



Climate Change in the Northern Colorado Plateau Network

Current Findings and How Future Monitoring Will Detect It

The Northern Colorado Plateau Network (NCPN) is one of 32 National Park Service inventory and monitoring networks that have implemented vital signs monitoring to assess the condition of park ecosystems and develop a stronger scientific basis for stewardship and management of natural resources across the National Park System. The primary ecosystem driver in the Colorado Plateau region is climate—particularly, precipitation and temperature. Several recent modeling efforts have predicted that impacts from climate change will be more pronounced in the Southwest than in other parts of the U.S. The NCPN is monitoring several vital signs that will likely show the effects of climate change. This brief offers a summary of the network's local-scale findings to date, as well as a summary of how NCPN monitoring will detect future change.

Current Findings

Vegetation Maps Identify Types Threatened by Climate Change

Vegetation maps have been completed for many Northern Colorado Plateau Network parks. As part of this process, certain vegetation types that may be susceptible to climate changes were identified in each park. Those communities included greenleaf manzanita (*Arctostaphylos patula*) shrublands, Douglas-fir–Gambel oak (*Pseudotsuga menziesii*/*Quercus gambelii*) forests, and quaking aspen/chokecherry (*Populus tremuloides*/*Prunus virginiana*) forests at Colorado National Monument (NM), and bluebunch wheatgrass (*Pseudoroegneria spicata*) herbaceous vegetation at Dinosaur NM. These communities were identified as particularly vulnerable for reasons such as limited distribution, isolation, and elevation limits of the parks.

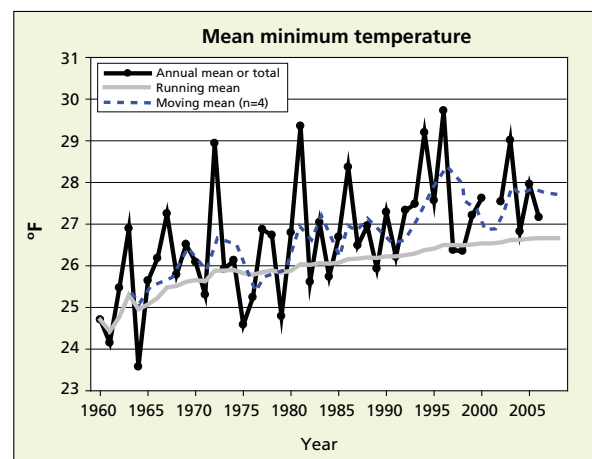
Climate Monitoring Indicates Hotter Temperatures and Less Snowfall

Most of the National Weather Service Cooperative Observer stations in the NCPN have reported a general increase in mean annual minimum temperatures over the past 25–50 years. There is also evidence for a declining trend in snowfall over the past 20–25 years. The 25–50-year observation period characteristic of the majority of NCPN stations illustrates general, common trends among stations, but is of insufficient length for us to confidently begin to discern climatic regime shifts by these stations alone. However, these local patterns are similar to regionwide trends that have shown increased temperatures and reduced snowfalls over the last 100 years. Estimates of climatic parameters derived from regional monitoring networks provide a backdrop for evaluating large-scale changes in abiotic drivers of change. For example, changes in vegetation cover may be compared to climatic trends to distinguish between natural and anthropogenic effects.



NPS/B. FIELDS

At Colorado NM, greenleaf manzanita shrublands are likely to be susceptible to climate change.



Bryce Canyon NP is one of several NCPN units where climate monitoring has detected an increase in mean annual minimum temperatures over the past 25–50 years.



The black-tailed gnatcatcher has been recently recorded in Pipe Spring NM, at the northern edge of its breeding range.



Yampa River, Dinosaur NM.

Biological Inventories Identify Range Shifts

Extensive biological inventories completed in NCPN parks provide anecdotal evidence for possible range extensions and shifts. NCPN inventories did not cover all of a species range, nor provide comprehensive abundance data—but in many instances, they were the first comprehensive surveys conducted, and anecdotal evidence, when combined with other studies, still provides useful information. For example, the black-throated gray warbler (*Dendroica nigrescens*) was found at Fossil Butte NM for the first time. This location is near the northern edge of its range in the central U.S. Four species, black-tailed gnatcatcher (*Polioptila melanura*), Lucy's warbler (*Vermivora luciae*), Abert's towhee (*Pipilo aberti*), and rufous-crowned sparrow (*Aimophila ruficeps*), were all detected at Pipe Spring NM, which lies on the northern edge of the breeding range for all four species. During a herpetological inventory at Black Canyon of the Gunnison National Park (NP) and Curecanti National Recreation Area (NRA), the northern leopard frog (*Rana pipiens*) was absent after being present in the past. This species has disappeared from many parts of its historical range in Colorado, and has recently been proposed for listing under the Endangered Species Act, with climate change cited as one of the reasons for its decline. The lack of recent sightings at these two parks may reflect this amphibian's overall decline in distribution and abundance in the southern Rocky Mountain region.

