

Why Monitor Park Health?

By Gary E. Davis and William L. Halvorson

Some pragmatic park managers are asking "Why should I monitor park resources? I already know about more problems than I can afford to address for a long time, why spend money looking for additional problems?"

These are serious questions, especially when asked in the fiscal climate of Gramm-Rudman deficit reduction and eroding park budgets. The immediate answer stems from our profound lack of knowledge of park resources and the forces that sustain them. With the current level of knowledge we cannot be certain we are addressing the most critical issues. We may find ourselves treating ingrown toenails while our patient is dying of undiagnosed cancer.

The authors have been professionally concerned about the conditions of natural resources in national parks for nearly a quarter of a century as fire control aid, park ranger, resource management specialist, and research scientist. Our experience and research in aquatic and coastal ecosystems provided early opportunities to witness, in short time periods, the dynamic nature of such systems. We witness firsthand how important were extreme "catastrophic" events in shaping long-term resource conditions in places like New England, the Virgin Islands, South Florida, and the California Channel Islands. From this perspective, it was apparent that the Service was trying to preserve natural systems without understanding how they were constantly changing.

In addition to natural dynamics, we also saw the ecological integrity of parks threatened because the NPS did not have adequate information upon which to act or with which to compete in political battles over urban encroachment and allocations of water and fishery resources. It became clear to us that if the parks were to survive into the 21st century as anything more than pleasuring grounds and emotional retreats from urban landscapes, the NPS must obtain and maintain evidence that is defensible in a court of law on the condition of park resources.

What is needed is nothing less than a continuous program for monitoring natural resources, equivalent to those programs that already exist for monitoring facilities, personnel, and fiscal resources. In 1980, Congress provided a legislative mandate to inventory and monitor population dynamics of marine and terrestrial species in Channel Islands NP. We used that opportunity to develop a park-based ecological monitoring program. Based on that experience, we will share with you our ideas about WHY the National Park Service needs to monitor natural resources, WHAT natural resources should be monitored, and HOW to monitor them. Furthermore, we propose that the Channel Islands NP program could serve as a useful model for other parks.

WHY Monitor

In addition to being pleasuring grounds and emotional retreats, national parks as natural ecosystems also provide society with the greatest possible diversity of wild gene pools and serve as ecological standards of "miner's canaries" for the biosphere. The NPS mission is to maintain healthy park ecosystems by preserving and protecting unimpaired parks and restoring others to produce vignettes of primitive America.

Healthy parks, just like healthy people, maintain themselves. However, the NPS must play the role of

family physician for parks by:

1. Determining when the park is sick by monitoring ecological health with regular checkups.
2. Treating illness (dysfunction) and repairing damage, and
3. Preventing illness and mitigating threats.

A natural resource monitoring program must provide the same kinds of information to park managers that health monitoring provides to physicians. It must indicate current health, predict future conditions, be sensitive to subtle chronic stresses, identify overt lethal threats, and suggest effective treatments for dysfunction. An effective monitoring program also will help identify causes of system dysfunction in addition to identifying signs and symptoms.

Development of modern medicine provides a good analogy to understand the "state of the art" of natural resource management. Diagnosis and treatment of dread diseases like cancer have come a long way in the 400 years since William Harvey discovered the function of the heart and circulatory system. In the 17th century, people died of cancer without diagnosis or treatment of underlying causes. Fifty years ago cancers were diagnosed posthumously but not treated. Twenty years ago, with late diagnosis, radical surgery, and harsh chemical and radiation treatments, few people survived cancer. Today we monitor our bodies, diagnose earlier, treat with minor surgery and chemotherapy, and many survive. In the next generation, more reliable monitoring, precursor diagnosis, and more effective treatment will "cure" our children's generation of cancer. And in the near future, we hope to understand cancer's cause and prevent it from occurring in our grandchildren.

Natural ecosystems are dying in parks and we can't even diagnose the illnesses, let alone identify their causes, prescribe treatments, or begin preventive actions. Our present level of knowledge of ecosystem management is equivalent to the 17th century level of human medicine. Long-term ecological monitoring is the first step in learning how to assess ecosystem health, establish normal limits of variation, diagnose illness, and develop preliminary treatments. We have to learn what and how to monitor, and how to use the results before we can develop our first generation of treatments. Development of effective treatments for ecosystem dysfunction require knowledge of causes. Clinical observation and experimental research identified causes of human disease, but causes of change in natural systems are poorly known. Monitoring identifies potential agents of change by correlation, like clinical observation, and helps frame experimental designs to identify actual causes that will lead to development of effective treatments.

WHAT To Monitor

We need to discover the "vital signs" of park ecosystems, learn how to monitor them, define normal conditions, and develop treatments to mitigate human impacts. Just as a physician monitors patients' vital signs we need to monitor ecosystem parameters. Physicians measure pulse, blood pressure, temperature, weight, height, age and can determine present health and project near-term future health from these and other basic parameters of human physiology.

