Greater Yellowstone Network

National Park Service
U.S. Department of the Interior
Inventory & Monitoring Program

Inventory and Monitoring in the National Park Service

The National Park Service's mission is to manage park resources unimpaired for future generations. Protecting and managing some of our nation's most significant natural resources requires basic knowledge of the condition of the ecosystems and species that occur in national parks. To better understand the health of the parks, the National Park Service Inventory and Monitoring (I&M) Program was established in the early 1990s. This program organized all parks with significant natural resources into 32 networks based on proximity and ecological similarity.

There are two major components to the I&M Program (1) gathering baseline information about parks through natural resource inventories, and (2) conducting long-term monitoring for key indicators of ecological health, or *vital signs*.

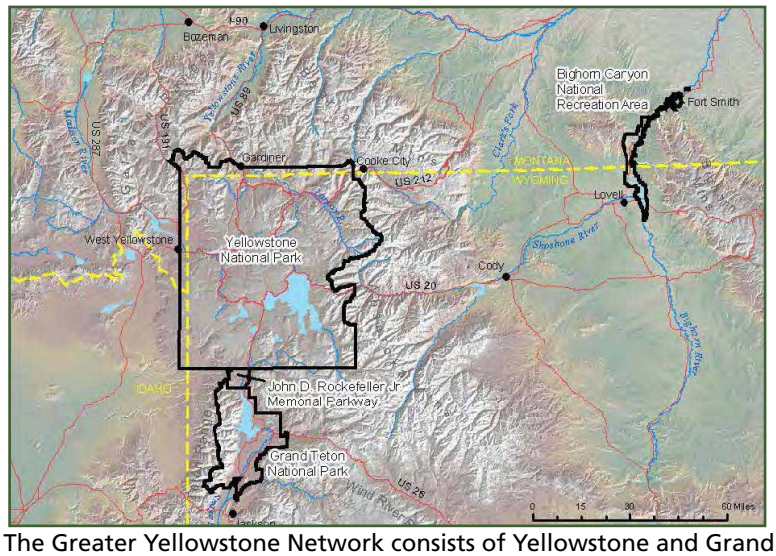
I&M program staff conduct fieldwork and complete analyses on a range of topics from climate to water quality and on ecological communities from semi-arid sage steppe to alpine. This fieldwork provides park managers with scientific findings to make informed decisions that preserve and protect park resources for public enjoyment. Synthesized information from I&M products is made available to resource managers, interpreters, rangers, and the public.

Long-term vital signs monitoring helps describe changing conditions of natural resources to inform adaptive management decisions, and thus to better protect park resources today and for future generations.

About the Greater Yellowstone Network

The Greater Yellowstone Network (GRYN) is composed of four national park units in Wyoming, Montana, and Idaho. Grand Teton and Yellowstone national parks, and the John D. Rockefeller, Jr. Memorial Parkway are the core of the 18-million-acre Greater Yellowstone Ecosystem (GYE), one of the largest, relatively intact natural areas in the contiguous United States. These three units include a broad range of climatic zones, habitat types, and elevation profiles, and encompass great biological diversity. Sagebrush, lodgepole pine forest, wetlands, large rivers, and alpine meadows are a few of the ecosystems GRYN monitors. Bighorn Canyon National Recreation Area and the Pryor Mountain Wild Horse Range include juniper-mountain mahogany and ponderosa pine woodlands, unique desert cushion plants, shrublands, and riparian ecosystems.

The GYE contains the headwaters of the Yellowstone, Snake, Bighorn, and Shoshone rivers. These watersheds are characterized by landscapes influenced by a diversity of geologic processes and support distinct plant and animal communities including a diversity of large mammals. Taken together, the unique geologic, hydrologic, and biological characteristics of this region set it apart from other regions in the continental United States.



The Greater Yellowstone Network consists of Yellowstone and Grand Teton national parks, Bighorn Canyon National Recreation Area, and the John D. Rockefeller, Jr. Memorial Parkway.



Monitoring common resources across the parks increases our understanding about ecosystems in the region and how they are changing. Greater Yellowstone Network parks include Yellowstone (left) and Grand Teton (middle) national parks, and Bighorn Canyon National Recreation Area (right).

Vital Signs Monitoring

The goals of natural resource monitoring for the National Park Service are to (1) determine the status and trends in selected indicators (vital signs) of the condition of park ecosystems to inform managers' decisions and to work effectively with other agencies and individuals for the benefit of park resources; (2) provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management; (3) provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments; (4) provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment; and (5) provide a means of measuring progress towards performance goals.

GRYN adopted three broad monitoring questions. Answers to these questions, achieved through specific monitoring objectives and information from other programs monitoring natural resources within the GRYN parks, present an integrated examination of the state of the parks' ecosystems.

