National Park Service
U.S. Department of the Interior

Intermountain Region
Inventory & Monitoring Program

Monitoring Ecological Responses to Climate Change

Climate change presents significant risks to our nation's natural and cultural resources. In order to meet the challenge of managing national parks in the face of global climate change, it is critical that the National Park Service has high-quality, natural resource monitoring and inventory data to track changes as they occur. The Greater Yellowstone Inventory and Monitoring Network (GRYN) is collaborating with the Rocky Mountain (ROMN) and Upper Columbia Basin (UCBN) Networks to implement a High Elevation Climate Change Response Strategy. This strategy focuses on high elevation parks and enhances natural resource monitoring of select vital signs, including climate, pika, five-needle pine, snowpack and phenology, and alpine habitats. These data and other vital signs will be used to evaluate and report status and trends of park resources for the purpose of facilitating adaptation planning and management.

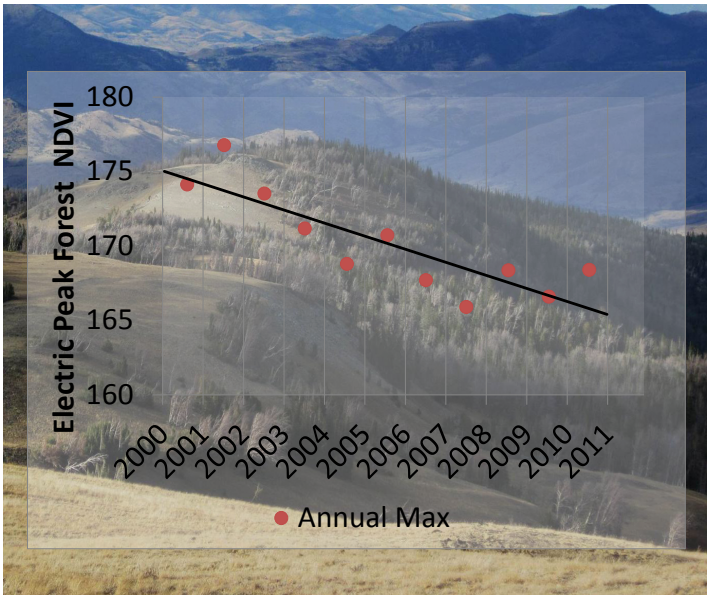
It is important to communicate to managers and the public changes observed through monitoring. To begin this process, two videos were produced focusing on climate change response monitoring across the high elevation parks, and monitoring related to the American pika. These films are available to view through the Greater Yellowstone Science Learning Center (see link below).

Climate

Climate is one of the primary drivers of the physical and ecological processes that determine the distribution, structure, and function of ecosystems. Moreover, there is evidence that climate has changed in the past century and will continue to change. The GRYN, in partnership with the ROMN, uses climate data collected by national networks to analyze the status and trend of five variables in park units: temperature, precipitation, streamflow, drought, and snowpack. By accessing and analyzing climate data for the high-elevation parks, park and network staff will be better able to understand and interpret changes in status and trends of other vital signs.

Snowpack Extent and Vegetation Phenology

Snowmelt in the alpine areas of the Rocky Mountains is critical to both the quality and quantity of water in freshwater lakes, wetlands , and streams, providing 60 to 80 percent of streamflow in the West. Climate change is expected to affect both snow accumulation and rate of spring melt. Vegetation phenology, or timing of significant biological events, is also widely accepted as an indicator of climate change. The GRYN tracks changes in seasonal patterns of vegetation "greening," and snowpack melt with satellite imagery. Eleven years of Moderate Resolution Imaging Spectroradiometer (MODIS) normalized difference vegetation index (NDVI or "greenness") and snow extent image products are combined with climate data to improve understanding of vegetation phenology patterns and snowpack extent for high elevation parks. Analysis of NDVI and snow cover has been completed for City of Rocks National Reserve, the Pryor Mountain Wild Horse Management Range at Bighorn Canyon, and the Electric Peak area of northern Yellowstone. The forested flanks of Electric Peak show a decline in greenness over the eleven-year period coincident with tree mortality. A longer observation record will help determine if the underlying cause is climate related. Snow cover extent and timing of melt in the alpine region of the peak provide insight to the variability of annual weather patterns that fluctuate within longer-term cycles. For instance, 2011 snow cover in the alpine region lingered 24 days longer than the average duration of snow cover in the 10 years preceding 2011.



