

## A MONITORING STRATEGY FOR THE NATIONAL WILDERNESS PRESERVATION SYSTEM

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In 1964, the Wilderness Act (P.L. 88-577) established the National Wilderness Preservation System (NWPS), currently composed of nearly 39 million hectares in 564 separate units, ranging in size from 2.4 hectares to 3.5 million hectares. The purpose of the NWPS is “. . . to secure for the American people of present and future generations the benefits of an enduring resource of wilderness.” The Act further states [Sec.2.(a)] that these areas:

. . . shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness . . .

What are these benefits that the American people derive? Will wilderness managers know if and when the “enduring resource of wilderness” is no longer providing these benefits? One way to answer these questions is through a broad-based monitoring program that addresses experiential, social, and ecological issues.

Monitoring programs currently exist in several wildernesses, but there is little coordination across areas or among the variety of purposes for monitoring. The NWPS is composed of extremely diverse units, varying in ecosystem types, geographical location, size, use, and benefits. In addition, four different federal agencies administer wildernesses within the NWPS. This diversity is beneficial, but likely renders any single monitoring program developed in one area for one purpose inadequate to meet the full breadth and

depth of social and ecological issues of concern. Furthermore, information about monitoring techniques that can be used in wilderness is largely nonexistent or so diffuse that it is difficult to apply. This lack of coordination and information, and the tremendous diversity within the NWPS, strongly suggests the need for a coordinated, comprehensive monitoring strategy that can fit the needs of individual agencies and units across the NWPS.

The monitoring strategy we propose seeks to achieve a comprehensive, integrated program of wilderness monitoring, an umbrella under which individual agencies and units of the NWPS develop specific programs and protocols to fit their individual needs. This monitoring strategy has two key elements: 1) a comprehensive conceptual model that provides the goals and an organizational framework for all monitoring and 2) a strategic, step-by-step, iterative process that provides: a) interaction of scientists with management personnel for integrating their respective experience and expertise and 6) periodic review and updating of all monitoring policies, programs, implementation, and use of data.

### CONCEPTUAL MODEL OF WILDERNESS MONITORING

Our conceptual model, based on the above quote from the Wilderness Act of 1964, and further, a mandate in the Act to report to the President “. . . on the status of the wilderness system . . .” identifies three primary purposes for all wilderness monitoring:

1. to improve wilderness management (Wilderness Management Monitoring);
2. to improve the acquisition and use of knowledge from wilderness (Wilderness Reference Monitoring); and

- to improve assessment of the status and trends of the NWPS (National System Monitoring).

The first two primary purposes, wilderness management monitoring and wilderness reference monitoring, can each be subdivided into two distinct goals, yielding a total of five monitoring goals. These five goals provide a conceptual and organizational framework for experiential, social, and ecological monitoring across the NWPS.

### Wilderness Management Monitoring

Monitoring to improve wilderness management is subdivided into two goals: 1) to protect wilderness character and 2) to provide public uses to which wilderness is devoted.

**Wilderness Protection Monitoring.** An essential goal of wilderness management is to protect the wilderness resource from agents that threaten any unnatural change in wilderness character. Thus, there are two distinct aspects of concern in wilderness protection monitoring: 1) the agents of change (which we call threats) and 2) the attributes of wilderness character that are threatened. These relationships are conveniently displayed as a matrix. (See Figure 1.) Agents of

change are both internal (e.g., grazing) and external (e.g., air pollution) to the wilderness, can be activities (e.g., recreation) or the direct effects of these activities (e.g., water pollution), and can also be management actions (e.g., fire suppression). Additional threats, either existing or others that may surface in the future, are reflected in the *Other* category. Attributes of wilderness character we seek to protect include ecological components and processes, cultural sites, and human experiences dependent on wilderness character.