How Monitoring Will Detect Climate Change

Big River Monitoring and Riparian Systems

The NCPN is developing and implementing big-river monitoring at Dinosaur NM, Canyonlands NP, Black Canyon of the Gunnison NP, and Curecanti NRA. These four parks contain portions of the Colorado, Green, Gunnison, and Yampa rivers, four of the principal rivers comprising the upper Colorado River drainage. The Colorado River basin is a critical landscape element and driving force in Colorado Plateau ecosystems. Big rivers on the Colorado Plateau are fed by snowmelt from the surrounding mountains. They flow through arid lands and are biodiversity hotspots, making them excellent indicators of climate change at a broad ecosystem level. Large percentages of park fauna depend on these rivers for at least some portion of their life cycle, as riparian vegetation supports up to 80% of species diversity in desert ecosystems.

Climate-related changes in snowpack amount and snowmelt timing will have major effects on big rivers, as water availability and flow variability have the potential to greatly alter the structure and functioning of riparian ecosystems and their sensitivity to other anthropogenic stressors. Anecdotal information indicates that earlier spring runoff may be favoring riparian willows (*Salix* spp.) and exotic tamarisk (*Tamarix chinensis*) over cottonwoods (*Populus* spp.). Lower snowpack levels could also reduce the occasional, large floods from snowmelt that are crucial to resetting the system through scouring. As precipitation and temperature regimes shift, riparian vegetation will be affected by corresponding changes in evapotranspiration and groundwater elevation. The NCPN is partnering with the U. S. Geological Survey (USGS) and Utah State University to develop integrated river-monitoring procedures that incorporate geomorphology, vegetation, and groundwater.

Springs and Seeps

Water and water-dependent ecosystems are scarce resources in the arid and semi-arid southwest, and are generally regarded as biodiversity hotspots. Springs, seeps, and hanging gardens provide essential water, food resources, and wildlife habitat, and are important oases of productivity in desert landscapes. Precipitation is critical to the existence of springs; size, frequency, and duration of precipitation events are key factors influencing spring-water availability. Climate change is expected to alter ground and surface water quantity, as well as seasonal patterns of flooding and drought, and springs will be a direct indicator of these changes. The NCPN is currently investigating the possibility of determining recharge intervals for springs selected for monitoring. Understanding which springs are regularly recharged with new water (e.g., few–50 years), versus springs that are recharged over hundreds to thousands of years, will allow us to prioritize springs in our monitoring plan. Springs that are regularly recharged are more likely to be susceptible to climate change and most likely to be of high management concern. Monitoring spring and seep ecosystems will enable a more thorough understanding of the impacts of human activities on these ecosystems.

Uplands

Global climate change is expected to alter the type (e.g., rain versus snow) and amount of precipitation and the seasonality of large precipitation events, with unknown implications for plateau systems. Predicted increases in temperature may increase physiological stress in trees, leading to greater susceptibility to infestation by insects and pathogens, and can also alter the elevation domain of species, leading to the migration of forest communities farther upslope. NCPN upland monitoring at Canyonlands NP was designed to detect effects of climate change on biological soil crusts in grassland and shrubland ecosystems. Initial analysis of older park data sets by USGS researchers suggests that declines in native bunchgrasses and increases in certain shrub species may be related to specific climate trends. NCPN upland monitoring at Capitol Reef NP was designed to compare grasslands that are currently grazed with those that have been previously grazed. The park plans to use this data to facilitate the optimal grazing management in the face of climate change.

At the high altitudes of Cedar Breaks National Monument, NCPN upland monitoring was designed to detect effects of climate change on species richness and cover of dominant species. Specifically, park managers would like to examine the extent and expansion of exotic smooth brome (*Bromus inermis*), recovery of spruce-fir forests from spruce budworm (*Choristoneura fumiferana*), expansion/contraction of subalpine meadows and spruce-fir forests, and how the distribution of white fir (*Abies concolor*) may shift from lower to higher elevations with climate change. Similar climate change issues will likely be addressed as upland monitoring is implemented at Bryce Canyon NP.



MARK WEISINGER

NCPN staff are trying to determine which springs and seeps may be most likely to be affected by climate change.



NPS

Upland monitoring plot, Canyonlands NP.

