Achieving a Nexus of Science, Management, and Policy in the Sierra Nevada

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The policies and strategies that guide the use and management of lands in the Sierra Nevada ecoregion depend on objective scientific information. In recent years, the region has attracted increasing attention from visitors, developers, environmentalists, businesses, scientists, and politicians as well as local residents, resource managers, and research groups. And the effects of management decisions on the status and trends of lands and natural resources in the Sierra Nevada seem to carry more weight each year. Accordingly, a great deal of new ecological information has been collected and synthesized for many different purposes. Efforts such as the Sierra Nevada Ecosystem Project (Elliot-Fisk and others 1996) and the Lake Tahoe Watershed Assessment (Murphy and Knopp 2000) illustrate both the interest and effort that have been devoted to gathering and using scientific information to support regional management. Links between science and policy, however, are often extremely difficult to forge. They require collaboration among institutions and individuals that have different traditions, needs, and goals. The potential for collaboration between scientists and managers to resolve increasingly critical challenges has not yet been fully tapped.

No single conference or institution can provide a thorough overview of current scientific insights or ensure their application to management. The intent of the organizing committee for the 2002 Sierra Nevada Science Symposium was to present a sample of current scientific work, facilitate access to more detailed sources of information, and provide a forum for application of such information in the context of land and resource management. The content of presentations ranged from recently gathered scientific data to planning and management processes and tools based on such data. The symposium provided a valuable opportunity for disseminating scientific evidence to managers, policy makers, scientists, and the public—and ultimately, perhaps, influencing policy decisions. The organizing committee supports the many other efforts intended to achieve similar goals and acknowledges the need for integration.

The four specific objectives of this symposium were

1. To highlight current ecological research and monitoring in the Sierra Nevada;

2. To provide access to information on research, databases, and Web sites related to research in the Sierra Nevada;

3. To identify research needs and priorities of organizations, particularly those with a stake in managing resources or lands in the Sierra Nevada; and

4. To explore the potential to expand research opportunities in the Sierra Nevada, including identifying possibilities for collaboration among multiple agencies, institutions, students, and interns.

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The three days of the 2002 Sierra Nevada Science Symposium (October 8–10, 2002) did not provide sufficient time to address these objectives in detail; however, we hoped that the meetings and interactions facilitated by the symposium would catalyze many more. A somewhat distinct issue, however, is what may be needed to make an effective, productive, and lasting connection between the scientific and management communities. In the following pages, we explore this question before delving into the substance of the presentations made during the symposium itself. We hope this section will serve as a foundation for bridging the sometimes deep chasm between science and management.

The Respective Roles of Science and Policy

Scientific approaches and processes differ from the approaches used to manage resources and execute policy in several fundamental ways.

Approach to resolving issues

Throughout their professional development, scientists are trained to think critically and probe the unknown. Posing questions and testing hypotheses is the substance of scientific inquiry. Encouraging curiosity and innovation breeds free thinkers who question the status quo. In contrast, managers and policy makers are required to reconcile often contentious issues through compromise and collaboration. These professionals must seek input from, and eventually facilitate agreement among, an array of positions on any given issue. In practice, independent thought and opinion, although always an asset at some levels, can hamper progress toward collaborative solutions.

Interpretation of information

Scientists work in the realm of data sets and statistical analyses that produce probability statements rather than absolute answers. Outcomes are never certain, particularly when dealing with natural systems in which variation can be overwhelming and results difficult to interpret. Yet managers and policy makers are under pressure to make decisions that have definitive outcomes. These two approaches to using and evaluating information can be diametrically opposed.

Timeframe for activities

Research endeavors tend to follow a predictable pathway. A question is posed, hypotheses are developed, experiments are designed, data are collected and analyzed, and results and conclusions are ultimately published in peer-reviewed journals. This process takes time, often long periods of time, depending on the question and conditions under which the work is conducted. Ask a question today, and expect a scientifically defensible, although perhaps equivocal, answer some years later. In contrast, policy makers and natural resource managers make decisions daily, with little time for contemplation, much less for experimentation. They must sort through the body of available information rapidly, arriving at an ostensibly definitive answer (which may or may not lead to concrete action) within a limited timeframe. All decisions have implications for resource management and conservation, including decisions that result in no action taken.