This matrix defines the entire range of potential impacts and provides an organizational framework for a monitoring program. Monitoring protocols need to be developed for assessing the magnitude of each threat and the amount of impact or change in wilderness attributes caused by these threats. For most of these threats and impacts, specific parameters (and indicators where necessary) will need to be agreed upon or developed. In some cases, for example, air pollution, considerable progress has already been made on protocols for wilderness monitoring.

**Wilderness Use Monitoring.** In addition to protecting the wilderness resource, the agencies that manage wilderness are directed to provide for the public purposes of recreational, scenic, scientific,

		Potential Threats <sup>1</sup>									
		Recreation	Fire	Pollutants	Domestic Livestock	Adjacent Lands	Water Projects	Mineral Activities	Exotic Species	Other <sup>2</sup>	
Attributes of Wilderness Character	Air										
	Aquatic Systems										
	Rocks/Landforms										
	Soil										
	Plants										
	Animals										
	Ecosystems/Landscapes										
	Cultural Sites										
	Wilderness Experiences										

<sup>1</sup>Including both the agent of change and associated management  
<sup>2</sup>Including scientific uses, overflights, other laws and mandates, inholdings, subsistence, previous uses, wildlife extirpations, and future threats.

Figure 1. Conceptual matrix for Wilderness Protection Monitoring.

educational, conservation, and historical uses. The goal of wilderness use monitoring would be to improve the ability of wilderness managers to provide for these purposes to which wilderness is devoted. In wilderness use monitoring, these uses are considered beneficial; whereas under wilderness protection monitoring some of these uses are considered threats. The Wilderness Act, and subsequent legislation, also allows some uses of wilderness that are not directly related to the above recognized beneficial uses. Some of these allowable uses include grazing, mining, subsistence, and aquaculture.

Managers need to provide services to accommodate these uses, improve communication with users, and evaluate the effectiveness of these services. These relationships are illustrated as a matrix. (See Figure 2.) Each cell of the matrix represents an information and monitoring need, lying at the intersection of the various beneficial and allowable uses of wilderness with the various attributes of use or service.

### Wilderness Reference Monitoring

Monitoring to improve the acquisition and use of knowledge from wilderness is also subdivided into two different goals: 1) to detect subtle and long-term changes in global conditions and 2) to improve management of natural resources on non-wilderness lands.

*Global Change Monitoring.* The purpose of this monitoring is to improve our ability to detect the subtle and long-term effects of global climatic change. Wilderness is particularly appropriate for this type of monitoring because it is relatively unaffected by human activities and in the future, wilderness and other protected lands may be the only such places remaining in our increasingly human-modified landscapes. There are several global change monitoring programs currently operating throughout the United States and the world, both within and outside of wilderness, and any new proposed monitoring program would be fully integrated with these other programs.

This type of monitoring is concerned with the full breadth and depth of ecological systems and is illustrated as a matrix. (See Figure 3.) In this matrix, three primary ecological attributes of wilderness character (composition, structure, and function) are arrayed against the different levels of an ecological hierarchy (ranging from genes to the landscape or region). Global change monitoring would attempt to define baseline levels and their *natural* variation for each cell of this matrix.

*Ecological Reference Monitoring.* The purpose of this monitoring is to produce information about wilderness ecosystems and their variation that can be used to improve the management of non-wilderness lands and natural

		Purposes and Uses						
		Recreational	Scenic	Scientific	Educational	Conservation	Historical	Other Allowable Uses
Attributes of Uses and Services Provided	Amount of Use							
	Characteristics of use							
	Characteristics of users							
	Amount of service							
	Quality of Service							

Figure 2. Conceptual matrix for Wilderness Use Monitoring.

