decision makers, not scientists, ‘make’ decisions after they complete what is essentially a value-oriented integration of the ‘good and bad’ features of the outcomes of alternative management paths.

Since science information does not make decisions, what role should scientists have in effecting, validating, or evaluating decisions? We strongly contend that scientists should not advocate my particular outcome or decision. They should, however, advocate that the relevant scientific information be considered when a decision is made. Furthermore, scientists should determine whether the decision is ‘consistent’ with the science information.

Involvement of scientists on the team that revised the controversial Tongass Land Management Plan shed light on the application of scientific knowledge in forestry decision-making. We joined the planning team as full members, but maintained distinct and separate roles from National Forest System members. We were asked to assure that credible, value-neutral, scientific information was developed independently without reference to management decisions. We also displayed options and the likely levels of risk to resources and society associated with various management decisions. While adhering to our well-defined science role, we carefully avoided advocating any particular outcome for the Plan. We made no management recommendations or decisions, and offered no opinions as to the appropriate level of resource risk that managers should assume when making decisions.

We did, however, advocate that managers consider, correctly interpret, and use relevant scientific information in making decisions about future management of the Tongass. Consistent with advocating use of the best available scientific information in making management decisions, we examined how managers used scientific information in the plan and evaluated whether the decisions were consistent with the available information. The evaluation was initiated while the final alternative was in the formative stages so that managers could alter their management approach, if they desired to do so, before the Plan was finalized. Many management decisions were altered during this 'adaptive decision-making process' in which changes were made concurrent with iterations of our 'science consistence manuscript' (Everest et al., 1997). In the final analysis, the scientists considered that this effort, as much as any other aspect of the planning process, helped to produce a Forest Plan that managers deemed to be scientifically credible, legally defensible, and resource sustainable in the long-term.

Reflection on the involvement of science and the knowledge it generates al the management policy interface highlights two points that deserve attention as others engage in science-based forest planning and management. First, is the importance of establishing a clear understanding among scientists and managers early in the process regarding the criteria that will be used to evaluate the consistency of management decisions with available information. For example, our criterion regarding the use of 'all' available information in the decision-making process became difficult to validate. The desired result, managers not ignoring any relevant information, could likely have been obtained without imposing a standard that was difficult for us to evaluate. Embedding such criteria within a knowledge-based decision support system could help highlight their importance and ensure that the criteria were applied in the decision making/evaluaton process, as outlined in Fig. 1.

The second point involves the nature and extent of documentation for various modeling assumptions in traditional forest planning and the validation of subsequent modeling output, Several computer-based decision support and geographic information systems were used to project various resource outputs (e.g. timber harvest volumes, deer habitat capability, visitor user days) in the forest planning process. While highly useful to the planning process, the documentation levels demanded by science to evaluate the adequacy of the modeling assumptions in these systems and subsequent model outputs from them were beyond the standard used by analysts and modelers on the planning team. As such, the models represented somewhat of a ‘black box’ that should be avoided in future efforts by strong insistence on full documentation of all modeling assumptions and linkages, as well as validation of all model outputs. A rigorous and formal decision support system could likely be developed to address this problem.

An example from the Tongass may help to illustrate the issue. The harvesting of old-growth timber in small patches with two or three stand entries scheduled over a 200-year rotation (group selection) was one of the management scenarios modeled. The desired result of this action was to obtain a series of small patches of thrifty young-growth trees in the stand over time with different patches being cut during each stand entry. Evaluation of model output, unfortunately done ex post facto, indicated that during each 50- to 70-year re-entry the model, likely because of built-in economic constraints on harvest scheduling, simulated the re-cutting of the first patch on each re-entry rather than generating a new patch. While the land base affected by this inaccuracy was limited, the incident serves to emphasize the point that to avoid such surprises in land management planning there should be no undocumented modeling assumptions or outputs taken for granted.

To our knowledge, this intimate involvement of research scientists in resource decision making on federal lands was a ‘first’. Mills et al. (1999) describe the involvement of scientists in development of other U.S. federal policies, but none deal directly with a process to formally engage scientists in knowledge-based decision-making in management of federal lands. As more National Forests and other agencies responsible for the stewardship of public lands revise their resource management plans, it will be interesting to follow how the use of science and scientists is interfaced with policy making in the planning process (Meffic et al., 1998; Shaw et al., 1999). Will the Tongass model (Mills et al., 1998) be implemented elsewhere, as recently suggested by a national committee of scientists (USDA, 1999); or, will something else be developed? And, how will the public and the political process, which weighed in heavily during development of the Tongass Land Management Plan (US Senate, 1996), view this experience over time? Those of us involved in the process find it to be an appropriate way to move forward with science-based forest planning and management.

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