Inventory and Monitoring

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

MEETING THE MISSION

Inventory & Monitoring Division
Contributions to Intermountain Region
Park Science, Management, and Stewardship

2017





On the cover: In the National Park Service Intermountain Region, key natural resources at 75 parks are monitored by seven networks of the Inventory and Monitoring Division, Natural Resource Stewardship and Science directorate. This graphic shows the boundaries of each network, illustrated with a photo of a representative park in that network. A complete list of parks in each network, along with other summary information, is included in Appendix A of this document.

1) Rocky Mountain Network (*Photo:* Glacier National Park)
2) Greater Yellowstone Network (*Photo:* Grand Teton National Park)
3) Northern Colorado Plateau Network (*Photo:* Bryce Canyon National Park)
4) Southern Colorado Plateau Network (*Photo:* Mesa Verde National Park)
5) Sonoran Desert Network (*Photo:* Organ Pipe Cactus National Monument)
6) Chihuahuan Desert Network (*Photo:* White Sands National Monument)
7) Southern Plains Network (*Photo:* Pecos National Historical Park)

Unless otherwise noted, all photos in this document are courtesy of the National Park Service.

The following acronyms are used throughout this document:

National Park	NP	Chihuahuan Desert Network	CHDN
National Park and Preserve	NP&Pres	Greater Yellowstone Network	GRYN
National Monument	NM	Northern Colorado Plateau Network	NCPN
National Historic Site	NHS	Rocky Mountain Network	ROMN
National Historical Park	NHP	Sonoran Desert Network	SODN
National Recreation Area	NRA	Southern Colorado Plateau Network	SCPN
Memorial Parkway	MP	Southern Plains Network	SOPN
National Memorial	NMem	National Park Service	NPS
Wild and Scenic River	WSR	Inventory and Monitoring	I&M

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Foreword

Science-based management is critical to protecting, restoring, and maintaining national park ecosystems. Underlying the success of these efforts are the dedicated park managers who have committed their careers to resource protection. These managers are embedded in the resource. They study and learn how ecosystems and their components function and apply science information toward managing those resources. In many cases, that science provides value-added outcomes that extend the reach of resource management solutions beyond park boundaries.

The National Park Service Inventory and Monitoring (I&M) Division plays a unique role in providing scientific information on long-term monitoring of natural resources to park resource staff. This information informs assessments of ecosystem health, identifies changes in resource condition, and contributes to a wide array of resource management efforts.

The reach of I&M networks as partners in park resource management cannot be overstated. Across the Intermountain Region, network staff are helping to evaluate changes to backcountry alpine environments from aerial deposition, assess the health of remote springs and seeps in desert environments given changing climatic conditions, identify exotic plant invasions across a range of park ecosystems, and evaluate the health of rivers and riparian areas—to name just a few. The information provided to park managers is invaluable for decisions made today and in the future.

I&M staff collaborate with their park partners to attain the best outcomes for park resources and the American public. In addition to long-term data collection, analysis, and reporting, the seven excellent I&M networks in the Intermountain Region also provide a plethora of science support for park programs, are contributing to the scientific literature, and working hard to enhance public understanding of science in the national parks and in our world. This document highlights some of the accomplishments achieved through I&M and park partnership in the Intermountain Region during fiscal year 2017.

Michael Bozek
Intermountain Region Program Manager
Inventory and Monitoring Division

SCIENCE FOR DECISIONMAKING

Water Quality Data Lead to 303(d) Delisting Proposal

Yellowstone NP

Greater Yellowstone Network data were used to support the proposed removal of Soda Butte Creek from the 303(d) Impaired Waters List. The creek, which flows into Yellowstone NP, had been contaminated with heavy metals since gold and copper mining began upstream during the 1800s. In 2010, the Montana Department of Environmental Quality (MTDEQ) began removing tailings from the historic McLaren Mill, near Cooke City, Montana. The tailings (crushed rock that is the byproduct of the metal extraction process) were releasing heavy metals into Soda Butte Creek and the park. Following reclamation efforts, the Greater Yellowstone Network conducted water quality sampling throughout the Soda Butte watershed. The resulting data led to a determination, in November 2017, that metals conditions in Soda Butte Creek now support all beneficial uses. As a result, MTDEQ has recommended removing Soda Butte Creek from the 303(d) Impaired Waters List. The U.S. Environmental Protection Agency has granted preliminary approval. For MTDEQ and its project partners, this marks the first time a Montana water body has been proposed for 303(d) delisting for metals following a successful abandoned-mine cleanup.



Collecting water quality measurements on Soda Butte Creek, Yellowstone National Park.