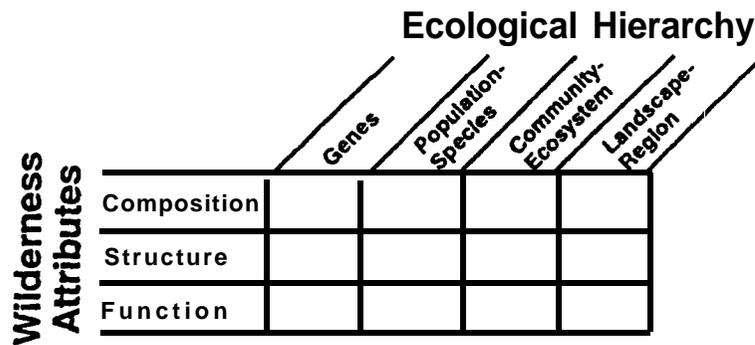


Figure 3. Conceptual matrix for Wilderness Reference Monitoring.

resources. A variety of ecosystems are actively managed, yet the long-term consequences of these actions are unknown. Wilderness lands, because they are relatively unmanipulated, can serve as reference benchmarks or baselines for assessing the effects of management on lands outside wilderness. The ecological understanding gained by monitoring in wilderness can be used to improve the long-term productivity and sustainability of actively managed lands.

Ecological reference monitoring is also concerned with the full range of ecological components and processes, so the global change monitoring matrix can also be used as an organizational framework for ecological reference monitoring. (See Figure 3.) However, different parameters are likely to be selected for each cell in the matrix because ecological reference monitoring is driven by information needs specific to managing natural resources, and not detecting global change.

### National System Monitoring

The purpose of this monitoring is to improve the ability of policy-makers (legislators and administrators) to assess the status of and trends in the NWPS. The emphasis here is on the entire wilderness system, not on specific areas. Unlike the previous monitoring goals, we do not offer a matrix of information needs for National System Monitoring. Instead, we suggest the following important types of information that might be included:

Descriptors of the NWPS - One monitoring objective would be to simply report accurate descriptive information on the physical aspects of the NWPS, including such items as the number of individual wilderness units by state, region, and agency; the number of acres by state, region, and agency; the number of miles of trail; the number of administrative facilities in wilderness; the number and descriptions of major ecosystem types represented in the national system; the number of endangered or threatened species represented in wilderness; and the amount of comparable substitutes to wilderness available.

Threats to the NWPS - Another objective would be to maintain an accurate record of the status of threats to the NWPS. These threats would include the agents of change described in Wilderness Protection Monitoring. For purposes of National System Monitoring, this information might be obtained by aggregating the results of Wilderness Protection Monitoring for all wildernesses in the system.

Trends in Condition of the NWPS - Another objective of National System Monitoring would be to produce accurate knowledge about trends in the condition of the system. If a few relevant indicators are chosen as core

indicators, and those indicators are monitored either in every wilderness or a set of representative wildernesses, trends in the wilderness character of the system could be documented.

Demands and Uses of the NWPS

Accurate knowledge about trends in demand, both expressed (through use or applications for use) and latent (desired, but not achieved) would be an important objective of National System Monitoring. Policy-makers should have access to information on such things as the number and characteristics of people who visit wilderness in a year, the amount of domestic livestock grazing in wilderness each year, the quantity of minerals extracted from wilderness, the number of applications for use that were rejected, and the number and characteristics of people who wanted to visit but were not able to for reasons other than use restriction.

