

The NPS Inventory & Monitoring Initiative

The Ecological Imperative

By Terence P. Boyle and Raymond Herrmann

Recent interest within the National Park Service for a more comprehensive and systematic inventory of natural resources and periodic monitoring to determine condition and to assess any man-induced changes has been manifested in the Natural Resources Assessment Action Program. Many parks have some resource inventory and monitoring (I&M) activities, however, many of these same parks are often at a loss to interpret collected environmental data when confronted with some of the more pervasive, complex threats to the integrity of their resources. In the past, many inventories of natural resources have been little more than lists of species and locations of samples sites; many monitoring efforts have been restricted to those mandated by human health concerns comprising a loose collection of assorted chemical constituents, often directed at concerns about water quality.

This article discusses the integration of management and technical aspects, and introduces a framework for conducting resource inventories and subsequent monitoring. Inventory and monitoring in the NPS is a responsibility shared between resource management and research. Therefore any program conducting environmental inventory and subsequent monitoring efforts should have certain critical elements that include: 1) a procedure for establishing clear co-responsibilities for resource managers and research scientists, 2) a concept of the ecological paradigm as a framework for the collection of information and interpretation of data in a resource inventory program, and 3) a rationale for using data generated in monitoring programs.

A primary role of resource managers is to secure information on threats and identify the needs for managing natural resources. Resource management needs should be put into a clear set of management objectives. It is the role of the research scientist to translate these management objectives into scientific hypotheses, data collection procedures, and conclusions. These two activities should be considered parallel and interacting.

I. The initial step is a clear statement of resource management programmatic concerns by the Park. These concerns may be mandated by legislation establishing the Park, come from pervasive threats such as pollution, result from land-use changes outside the Park boundaries, or be the consequences of management decisions. It is imperative that the statement of natural resource management concerns is both explicit and inclusive because it leads directly to and drives the other steps in the I & M process. This statement of concerns should be a joint effort between resource management and a research scientist. These individual resource management concerns should be arranged by priority to assign available resources.

II. The second step is the formulation of scientific tasks that are directly predicated from the resource management concerns in the first step. The set of scientific tasks should address the prioritized Park natural resources concerns, and in certain cases may also address broader issues that include long-term issues of regional or national importance. An explicit framework to implement these scientific tasks is as follows:

A) The scientific tasks should be in the form of explicit sets of testable hypotheses that address the Park specific and broader NPS resource management concerns.

B) These hypotheses will entail specific data set requirements. The level of effort in the data collection will be directly related to how the data will be used, i.e. for general

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knowledge and interpretation vs. for legal defense of resources.

C) At this point there will be a comparison of resources available and costs against the prioritized list of natural resource concerns addressed. In effect, this step will determine what tasks can be done. Both resource managers and scientific personnel should reach a consensus on the content of the final scope of work.

D) The data collection should have a Quality Assurance and Quality Control program

Table 1. Comparison of resource management and potential application of Ecological Paradigms in environmental inventories.

Management Inventory Needs	Ecological Paradigm
1) Single species population – fisheries – wildlife studies i.e. artiodactyls carnivores – endangered species – pest species	Population models – reproduction, growth, survival – Leslie matrix – structural analysis – analysis of limiting factors – inter-relationships competition, predation, etc.
2) Community – forest type – vegetation analysis – baseline data – environmental assessment	Succession model & climax Structural analysis – diversity – dominance – similarity – stability Production – primary – secondary Biogeography – immigration/extinction – species equilibrium
3) Ecosystem Stream/watershed	River Continuum Concept – functional group analysis – carbon transport – detrital processing – photosynthesis/respiration ratio – discontinuity – nutrient loss
4) Lake/watershed	Trophic status – nutrient flux – nutrient loading – limiting nutrient Physical/chemical analysis – surface area – hydrological turnover – depth Energy fixation & flow

in place before sampling takes place. This includes a precise statement of procedures of how data are to be collected, instrumentation used, use of chemicals or biological standards, and limits of detection.

E) There should be explicit plans for data storage, preservation, and archiving of appropriate samples. Considerations should be addressed as to who will be using the data and the time frame in which the data will be used.

F) The data should be subject to quantitative analysis that both establishes a basis for statistical parameters and forms a basis for accepting or rejecting the hypotheses generated by the resource management concerns.

G) Consideration of the final products in terms of written reports should be given before the inventory is begun. These products may range from a report written directly to the Park or the Regional Science Office, articles submitted to the peer reviewed literature, extensive materials covered in a monograph, or legal depositions and expert testimony.

This brief article cannot begin to cover inclusively all the technical aspects of inventories, however, these data should represent more than tabulations of data points in time and space. The NPS Resource Inventory and Monitoring Program must be designed to integrate the management concerns with a scientific/technical effort that identifies and quantifies key components of those resources with some level of ecological understanding that will allow both scientific comprehension and management interpretation. Here, we would like to introduce the term **ecological paradigm**, defined as a specific model or set of hypotheses encompassing comprehensive characterization of resources at the population, community, or ecosystem level of organization. There must be an ecological basis to the inventories that can explain changes in measured attributes of natural resources due to natural variability, naturally induced change, and man-induced change.

Examples of natural resource management concerns at different levels of biological organization and some of the technical aspects associated with specific ecological paradigms are found in Table 1.

Environmental monitoring of important natural resources is an extension of resource inventories. The same partnership and general procedures integrating management and scientific personnel in inventories should be developed to pose questions for monitoring programs. Resource managers are ultimately responsible for the questions posed by a monitoring program and final questions as to how the data will be used. Monitoring, by definition, is limited in magnitude and frequency of data collected. Resource management should be especially aware of the limits and conflicts inherent in any monitoring program. Two general opposing strategies of monitoring are 1) distinguishing departures from standard conditions, detections of violations of standards, or 2) establishing changes in conditions or key variables over time. These two contrasting activities have conflicting data requirements. Where resources are limited the environmental questions should be elaborated before the monitoring program begins.

This outline of technical aspects is not intended to be exhaustive of all possible aspects of natural resource inventories or environmental monitoring, nor should a resource inventory in a Park necessarily include all of the items elaborated in the lists. Inventory and monitoring in the National Park System is a relatively new concept and practice, and one that will vary among parks and evolve with time. These are essential steps that assign specific roles to resource managers and scientists to help insure useful knowledge in the managing of Park resources.

Herrman is Hydrogeologist and Boyle is Research Ecologist with the NPS Water Resources Division, Colorado State University, Fort Collins, CO 80523.