Integrating Natural and Cultural Resource Management through I&M

Bent's Old Fort NHS, Pecos NHP, Sand Creek Massacre NHS, and Washita Battlefield NHS

In small parks that protect historic sites, Southern Plains Network data are helping facilitate integrated management of natural and cultural resources. Network staff are working with pilot parks to develop interdisciplinary vegetation management planning. Under an adaptive management framework, staff from NPS fire, exotic plant management teams, and the parks use SOPN data as part of an annual decisionmaking process for vegetation management. Involving interpreters in this process has enabled them to address park vegetation management in interpretive programs. Based on interest from other network parks, this approach may be extended beyond the four pilot parks.



Bent's Old Fort National Historic Site.

SCIENCE FOR DECISIONMAKING



The Green River winds its way through Dinosaur National Monument.

Vegetation Data Influence Discussion on Proposed Flows

Dinosaur NM, Canyonlands NP

The Northern Colorado Plateau Network is helping investigate possible unintended consequences from a proposed elevation of base flows out of Flaming Gorge Dam. The Upper Colorado River Endangered Fish Recovery Program is proposing the flows to help support larval fish. But in the past, the extra water from elevated flows during the growing season allowed vegetation to expand into areas where it otherwise would not have been. Backwaters and side channels that are crucial to these fish could become clogged with vegetation. As such, elevated flows could help endangered fish to hatch but degrade their habitat in Dinosaur NM, Canyonlands NP, and along the Green River to its confluence with the Colorado River. Preliminary analysis of network data supported the idea that elevated base flows could increase channel narrowing. A white paper by the U.S. Geological Survey supported these concerns. The NCPN program manager was invited to speak to the Colorado River Steering Committee on this matter so the NPS can develop a formal position. If the base flows go into effect, the network is urging increased monitoring with evaluation and assessment points.



The Sonoran Desert Network is partnering with Pima County, Arizona, to expand the reach of its vegetation monitoring.

Extending Understanding Beyond Park Boundaries

Saguaro NP and Organ Pipe Cactus NM

A collaborative program with Pima County, Arizona, will extend the scale of inference for park-based monitoring. With county funding, a crew of staff from Pima County and the Sonoran Desert Network sampled 24 new permanent monitoring plots in Pima County using the network's established protocol for monitoring vegetation and soils. Data from this collaboration will support effective park management by improving our knowledge of landscape-scale vegetation and soil conditions. Pima County contains the two largest network parks: Saguaro NP and Organ Pipe Cactus NM.

SCIENCE FOR DECISIONMAKING

Modeling Soil Water Availability Under Future Climate Scenarios

Aztec Ruins NM, Bandelier NM, Chaco Culture NHP, Glen Canyon NRA, Grand Canyon NP, Mesa Verde NP, Petrified Forest NP, Petroglyph NM, Wupatki NM

The Southern Colorado Plateau Network is nearing the end of a project to determine how changing soil-water availability might impact vegetation in nine of its network parks. Working with the U.S. Geological Survey, SCPN staff modeled soil-water potential at multiple depths for about 300 monitoring plots in these water-limited ecosystems. Those models were used to estimate possible future climatic impacts on soil-water potential at different depths and different times of the growing season. Across all parks, results indicated that soil-water availability will decline in spring and fall/winter. Soils are expected to dry earlier in spring, shortening the time they are moist during the growing season. This will likely have a substantial impact on plants that rely on that moisture. A manuscript is being prepared for publication in a peer-reviewed journal.



Volcanic grassland ecosystem, Wupatki National Mounument.

Joining Forces Against Cheatgrass on the Northern Great Plains

Little Bighorn Battlefield NM

The Rocky Mountain Network is assisting with a multi-region project on adaptive management of cheatgrass. Cheatgrass and Japanese brome are exotic invasive annual grasses that form dense stands and go dormant early in the growing season. These stands are highly fire-prone and turn what should be a seasonally changing, diverse mix of grasses and wildflowers into a uniform carpet that is brown most of the year. The project will improve understanding of how best to reduce and control cheatgrass by using monitoring to track the success of different treatments. The network ecologist participated in a workshop with staff from parks, the Northern Great Plains Network, and the U.S. Geological Survey. Participants discussed a structured decisionmaking process, determined treatment options and desired conditions, and started establishing performance metrics. Desired conditions have been drafted for Little Bighorn Battlefield NM, and the park has provided information on decisionmaking processes for vegetation and weed management. Collection of field data on annual bromes was piloted at three parks in 2017.



Native prairie threatened by cheatgrass in Little Bighorn Battlefield National Monument.

SCIENCE FOR DECISIONMAKING



Collecting a water sample at Lower Courthouse Wash, Arches National Park.