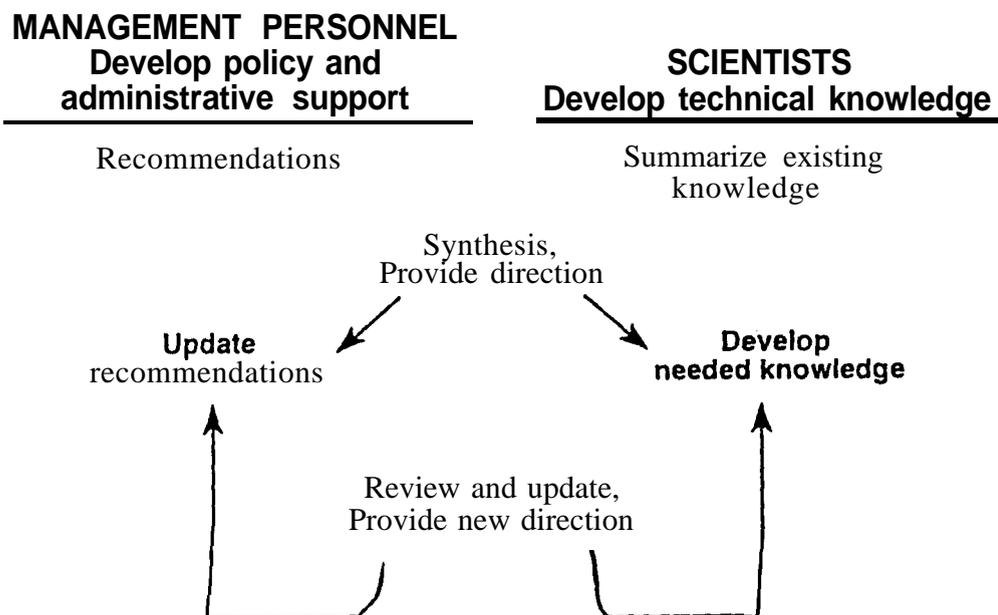
Societal Values and Benefits Associated with the NWPS - Another objective of National System Monitoring

would be to document trends in the value the public places on wilderness and the benefits that accrue to individuals and society as a result of the existence and use of wilderness.

**STRATEGIC PROCESS**

To move this conceptual model to a national monitoring program, we envision two relatively distinct groups of people working on two relatively distinct tasks: 1) administrators and managers with responsibility to develop policy and administrative support and 2) scientists with responsibility to develop technical knowledge. Interaction between both groups, and integration of their respective areas of expertise and recommendations, are absolutely vital to the success of a comprehensive monitoring program.

Interaction and integration of ideas will most likely succeed following a step-by-step, iterative process. (See Figure 4.) This process would begin with management personnel developing initial recommendations on such issues as agency values and benefits of monitoring, the value and use of a set of *core* parameters by every wilderness, administrative support structures and funding mechanisms for individual wilderness



**Figure 4.** Strategic process for integrating scientific information with management direction and review and updating of monitoring programs.

monitoring programs, linkage among agencies, and procedures for assuring the quality, handling, storage, and use of data. Scientists would then summarize existing knowledge related to all three purposes of NWPS monitoring. Scientists would then be in a position to identify gaps in knowledge and issues that are likely to be of high priority.

Information from both groups would then be synthesized and initial guidance and direction offered. Priorities for monitoring would need to be forged out of this synthesis. Based on this guidance; management personnel would need to review their initial recommendations, while scientists would likely need to develop more knowledge about specific threats, impacts, and monitoring protocols. Updated recommendations and new scientific information would then allow a new and more complete synthesis and integration of ideas, resulting in new guidance and direction.

The iterative process described above would endeavor to draw upon the expertise of both scientists and management personnel, while at the same time blurring the distinction between these two groups of people in developing the final product: a comprehensive and coordinated monitoring strategy. In addition, each iteration provides a structured process for reviewing successes and failures in all aspects of the monitoring program (conceptual development and field application), incorporating the newest scientific information, and providing timely and specific guidance to improve monitoring programs.

## CONCLUSIONS

The strategy or *umbrella* outlined above provides a comprehensive, flexible, and continually evolving program to begin monitoring the NWPS. In addition, many substantive issues will need to be resolved, or at least explicitly recognized, including agency linkages, quality assurance, systems for collecting and storing data, appropriate analysis and use of data, turf battles, an attitude of resistance to change, lack of scientific information, and lack of funding. Such a comprehensive, coordinated monitoring program will likely re-

quire enormous amounts of time and effort. In our view, the benefits to the NWPS clearly outweigh these costs.

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