Long-term Monitoring in NPS Sierra Nevada Network Parks

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Attaching a tree tag to a lodgepole pine in a high-elevation forest monitoring plot in Kings Canyon National Park.

ABSTRACT

The National Park Service (NPS) established the Inventory and Monitoring (I&M) Program in the late 1990s to perform baseline inventories of natural resources and monitor a modest set of indicators of ecosystem condition, a.k.a "vital signs" (Fancy et al. 2008). As one of 32 I&M networks, the Sierra Nevada Network (SIEN) was created to address these goals at Yosemite National Park, Sequoia and Kings Canyon National Parks, and Devils Postpile National Monument (Figure 1). Having worked closely with park staff and cooperators to select vital signs and develop methods, SIEN will follow six detailed protocols to monitor status and long-term trends in 10 physical and biological vital signs, ranging from lake water chemistry to bird communities and high-elevation forest dynamics. Our results will be used to determine the condition of these resources, identify the natural range of variation, provide early warning of abnormal conditions, and help managers make better-informed decisions.

Another key element of the I&M program is proper stewardship of collected information - so that it remains accessible to park managers, scientists, and public audiences over the long-term. By sharing expertise, methods, data, and results among SIEN parks and its partners, SIEN supports the development of regional resource management goals and evaluation of progress towards these goals over time. Here, we summarize the development of our program, our approach to monitoring protocol development and sampling design, and the ecological importance of vital signs selected.

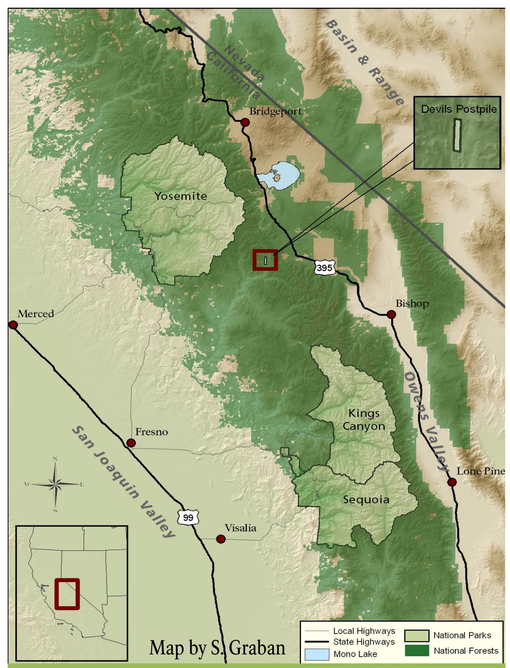


Figure 1. Parks within Sierra Nevada Network and regional context (inset).

PLANNING PROCESS AND VITAL SIGNS SELECTION

The monitoring program at each network was developed using a multi-step process, including synthesis of existing information, development of conceptual ecosystem models, selection of vital signs through a series of workshops, and development of a detailed monitoring protocol that specifies objectives, sampling design, and methods for data collection, management, analysis, and reporting. Vital signs were prioritized based on ecological significance, management importance, law and policy, and sensitivity to large-scale stressors, particularly climate change. Table 1 summarizes the monitoring projects that are being implemented in SIEN parks.

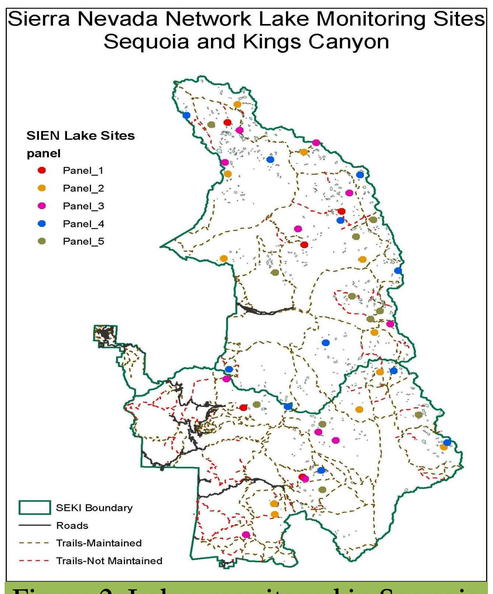


Figure 2. Lakes monitored in Sequoia & Kings Canyon National Parks

PROTOCOL DEVELOPMENT & SAMPLE DESIGN

SIEN staff worked with park staff and outside scientists to develop each monitoring protocol, including making decisions about objectives, sample designs, methods, and analysis. To detect status and trends at the park- or network-level, four of our projects (birds, high-elevation forests, lakes, and wetlands) employ a spatially extensive, probabilistic sample design based on a generalized random tessellation sampling (GRTS) algorithm (Stevens and Olsen 2004). To improve our status estimates for each resource, we employ a multi-panel sampling design where only a subset of the total number of sample units are visited on a regular interval or rotating basis (McDonald 2003). In three of the protocols, we improved our ability to detect trend by adding a panel of sites that will be visited each year. Figure 2 shows lake monitoring sites in Sequoia and Kings Canyon National Parks, where sites in panel 1 are visited annually and sites in other panels are visited every four years.