Measures of success

Scientists are responsible for conducting their work in an objective and scientifically credible manner and are judged by their peers on the merits of their research. The number, as

well as the quality, of an individual scientist's peer-reviewed publications is an important metric of success, as is the proportion of those publications on which he or she is the single or lead author. Policy makers and managers, too, are influenced by the weight of scientific evidence, but this is not the only criterion by which they make decisions. Managers are judged primarily, if not solely, by whether they reach appropriate solutions and accomplish goals. The ability to work productively with others and facilitate collaboration is highly valued within the policy and management community.

The Commensal Relationship Between Science and Management

We argue there is a commensalism between science and management. Management and policy making in the field of natural resource management, ipso facto, require scientific information. Managers need facts to first inform and later assess the results of their decisions. For their part, scientists who direct their efforts toward applied questions can receive not only intellectual and personal satisfaction but also social, political, and often financial recognition for their achievements.

Decisionmaking in other scientific disciplines has a closer and better-defined relationship to reliable information. Public health policy, for example, is tightly linked with experimentation and peer-reviewed results. Natural resource management does not have the same stringent requirement; nevertheless, research can be the foundation of many management decisions. Thus, managers and policy makers will frequently support research programs at some level. Scientists can and often do sustain their professional output without management-oriented motivation. As environmental problems have become more pressing, however, the scientific community has been increasingly attracted to questions that are generated by management needs. Tackling these questions can not only be scientifically challenging but also may allow researchers to contribute to resolving crucial issues.

Furthermore, the issue of funding cannot be ignored. In this regard, the relatively nonchalant attitude of some scientists toward management concerns is slowly shifting. Although management issues are not required to drive scientific research agendas, scientists may be drawn to sources of funding that accompany applied research. Accordingly, the bond between the scientific community and the management community can be strengthened over time. However, when scientists investigate applied or politically charged questions, they and their collaborators must strive to maintain objectivity. Scientific credibility will remain the primary, if not exclusive, currency of the scientific process, regardless of the social, legal, or economic context in which inquiry occurs.

Obstacles to Collaboration Between Scientists and Managers

There are many obstacles to making the relationship between the scientific and management communities congenial, let alone operational. Many of these obstacles relate to differing roles and responsibilities of scientists and managers. From the perspective of a scientist, successful field research is:

• well-designed; (Field experiments must surmount challenges, including but not limited to identification of uniform sampling units, discrimination of treatment effects from background environmental stochasticity, and establishment of controls and replicates.)

• conducted over a sufficient number of years to identify ecologically significant trends or causative relationships;

• not compromised by land use pressures and restrictions external to the experimental design or application of treatments; and

• adequately funded. (Expenses may accrue in field ecology because of the difficulty of collecting data, in remote locations, on study organisms that are often cryptic, have low densities, or have large home ranges.)

Characteristics of successful field research viewed from the perspective of a manager may differ from those viewed the perspective of a scientist. To meet their responsibilities, managers need:

• flexibility over when and how to manage any given piece of land or resources;

• the ability to rapidly respond to identified management needs;

• guidelines for management that can be easily interpreted and executed;

• the ability to meet annual production quotas;

• information on risks and uncertainties associated with specific decisions; and

• accountability with the public and stakeholders.

Differences in perspectives between scientists and managers are admittedly difficult to overcome. Successful relationships between research and management cannot be achieved in the absence of a set of advantageous circumstances.

Elements of a Successful Relationship Between Scientists and Managers

An enduring dialog between scientists and management exists in many different professional disciplines. At best, the outcomes can be productive and mutually satisfying. At worst, the relationship can be clumsy and ineffective, with frequent breakdowns in communication between collaborators. We believe that several attributes are typical of successful working relationships between scientists and managers.

Clearly defined roles. Scientists and managers have distinct roles and responsibilities both within their respective institutions and in partnerships. We need to acknowledge, respect, and appreciate these roles, develop clear and realistic expectations for each partner's contributions, and allow each to execute their responsibilities with minimal interference.

Cooperation. We need to develop systems that facilitate planning and logistical cooperation between science and management. Challenges include scheduling and design of treatments and subsequent data collection, logistical arrangements to support workers in the field, and efficient transfer of funds and management of shared budgets.

