Department of the Interior
National Park Service
Natural Resource Program Center

National Park Service Global Climate Change Activities, Contributions, and Needs

The National Park Service (NPS) is responsible for managing 391 park units, including more than 270 that contain significant natural resources. NPS supports a wide range of activities to address its mission to preserve these resources, unimpaired, for the enjoyment of future generations. Here, we summarize ongoing NPS monitoring activities, partnerships, and areas where capacity can be increased to contribute to a new DOI Climate Change (CC) monitoring initiative.

Historical and Current Monitoring

National parks protect many of the nation's most pristine and intact ecosystems. As a result, many parks are used as benchmark ecological sites because they are less influenced than other areas by the confounding effects of anthropogenic land use and land cover changes. The following examples highlight NPS-sponsored monitoring within National Parks to detect short and long-term climate change and effects on biota and ecosystems.

- **Vital Signs monitoring:** Parks have been organized into 32 Inventory and Monitoring (I&M) networks that have all begun long-term monitoring of the most important indicators ("vital signs") of park ecological conditions. Working with park managers and subject matter experts from more than 150 universities and partner agencies, the 32 networks have all identified their highest priority issues and monitoring needs, developed conceptual models of park ecosystems, and have developed databases and procedures for managing, analyzing, and reporting monitoring results. Organizational structures that include the superintendents and natural resource managers for all parks are in place. Virtually all of the high-priority Vital Signs summarized in Table 1 are directly or indirectly related to climate change.
- **Climate monitoring stations:** More than 2200 climate stations are located within National parks, including state-of-the-art Climate Reference Network stations (CRN) in 19 parks in the I&M Program - 17% of all CRN stations. NPS hosts stations associated with many state and local networks, including the NWS Coop, SNOTEL, and RAWS, and parks are located in all major biomes.
- **Inventory and provision of climate data:** This year NPS completed an inventory of all existing climate monitoring stations in or near approximately 280 parks. NPS currently has direct access to multiple climate databases and is working with Regional Climate Centers to provide historical and current climate data collected by multiple mesonets. (see: http://www.wrcc.dri.edu/nps/reports.php)

Leveraging NPS Investments

With the establishment of the I&M program, NPS has invested much time and effort to compile, evaluate, synthesize, and disseminate monitoring data to parks and partners. This systematic, park-based approach provides a functional, on-the-ground monitoring infrastructure that can be enhanced to significantly contribute to DOI climate monitoring needs.

- **Park-based scoping of climate change indicators:** All 32 NPS I&M networks completed a multi-year, comprehensive scoping process to identify and prioritize Vital Signs. This process involved several thousand NPS staff and technical experts. Most high-priority Vital Signs selected for monitoring were also identified by the DOI Climate Change Task Force Land and Water Management Subcomittee as key resources likely to be affected by climate change.
- **Legacy data inventories:** All 32 NPS I&M networks have cataloged and evaluated historic datasets collected within parks. In many parks, effects of climate change are already documented via reports,

photographs, range assessments, and scientific surveys. For example, changes in glacier mass are well documented from photographic record, and from ongoing mass balance studies in e.g. North Cascades, Glacier, and Glacier Bay National Parks.

- **High-quality data collection and management:** All monitoring supported by the NPS I&M Program complies with peer-reviewed protocols, includes complete metadata, and observational data are professionally managed. Protocols are shared on the internet and through the NBII Natural Resource Monitoring Partnership (NRMP).
- **Existing climate change partnerships:** NPS is an active participant in climate change monitoring and research programs including the CRN, the National Phenological Network (NPN), and the Consortium for Integrated Climate Research in Western Mountains (CIRMOUNT). Park-based projects sponsored by USGS, NASA, and NSF are focused on detecting, understanding, and mitigating climate change impacts on parks and associated ecosystems.
- **Education and Outreach:** Among all DOI agencies, National Parks are the most visited and iconic environments for the public to experience the consequences of climate change. NPS has a unique capacity through NPS Research and Learning Centers, and interpretive and educational programs to communicate the effects and importance of climate change.

NPS needs from a DOI CC Initiative

NPS has recently established a nationwide system of monitoring networks that are collecting data at appropriate spatial and temporal scales to address the needs of the DOI Climate Change Task Force. A strategy should be adopted that leverages previous DOI investments in NPS I&M climate-related monitoring.