There are several legitimate ways to describe ecosystems. Among the more popular and potentially useful for long-term monitoring are biodiversity, energy flux, nutrient cycles, and population dynamics. Bio-

diversity is an important attribute of the biosphere that functions at many levels: genetic, individual, population, community, and even ecosystem. The repeated inventories required to monitor biodiversity are expensive and difficult to conduct. They require highly skilled surveyors to identify the elements of diversity. The most common level of ecological diversity, the species, is not very sensitive to environmental stresses and provides only a record of the past. Changes in diversity are difficult to assess and ambiguous to interpret in terms of system changes. They are also difficult to apply to management issues.

Energy flux provides a common currency for comparisons among system elements by reducing everything to kilocalories. Measurements of energy in ecosystems is often complex and difficult in the field, and frequently requires destructive sampling (e.g. estimating biomass in root systems). Changes in energy flux also are difficult to interpret in terms of system health.

Ecological limiting factors, such as nutrients, can be used to characterize ecosystems. Drawing on an important management principle, this approach to system monitoring selects a few critical control points in the system and evaluates the flow of selected constituents through those points. This approach requires an extensive *a priori* understanding of ecosystem structure and function, and as with energy flux, measurements are often complex and difficult to conduct in wilderness settings. The results also are difficult and ambiguous to interpret.

Population dynamics, the ways in which populations change, offers the best solution to the biological component of NPS ecosystem monitoring. Parameters of populations like abundance, distribution, age structure, reproductive effort, and growth rate are easily measured, sensitive to subtle, chronic stress, and can project future conditions. This approach also reflects a wide variety of environmental conditions because organisms integrate effects of influences like predation, competition, and food condition, and express their responses as easily measured population parameters. Parameters such as age structure and reproduction permit projections of future conditions, providing early warnings of pending problems. Subtle, chronic stresses are reflected in reduced growth and reproductive rates. Interpretation of these parameters is direct and can be synthesized into system level applications, and most management controls operate at the population level, so applicable to management issues is direct and measurable.

The selection of taxa to monitor may be one of the most perplexing aspects of designing a monitoring program. At Channel Islands NP we took a Delphi approach, with selection guidelines. After dividing park resources into an exhaustive list of large, mutually exclusive, classical taxonomic categories, experts in each taxon were asked to select species that represented a broad array of ecological roles, with examples of many trophic levels and life forms from primary producers to top carnivores and sessile invertebrates to wide ranging birds and mammals. Species with legal status or specifically mentioned in park enabling legislation were included, as were endemics and aliens, harvested taxa, dominants characteristic of whole communities, common taxa, and heroic or charismatic species. Major environmental factors, such as weather and sea temperature are also important determinants of system dynamics, and must be monitored. Some professional judgment is required to determine if exist-

ing resource inventories are sufficient to identify system "vital signs," but we suspect that most parks have enough information with which to proceed.

Site selection is also important. It is important to put the thermometer under your tongue every time to get reliable body temperature readings, but it is not necessary to measure body temperature on a uniform grid all over your body to get an accurate reading. Monitoring locations need to be stratified to efficiently sample selected populations. Sites need to be representative of the entire system to be monitored, but it's too expensive to sample on uniform grids just to satisfy GIS software.

HOW To Monitor

At Channel Islands NP a step-down plan was used to describe the tactics of monitoring system design (Fig. 1). The major activities were a literature review funded by the Man-in-the-Biosphere Program, monitoring population, dynamics, and report preparation. Design and testing of monitoring protocols was the major research effort, which consisted of two activities: 1) species selection, accomplished through literature reviews, field surveys (inventories) and application of selection criteria, and 2) a series of design studies to develop monitoring protocols. Each design study summarized historical data, selected or designed sampling systems, established data management procedures, established reporting procedures, and field tested and documented the protocol in a handbook.

Long-term programs must be capable of adapting to changing conditions and improved technology without losing continuity. Changes in monitoring protocols are documented in the annual report on the condition of each resource category and the handbooks are updated accordingly. Ten handbooks have been completed to date: pinnipeds, sea birds, rocky intertidal communities, kelp forest, terrestrial vertebrates, land birds, terrestrial vegetation, fishery harvest, weather, and visitors. Two more are in production: terrestrial invertebrates and sandy beaches and estuaries.

Even though this approach divides park ecosystems into arbitrarily defined, but manageable units, application of results will require synthesis, into ecologically complete units. This synthesis requires collaboration of both resource management and research personnel. Natural resource monitoring must be conducted as a scientific endeavor, but it is conducted as a base-funded resource management operation, not as research.

The population dynamics based system designed for Channel Islands NP is a good model for other NPS units. Channel Islands NP faces overt threats to park ecosystems that are common to many parks: alien species, air and water pollution, and direct human impacts, such as fishery harvest, trampling and collecting, trail erosion, and wildlife disturbance. The diversity of marine and terrestrial resources at Channel Islands also assures analogs with most other park units.