NPS/DAVID THOMA

Graph indicating a decrease in NDVI related to tree die off.

http://science.nature.nps.gov/im/units/gryn/index.cfm
http://www.greateryellowstonescience.org

Five-needle Pine—Whitebark Pine

Five-needle pines are foundational species in high elevation ecosystems across the West. All western species of five-needle white pines and their associated ecosystems could be affected by changes in climate by causing a shift in pathogen ranges, which may lead to an increase in non-native white pine blister rust, increased frequency and intensity of native mountain pine beetle outbreaks, changes in the frequency of severe fires, and drought stress. There is an increased level of interest in understanding the status of white-bark pine, partly due to its addition by the U.S. Fish and Wildlife Service as a candidate species eligible for endangered species protection in July 2011. Given the ecological importance of whitebark pine, an interagency whitebark pine monitoring group—including the National Park Service, Forest Service, and U.S. Geological Survey—developed a protocol and have been monitoring status and trend of whitebark pine stands since 2004 in the Greater Yellowstone region.

NPS

Sagebrush in Bighorn Canyon National Recreation Area.

Alpine Vegetation and Soils

The cold and relatively little-exploited alpine ecosystems, are among those where climate change impacts are expected to be pronounced and detectable early on. The GRYN and ROMN collaborated to implement alpine vegetation and soils monitoring in high elevation parks. National parks including Glacier, Yellowstone, Grand Teton, Rocky Mountain, and Great Sand Dunes are now participants in the Global Observation Research Initiative in Alpine Environments (GLORIA) monitoring network. Monitoring includes sampling of vascular plants, soil temperature, and temperature at a set of four alpine summits along an elevation gradient. This set of sites span alpine environments from northwest Montana to southern Colorado. Information is available through the GLORIA website at http://www.gloria.ac.at/ as well as on network-affiliated sites.

Amphibians

Climate change is anticipated to cause shifts in the distribution and abundance of amphibians on a global scale. In the GRYN, impacts could include earlier breeding, resulting in more frequent exposure to killing frosts and a longer larval period because water temperatures warm more slowly in early spring, leading to higher larval mortality. Reduced water storage as snow, early runoff, and an increase in evaporation due to warmer summer temperatures may reduce habitat for adult amphibians. The GRYN is working in collaboration with the U.S. Geological Survey's Amphibian Research and Monitoring Initiative to determine the status of amphibians in Yellowstone and Grand-Teton National Parks.

Upland Vegetation—Sagebrush Steppe

Sagebrush steppe is one of the most altered ecosystems in the intermountain West. Substantial sagebrush areas have been converted to agriculture, heavily grazed, and degraded through altered fire regimes and the invasion of exotic plants. Changes in climate are expected to further alter fire regimes and increase invasive species in sagebrush steppe and low-elevation woodlands. In 2011, the GRYN implemented vegetation monitoring in Bighorn Canyon National Recreation Area adapting a protocol developed by the UCBN and may implement this protocol at Grand Teton National Park in the future. Yellowstone National Park also has upland vegetation monitoring data that may be useful in addressing climate change responses in sagebrush-steppe and grassland systems. The three networks collaborated with the U.S. Geological Survey to explore ways to integrate vegetation data across different protocols.

Water Resources

Water resources in the GRYN are projected to be profoundly influenced by climate change, including changes in timing and duration of hydrologic regimes and water temperatures, altering food web interactions, species diversity, and nutrient dynamics. Since 2005, the GRYN has been monitoring alpine lakes, rivers, and streams annually for five core parameters (dissolved oxygen, pH, specific conductance, temperature, and discharge), water chemistry, and macroinvertebrates.

Bingham, B., M. Britten, L. Garrett, P. Latham, and K. Legg. 2010. Enhanced monitoring to better address rapid climate change in high-elevation parks: a multi-network strategy. Natural Resource Report NPS/IMR/NRR—2011/285. National Park Service, Fort Collins, Colorado.

Jean, C., R. Daley, M. T. Tercek, and S. T. Gray. 2011. High elevation national parks: 2010 climate summary report. Natural Resource Data Series NPS/GRYN/NRDS—2011/203. National Park Service, Fort Collins, Colorado. https://irma.nps.gov/App/Reference/Profile/2180512?code=2180512