- **Enhanced ecological monitoring.** Parks are premier sites for detecting effects of climate change. NPS has an in-place framework for monitoring high-priority Vital Signs, and this NPS investment can be leveraged to provide effective monitoring of climate changes by increasing the spatial coverage, sampling intensity, or number of climate-relevant vital signs. Enhancement of the existing system is an efficient and cost-effective means for rapidly improving DOI capacity to detect and understand effects of climate change across a broad spectrum of habitats and ecosystems.
- **Forecasting climate changes at relevant scales.** Park management actions typically occur at landscape scales, and improvements in model downscaling techniques will enhance the value of predictions from climate models at management-relevant scales.
- **Integrated assessments of impacts** to a broad range of resources. The range of pertinent issues to biota, hydrology, disturbances, and infrastructure and facilities is clearly documented by IPCC and others. Assessments are needed to evaluate a range of both climate change and response scenarios. Scenario analyses must address priority concerns of park staff, as articulated by selection of priority Vital Signs.
- **Communication and education** materials suitable for a range of audiences, and based on sound science.
- **Guidelines for implementing DOI's adaptive management principles.** Clear connections between hypotheses, management actions proposed by the Climate Change Task Force, and ecological monitoring will help ensure alternative actions are evaluated and that results influence future management responses.

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Table 1. A summary of the 32 NPS I&M networks and parks conducting long-term vital signs monitoring using existing funding (including partnerships with others where the networks will deliver data summaries to park managers and planners).

Vital Sign Category	Example Measures (varies by network)	# of Networks	# of Parks
Weather and Climate	Temperature, precipitation, wind speed, ice on/off	32	258
Water Chemistry	pH, temperature, dissolved oxygen, conductivity	32	241
Invasive/Exotic plants	Early detection (predictive search models); presence/absence, area covered by exotic species	29	236
Land Cover and Use	Area in each land cover and use type; patch size & pattern	29	230
Surface Water Dynamics	Discharge/flow rates (cfs), guage/stage height, lake elevation, spring/seep volume, sea level rise	29	192
Birds	Species composition, distribution, abundance	29	177
Ozone	Atmospheric ozone concentration, damage to sensitive vegetation	20	147
Fire and Fuel Dynamics	Long-term trend of fire frequency, average fire size, average burn severity, total area affected by fire	20	125
Mammals	Species composition, distribution, abundance	23	124
Wet and Dry Deposition	Wet deposition chemistry, sulfur dioxide concentrations	18	108
Forest/Woodland Communities	Community diversity, coverage and abundance, condition & vigor classes, regeneration	16	104
Visibility and Particulate Matter	IMPROVE network measurements; visibility and fine particles	21	100
Aquatic Macroinvertebrates	Species composition and abundance	17	100
Vegetation Complexes	Plant community diversity, relative species / guild abundance, structure / age class, incidence of disease	15	98
T&E Species and Communities	Population estimate, relative abundance, cross-park distribution, sex ratio, age class ratio	20	98
Soil Function and Dynamics	Soil nutrients, cover and composition of biological soil crust communities, soil aggregate stability	15	97
Nutrient Dynamics	Nitrate, ammonia, DON, nitrite, orthophosphate, total K	12	89
Air Contaminants	Concentrations of semi-volatile organic compounds (SOCs), persistent organic pollutants (PCBs, DDT), Hg	15	87
Stream/River Channel Characteristics	Channel width, depth, and gradient, sinuosity, channel cross-section, pool frequency and depth, particle size	14	85
Amphibians and Reptiles	Species distribution & abundance, population age/size structure, species diversity, percent area occupied	20	82
Groundwater Dynamics	Flow rate, depth to ground water, withdrawal rates, recharge rates, volume in aquifer	12	73
Insect Pests	Extent of insect related mortality, distribution and extent of standing dead/stressed/diseased trees, early detection	9	64
Fishes	Community composition, abundance, distribution, age classes, occupancy, invasive species	14	57
Toxics	Heavy metals, organochlorides, PCBs, dioxins, mercury	9	54
Riparian Communities	Species composition and percent cover, distribution and density of selected plants, canopy height,	9	51
Invasive/Exotic animals	Invasive species present, distribution, vegetation types invaded, early detection at invasion points	12	50
Microorganisms	Fecal coliform, *E. coli*, cyanobacteria	7	40
Wetland Communities	Species composition and percent cover, distribution and density of selected plants, canopy height, aerial extent	9	40
Coastal/Oceanographic Features & Processes	Rate of shoreline change, sea surface elevations, area and degree of subsidence through relative elevation data	8	35
Grassland/Herb Communities	Composition, structure, abundance, changes in treeline	9	35
Soundscape	Types and time periods of natural and anthropogenic sound; percent-time-audible	7	33
Extreme Disturbance Events	Type, frequency, size and location of extreme disturbance events such as windthrow, landslides, floods, and drought	3	27

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