Table 1. Long-term resource monitoring projects in the Sierra Nevada Network.

Project Name	Vital Signs Monitored	Parks Included	Project Status
Birds	Bird populations	All SIEN parks	Implemented 2011.
High-elevation Forests	Foxtail and whitebark pine populations	SEKI, YOSE*	Implemented 2011.
Lakes	Water chemistry, amphibians	SEKI, YOSE	Implemented 2008.
Rivers	Surface water dynamics	All SIEN parks	Protocol peer-reviewed, under revision. Implementation in 2013.
Climate Reporting	Weather and climate, snowpack	All SIEN parks	Protocol finalized 2012. Implementation in 2013.
Wetlands	Plant communities, macroinvertebrates, and groundwater level	All SIEN parks	Protocol peer-reviewed, under revision. Implementation 2014.

*SEKI=Sequoia and Kings Canyon National Parks, YOSE=Yosemite National Park.

REFERENCES

Fancy, S. G., J. E. Gross, and S. L. Carter. 2008. Monitoring the condition of natural resources in U.S. National Parks. Environmental Monitoring and Assessment 151: 161-174.

McDonald, T. L. 2003. Review of environmental monitoring methods: survey designs. Environmental Monitoring and Assessment 85: 277-292.

Stevens, D. L. and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99: 262-278.

VITAL SIGNS MONITORED AND REASONS FOR SELECTION

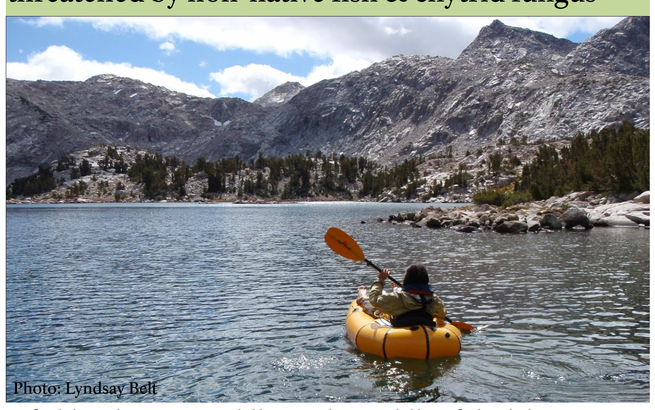
BIRDS – high species diversity; occur across entire range of parks' elevations; sensitive to climate change and altered fire regimes

Observers listen for birds like this pygmy nuthatch along point count transects throughout the parks.

HIGH-ELEVATION FORESTS – foundational species in subalpine ecosystems; threatened by a non-native pathogen, beetles, and climate change

Whitebark pine was warranted for listing as a federally endangered species in 2011.

LAKES – sensitive to air pollution (contaminants, nutrients) & climate change; wildlife habitat threatened by non-native fish & chytrid fungus

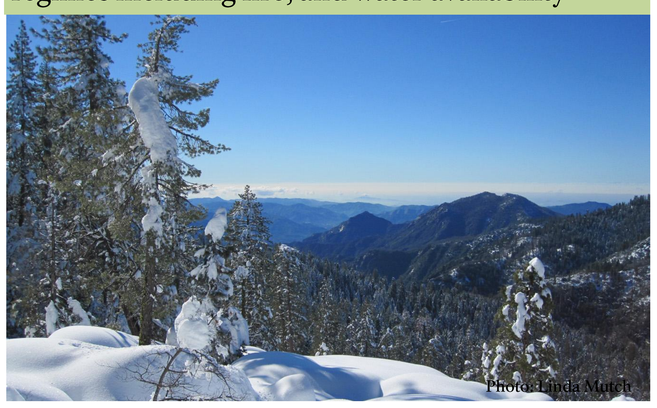


A field technician paddles to the middle of the lake to collect water samples.

WETLANDS – high biodiversity; wildlife habitat; sensitive to local & regional stressors (e.g., nonnative plants, climate change) & human disturbance (e.g., stock use, altered hydrology)

NPS staff and university cooperators install a wetlands monitoring plot.

CLIMATE – driver of physical and biological processes that affect s plants, animals, disturbance regimes including fire, and water availability



SIEN will gather and synthesize data from existing meteorological stations and snow courses in annual weather reports.

RIVERS – water supply for parks' ecosystems and much of California; seasonal flow patterns sensitive to changes in climate

SIEN staff work with Devils Postpile NM staff to monitor the Middle Fork of the San Joaquin River.