- *What is the status and trend of selected ecosystem drivers and stressors currently or potentially affecting park resources?*
- *What is the status and trend of selected species and communities (both plant and animal) and how are they changing as ecosystem stressors and drivers change?*
- *What knowledge of drivers, stressors and resources of concern will affect sound management decisions and help to protect key resources or provide scientific evaluation and interpretation of ecosystem change?*

Table 1. Active vital signs monitoring of the Greater Yellowstone Network.

Vital Sign	Date Initiated	Link to Information and Activities
Amphibians	2005	http://science.nature.nps.gov/im/units/gryn/monitor/amphibians.cfm
Climate	2007	http://science.nature.nps.gov/im/units/gryn/monitor/climate.cfm
Ecological Response to Climate Change[1]	2010	http://science.nature.nps.gov/im/units/gryn/monitor/climate_change.cfm
Land Use	2010	http://science.nature.nps.gov/im/units/gryn/monitor/land_use.cfm
Upland Vegetation	2011	http://science.nature.nps.gov/im/units/gryn/monitor/upland_veg.cfm
Water Resources	2004[2]	http://science.nature.nps.gov/im/units/gryn/monitor/water_resources.cfm
Whitebark Pine[3]	2004	http://science.nature.nps.gov/im/units/gryn/monitor/whitebark_pine.cfm

[1] Climate change monitoring is a collaborative effort with the Rocky Mountain Network.
[2] Regulatory parameters started in 2004; additional components were added later.
[3] An interagency collaboration throughout the Greater Yellowstone Ecosytem.

The GRYN vital signs (Table 1) include a suite of physical, chemical, and biological elements and processes that are important to network parks.

For more information, contact:
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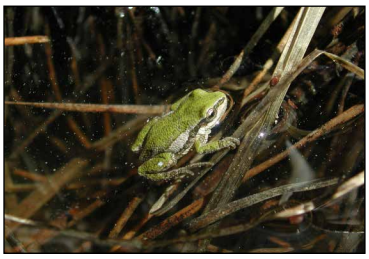
Vital Signs Monitoring Summaries

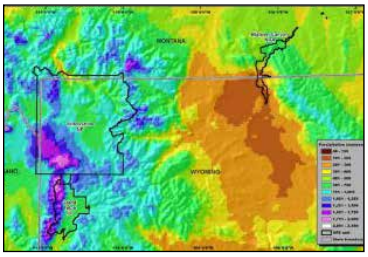
Amphibians and Wetlands



Wetlands and amphibians are sensitive to climate change. In Grand Teton and Yellowstone national parks, amphibians depend on limited shallow wetland habitat. Each year, the GRYN monitors amphibian species widely found in the parks—Columbia spotted frog (*Rana luteiventris*), boreal chorus frog (*Pseudacris maculata*), tiger salamander (*Ambystoma mavortium*), and boreal toad (*Anaxyrus boreas*). Comprehensive monitoring of amphibians requires surveying and revisting hundreds of wetlands and potential breeding sites annually.

The overall goal of the long-term monitoring program is to characterize changes in wetland condition and estimate occupancy rates for breeding native amphibian species. Annual monitoring is used to track and quantify changes in the number and quality of potentially suitable breeding sites. Our monitoring is combined with other Amphibian Research and Monitoring Initiative (ARMI) regional and national monitoring efforts to better understand trends in amphibian populations. Hydrological fluctuations can cause population numbers to vary from year to year, and data collected to date indicate that recent changes are within the range of natural variation and populations are generally stable in Grand Teton and Yellowstone national parks.

Climate



Climate is the set of long-term, average meteorological conditions that occur over several decades or longer. Unlike weather, which fluctuates greatly in the short term and is difficult to predict, climate is relatively stable, and many organisms have adapted to its predictable rhythms. As a result, climate is a driving force behind many ecological processes. For example, average temperature and precipitation determine the distribution of plant and animal species and the rate at which they grow. Temperature and precipitation regimes also strongly influence the frequency and severity of forest fires, the intensity and timing of peak stream flow and local and regional drought, which are important factors in natural ecosystem processes.

Climate monitoring describes five key climate metrics: precipitation, temperature, snowpack, drought, and streamflow. Data for climate monitoring are obtained from national meteorological and surface monitoring programs including the National Weather Service, Cooperative Observer Program, the Natural Resources Conservation Service, Snow pack telemetry (SNOTEL), and the U.S. Geological Survey Stream Gauging Network and made available at http://www.climateanalyzer.org. Here individuals can customize queries, generate monthly and annual statistics and make comparisons with climate normals.