Sustained support. The ability to obtain defensible results is usually predicated on stable and continuous research. Shifts in funding or logistical support hamper collective efforts to achieve explicit goals.

Integrated structure. Planning and executing scientifically defensible field research requires commitments that may be atypical of traditional land management endeavors. This obstacle may be easier to surmount if partnerships focus on testing questions associated with the effects of common management practices. An understanding that clear hypotheses and rigorous application of treatments increase the practical value of research results and the strength of statistical inferences is essential.

Coordination of timing. Timeframes for planning and executing management activities are usually different from those of research projects. More effective synchronization of efforts is necessary to achieve both scientific and management objectives.

Shared expectations of results. Research often has a relatively extensive lead time for development of experimental design and logistics, followed by long periods of data collection, subsequent analysis, and preparation of reports, manuscripts, and other products.

As a result, the timetable for outcomes is often perceived as slow relative to the need for answers by managers. Additionally, scientific results are customarily presented in qualified or conservative terms; rarely does research provide categorical support for subsequent management decisions. Nevertheless, scientific information can provide the evidence necessary to make defensible, incremental decisions. We need to explore mechanisms for meeting the expectations of both scientists and managers with respect to research results.

Implementation of adaptive management. Management objectives and scientific research that address the same issues can be pursued independently, but success is far more likely when they are pursued in concert. Planning efforts, expectations, and outcomes need to be integrated, especially in facilitating adaptive management.

Shared accountability for returns on investments. If scientists and managers are to work together in the Sierra Nevada, public accountability must be shared. We need to consider how to develop an accountability framework in which each partner takes some responsibility for the success of the others

Application of Science to Management in the Sierra Nevada

Land management issues in the Sierra Nevada are gaining national and even international attention. Controversy over appropriate land stewardship for the present and future is growing. Science has contributed significantly to this debate; in fact, the Sierra Nevada Ecosystem Project in 1996 made a landmark initial impact on the discussion of ecological sustainability. In recent years, this debate has intensified over such topics as conservation of the California spotted owl, fisher, goshawk, American marten, and other vertebrates thought to be dependent on old-growth forest conditions; management of fuels and wildfire; conservation and restoration of aquatic systems and riparian areas; sustainable harvest of forest products; and extensive and growing demand for an array of recreational uses. Currently, the most important resource issue in the Sierra Nevada may be sustaining the reliable production of water for domestic and agricultural uses.

The Sierra Nevada, like most other ecosystems around the world, has long passed a threshold of apparently inexhaustible natural resources. Competition for resources to support different land uses, whether real or postulated, is increasing. As a result, the timeframes in which managers must make decisions are shrinking. The real merits of "good science" are taking on a new meaning. As managers venture into the crossfire, they need the products of well-developed scientific inquiry. Simultaneously, scientists have unprecedented opportunities to contribute meaningfully to an expanding knowledge base.

Notwithstanding the mixed success of previous relationships between scientists and managers, we believe that an adaptive management strategy that is well constructed, well funded, and well supported offers the best hope for achieving diverse objectives. We envision programs in which scientists and managers collaborate to identify monitoring and research priorities. The resulting investigations generate scientific information, which in turn allows managers to assess the performance of management strategies relative to management objectives. Strategies can be continued, modified, or discontinued accordingly; further testing maintains the cycle by providing a flow of information that can justify and validate future decisions.

Collaborative efforts between scientists and managers can begin modestly, attempting to confront small suites of key issues. But partnerships must have support and encouragement from the overwhelming majority of stakeholders concerned with the future of the Sierra Nevada, and these partnerships must have opportunities to adapt to the expectations and needs of diverse interest groups. Such partnerships do not require establishment of a new bureaucracy but rather require a collaborative venture among existing organizations and interests. Policy makers, managers, scientists, and the public must work together to define

initial objectives and expectations and commit to supporting what will be a very long process. While appropriate adaptive management may eventually become fairly complex, a prudent approach at this juncture is to pursue collaboration on a relatively short list of the highest priorities, execute monitoring and research with the highest scientific standards, and build from initial partnerships as other needs are identified.

In the chapters that follow, we believe there is substantial cause for optimism that a new collaboration between science and management can help us achieve sound stewardship of the unique natural resources in the Sierra Nevada ecoregion.