Sampling Park Waters for Emerging Contaminants

Arches NP, Bryce Canyon NP, Canyonlands NP, Capitol Reef NP, Dinosaur NM, Timpanogos Cave NM, Zion NP

Contaminants of emerging concern are pollutants that have not traditionally been tested for during water quality sampling. They also may not be adequately cleansed by current wastewater treatment methods. Examples include pesticides, pharmaceuticals, and personal care products. In partnership with the Environmental Protection Agency (EPA) and U.S. Geological Survey (USGS), the Northern Colorado Plateau Network has been sampling waters for these pollutants in seven network parks for several years. In 2016, the U.S. Fish and Wildlife Service and Utah Department of Water Resources donated field-crew time and equipment to collect fish for pollutants testing. Also, a USGS-NPS Water Quality Partnership grant funded sampling of bed sediments. A manuscript is currently in preparation. A follow-up proposal with EPA was recently ranked third in the nation and is a likely candidate for funding. The most recent report on results from this project can be found at https://irma.nps.gov/DataStore/DownloadFile/551578.



A whitebark pine tree towers above its surroundings on the Beaverhead-Deerlodge National Forest, Montana.

Working Across Boundaries to Save a Keystone Species

Grand Teton NP, Yellowstone NP

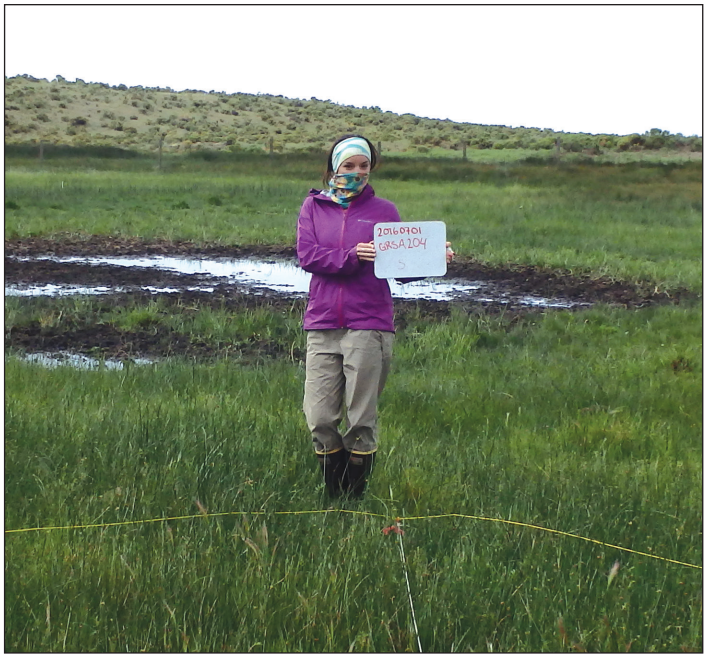
The Greater Yellowstone Network completed its fourteenth year of interagency whitebark pine monitoring. This tree is a keystone species found on subalpine federal lands throughout the West. Whitebark pine provides food and shelter for many species, including grizzly and black bears, red squirrels, and Clark's nutcrackers. The network co-led the compilation of data and reports from all NPS parks, networks, and regions related to whitebark pine. The information was provided to the U.S. Fish and Wildlife Service for use in developing a Species Status Assessment report and a proposed listing review of whitebark pine. The network also helped develop a database to track management actions related to whitebark conservation across the Greater Yellowstone Ecosystem. The BLM included the network's whitebark pine monitoring program in its Western United States Technical Reference 6711-7, Strategy for Five-Needle Pines.

SCIENCE FOR DECISIONMAKING

Climate Data Support Scenario Planning

Great Sand Dunes NP&Pres and others across three networks

Staff from the Greater Yellowstone, Northern Colorado Plateau, and Rocky Mountain networks continued to work with Mike Tercek (Walking Shadow Ecology) to derive park-scale summaries of water-balance characteristics (snowpack, snowmelt, soil water balance, annual evapotranspiration, potential evapotranspiration, water deficit, and runoff) across historical, current, and projected future climate scenarios. Having increased understanding of water-balance conditions (e.g., runoff quantity and timing, fuel-moisture conditions, vegetation growth) at multiple timesteps will help parks plan for future management scenarios. This information is also crucial as the networks analyze and interpret their own monitoring data. Mike Tercek received the Director's Centennial Award for this work. In 2017, the team created a "Fire Danger" dashboard for Great Sand Dunes NP & Pres within the Climate Analyzer platform. The dashboard calculates and displays the Keetch-Byram Drought Index and thousand-hour fuel-moisture estimates.



Monitoring wetlands in Great Sand Dunes National Park and Preserve.