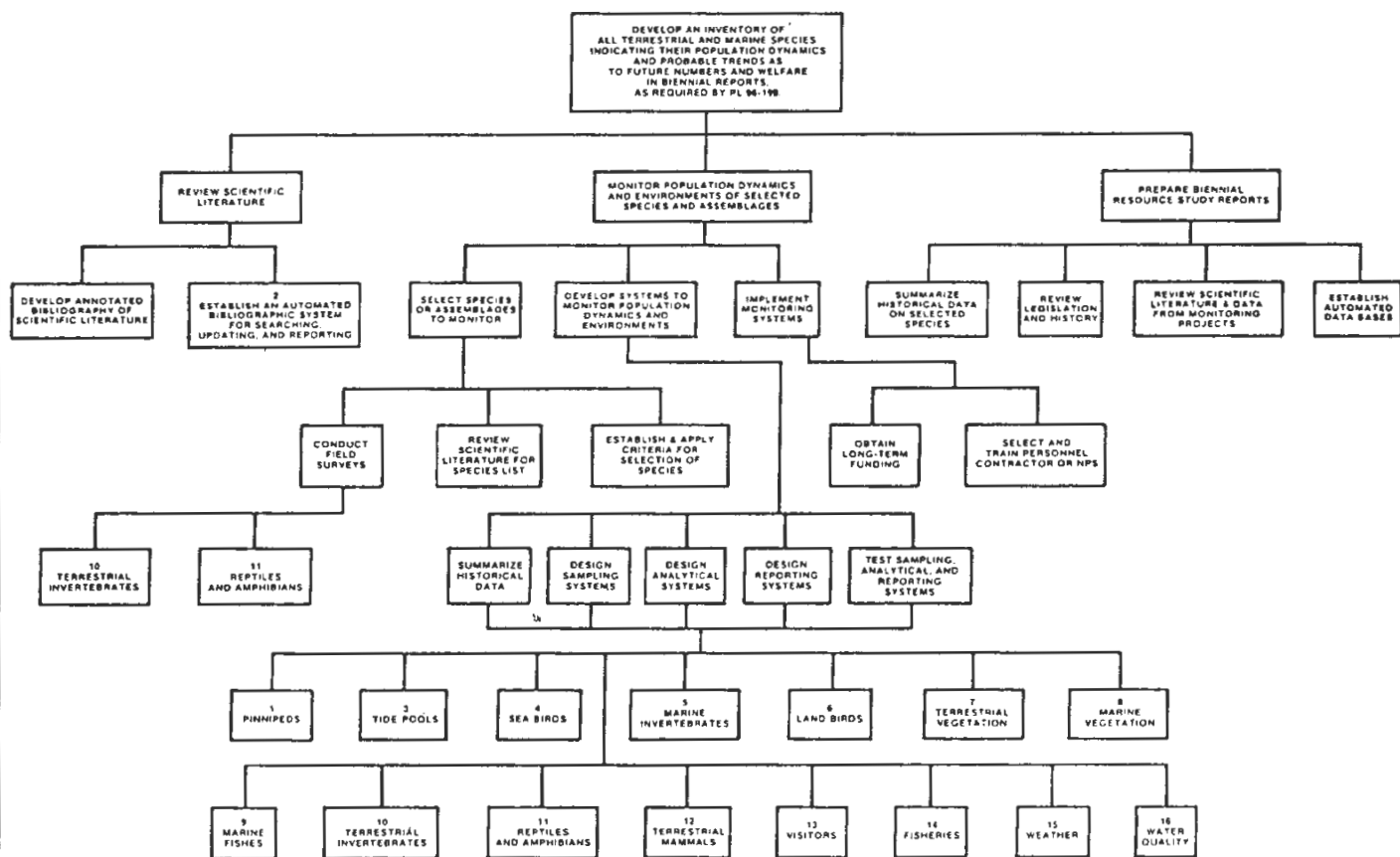
Summary

Natural resources need to be monitored to assess the health of park ecosystems, to determine normal limits of variation, to identify illnesses early enough to effectively and economically treat them, and to understand park systems well enough to prevent disfunction. The biological components of natural resource monitoring in national parks should be based on population dynamics of key species. These populations integrate environmental conditions and respond with changes in easily measured parameters, project future conditions for early warnings, are sensitive to subtle chronic stresses, permit direct interpretation of resource conditions and can be synthesized into system level applications.

In addition, many management controls on the system function at the population level. The Channel Islands model can be adapted for Service-wide application. The next great challenge is implementation and institutionalization. Now that we have begun determining why, what, and how to monitor, we need a commitment to scientific management and park-level base-funding to do it. If accountability for knowing the condition of park ecosystems were made equal to that for facilities, personnel, and fiscal resources, managers will find the best solutions for their units.

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STEP-DOWN PLAN FOR NATURAL RESOURCES MONITORING AT CHANNEL ISLANDS NATIONAL PARK, CALIFORNIA



NUMBERS INDICATE PRIORITY OF PROJECTS
ESTABLISHED BY SUPERINTENDENT, CHIS AND
NATURAL SCIENCE DIVISION, WFO