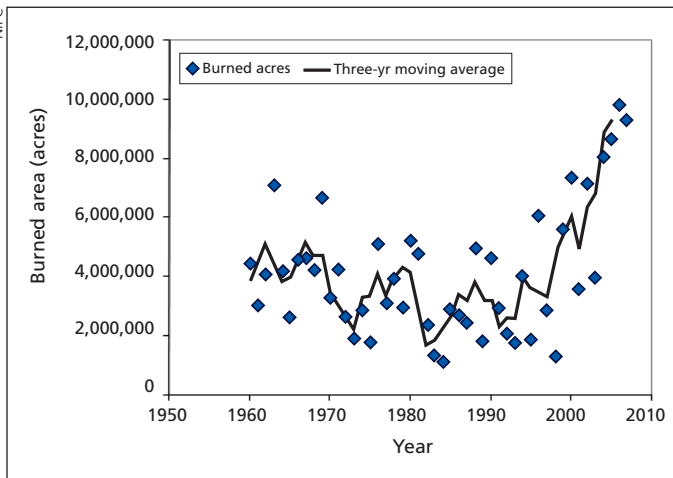


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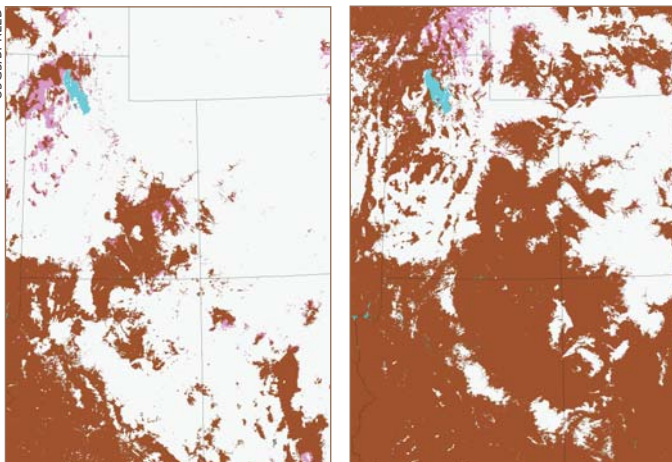
Climate change will pose special challenges at high-altitude parks, like Cedar Breaks NM.



During 2009, Salt Creek, in Canyonlands NP, dried completely for the first time in 10 years of monitoring by NPS staff.



Climate change may provide new opportunities for exotic plant invasions and lead to episodic reductions in soil moisture—a combination that can set the stage for fires. National Interagency Fire Center data from the past 10 years show an increase in acres burned in the western U.S.



MODIS images of Colorado Plateau snow cover, January 17–25 (left) and February 20–27, 2007 (right), indicating changes in soil moisture and runoff that may influence biological and physical processes.

Water Quality

Climate change may have direct and indirect effects on stream-flow and water quality. In several NCPN cold-water streams, summer temperatures have recently approached the maximums for supported wildlife. With climate change, temperatures in those streams may exceed the thermal tolerance of those species. Diurnal pH extremes, fueled by nutrient enrichment and high temperatures, further stress aquatic organisms. Precipitation and streamflow are known to be tightly coupled, as has been observed in parks where shallower winter snowpacks at higher elevations are directly followed by lower flows. As temperature and precipitation patterns affect the abundance, type, and distribution of vegetation cover in watersheds, changes in flood magnitude and duration, sediment loads, and water chemistry will occur. Salt Creek, in Canyonlands NP, and several pools in Hovenweep NM, dried completely in 2009 for the first time in 10 years of monitoring by Southeast Utah Group staff.

Invasive Exotic Plants

Climatic changes are predicted to provide exotic plant species with new opportunities for invasion. Because they fragment native ecosystems, displace native plants and animals, and alter ecosystem function, invasive exotics represent one of the most serious threats to natural ecosystem integrity. They can also alter fire regimes, for instance, by causing fires to burn more swiftly or intensely, or even introducing fire to systems that did not evolve with it. Data from the National Interagency Fire Center indicate that wildfires on western lands have increased significantly in the past 10 years, and several climate models predict that climate change will result in more frequent and extreme droughts that could episodically reduce water availability and soil moisture. An increase in exotic invasions, in combination with the decreasing soil moisture that may accompany climate change, could set the stage for fires with the potential to dramatically impact upland and aquatic ecosystems. NCPN monitoring of invasive exotics provides park managers with data on early detection of these species, which should allow them to deal with invasive exotic plant species effectively in the face of climate change.

Land Condition

Land-condition monitoring uses MODIS (MODERate Resolution Imaging Spectroradiometer) satellite imagery to measure vegetation productivity and snow-cover extent. The Normalized Difference Vegetation Index (NDVI) is calculated from imagery over time to estimate the start and end of the growing season, the time of peak production, seasonal productivity, and snow cover, all of which are indicators of ecosystem function and could be affected by climate change. Understanding broad-scale changes in land condition both in and near parks will help park managers to make better-informed management and mitigation decisions in a context of complex change.

For more information

Northern Colorado Plateau Inventory & Monitoring Program
National Park Service
P.O. Box 848
Moab, UT 84532
435-719-2346
<http://science.nature.nps.gov/im/units/ncpn/>