Ecological Response to Climate Change

As climate changes over the next 100 years, the Greater Yellowstone Ecosystem (GYE) and the Bighorn Basin areas are expected to experience warmer temperatures and may experience warmer temperatures and reduced annual precipitation, including a decrease in annual snowpack. These climate shifts may cause changes in ecosystem functions and species distributions. In order to help managers anticipate, identify, and address climate-related changes that could affect park resources, the GRYN, Rocky Mountain (ROMN), and Upper Columbia Basin (UCBN) networks prepared a High Elevation Climate Change Response Strategy in 2010 that adds emphasis to the monitoring and analysis of climate data, snowpack, and land surface phenology as well as climate-threatened species and communities including sagebrush steppe, alpine vegetation, and five-needle pine.

Alpine ecosystems are some of the most sensitive to climate change and disturbance. In coordination with the ROMN, the GRYN is monitoring alpine ecosystems through the Global Observation Research Initiative in Alpine environments (GLORIA). Monitoring includes sampling of vascular plants, and soil temperature at a set of four alpine summits along an elevation gradient. There are GLORIA sites in Rocky Mountain, Great Sand Dunes, Glacier, and Yellowstone national parks in addition to many others across the Rocky Mountains.

Network ecologists work with Grand Teton National Park to monitor sagbrush-steppe ecosystems to detect changes associated with climate change; and with U.S. Geological Survey scientists to understand how changes in climate may impact stream and wetland resources throughout the GYE. In addition, the network participates through the Great Northern Landscape Conservation Cooperative to understand how climate change may impact the region beyond the GYE.

Land Use

An increase in housing and road density can further fragment the landscape, decrease the size of the functional ecosystem, reduce connectivity among native habitat patches, isolate species in small patches, and increase the contrast in vegetation structure and function along park boundaries. Such changes outside park boundaries can have major implications to structural and functional ecosystem properties including fire frequency, species distributions, water quality, air quality, habitat fragmentation, soil erosion, and introduction of exotic species.

Approximately 67% of the land within the GYE is public land managed by federal agencies. The USDA Forest Service manages nearly 50% of the area while the National Park Service manages roughly 10%. Private lands make up about 30% of the area with the remainder of the lands under tribal, state, or local management. Population in the GYE was sparse at the turn of the 20th century, but has been steadily increasing. From 1990 to 2010, the population of the 34 counties in and surrounding the GYE grew by nearly 35% to over 930,000 residents.

Upland Vegetation

Sagebrush steppe ecosystems occupy the cold deserts of the western United States and are one of the largest ecosystems in North America. Across the west sagebrush steppe has been extensively modified by human activity and the health and function of these ecosystems are threatened by the invasion of cheatgrass and the expansion of juniper. GRYN upland vegetation monitoring is designed to detect changes in soil/site stability, hydrologic function, and biotic integrity. While it is too early to describe trends, the data collected to date tell us about the baseline conditions of targeted native and non-native plant species.

To date five non-native plant species have been reported during GRYN monitoring: cheatgrass (Bromus tectorum), Russian thistle (Salsola tragus), crested wheatgrass (Agropyron cristatum), halogeton (Halogeton glomeratus), and Japanese brome (Bromus japonicus). Detection of nonnative plants alerts managers of their presence so that actions can be taken (if necessary), and monitoring of non-natives over time can inform assessments of overall ecological condition.

Water Resources

Water resources are critical to the health and productivity of all landscapes, and especially in semi-arid and arid landscapes. Water resources are also important to visitor recreational experiences and their perception of these natural places. Working together with park staff, the GRYN has monitored water quality in network parks since 2004. The goal of monitoring is to assess condition and trends in water resources relative to the Clean Water Act, human health, and ecological function.

In order to track changes in the status and trends of water resources, monitoring protocols specific to the resources of each park have been implemented. These monitoring protocols were designed to provide park- and resource-specific information that is needed to identify, quantify, and understand changes in key water resources. The information gathered from this monitoring will aid in determining whether observed conditions are relatively static, within the natural range of variation, or changing in ways that may be linked to key environmental drivers or anthropogenic influences.

Whitebark Pine

Whitebark pine (*Pinus albicaulis*) occurs at high elevations and in subalpine communities in the Pacific Northwest and Northern Rocky Mountains. It is a key component in the upper ranges of these ecosystems where it provides a variety of ecological services, including regulating snowpack and providing high-energy food sources to birds and mammals. Currently, whitebark pine is impacted by multiple ecological disturbances. White pine blister rust (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*), wildfires, and climate change all pose significant threats to the persistence of healthy whitebark pine populations. In 2004, an interagency whitebark pine long-term monitoring program was established to detect and monitor changes in the health and status of whitebark pine populations across the GYE.

Substantial declines in whitebark pine populations have been documented throughout its range. White pine blister rust infection remains widespread and variable across the ecosystem with an estimated 20% to 30% infection rate among whitebark pine in the GYE. Recent data indicate that the annual rate of whitebark pine mortality in response to mountain pine beetle has decreased compared to the past several years.