Monitoring Increase (and Decrease) of Exotic Invasive Plants

Capitol Reef NP, Fossil Butte NM, Golden Spike NHP, Zion NP

The Northern Colorado Plateau Network monitors and maps invasive plants in eight network parks. Information from this monitoring can help park managers decide which plants to target with control efforts, and where to direct those efforts. It can also provide insight about the effects of completed control efforts. In 2016, invasive plants were found to have increased at Capitol Reef NP, Fossil Butte NM, and Golden Spike NHP. Tamarisk and Russian olive both saw large increases at Capitol Reef NP. The long-term nature of this monitoring also allowed network staff to detect a greater percentage of large patches of invasives in 2016. This indicates that existing infestations are expanding. Invasive increases at Fossil Butte NM were driven by creeping foxtail, quackgrass, and cheatgrass. Zion NP saw parkwide declines in Johnsongrass and Siberian elm but increased Scotch thistle.



Monitoring exotic plants at Capitol Reef National Park.

SCIENCE FOR DECISIONMAKING

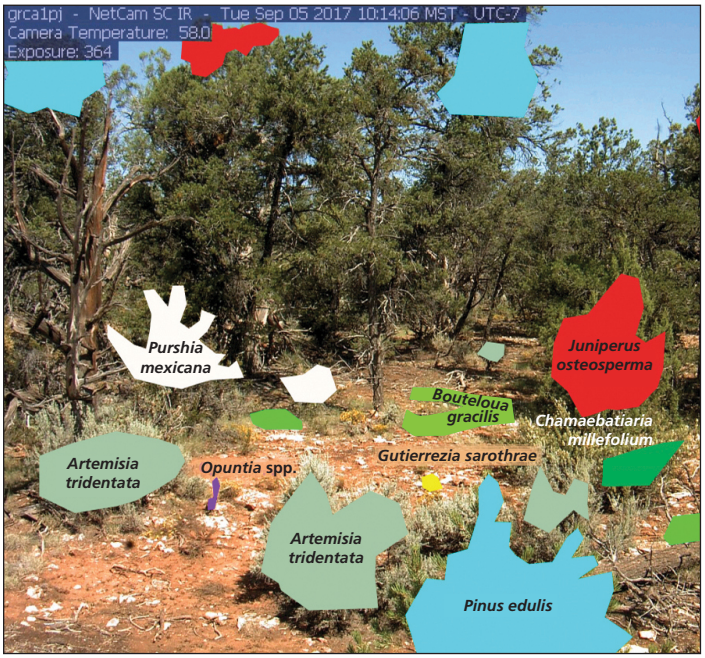


Monitoring wetland vegetation in Rocky Mountain National Park.

Modeling Natural and Human Impacts on Wetland Health

Rocky Mountain NP

The Rocky Mountain Network is working with the U.S. Geological Survey and Colorado State University to model relationships between human disturbance, ecosystem drivers, and wetland health in Rocky Mountain NP. The resulting model should provide park managers with a general "cause and effect" of how human and natural disturbances impact wetland health. Managers can use this tool to gauge how different restoration actions will likely affect wetland condition. The work was published in *Ecosphere*. In a proposed second phase, the ROMN staff hopes to develop a better understanding of relationships between wetland vegetation, hydrology, and beaver habitat requirements. This work, which would identify management thresholds for beaver–habitat relationships, will help inform plans for beaver dam restoration. It will also address the potential consequences for maintaining (or not) existing ungulate exclosures.



The stationary phenocam captures daily imagery of the same plants all year long. This gives SCPN staff some ability to groundtruth satellite signals of vegetation greenness. This is a photo from the phenocam, with plants labeled by network staff to show which species can be analyzed from within its view.

Phenocam Helps Groundtruth Satellite Data

Grand Canyon NP

Phenology monitoring documents when vegetation on the landscape is greening up, peaking, and senescing. It is often satellite-based, using the Normalized Difference Vegetation Index (NDVI) to analyze imagery captured with remote sensing. But it's also helpful to have an eye on the ground. In 2016, SCPN staff noticed an NDVI signal that seemed odd: peak greenness of pinyon-juniper (PJ) species was occurring in mid-winter. Through research, they found that this "winter green" signal occurs across most PJ ecosystems in southern Utah and northern Arizona, with no obvious explanation. They started looking for a way to confirm (or refute) the message from the satellite data. With assistance from the USGS, the network installed a ground-based phenology camera ("phenocam") at Grand Canyon NP. Comparing the NDVI data to the phenocam imagery will help SCPN staff to see when individual plant species are actually greening and senescing. The camera was installed near a PJ monitoring plot and connected to the nationwide PhenoCam Network. This gives the SCPN access to the PhenoCam Network's national database and archive. This project will not only improve SCPN's data interpretation, but may also be used as the basis for projects by students and citizen scientists.

SUPPORT FOR PARK PROGRAMS

Chihuahuan Desert Network

- Network staff provided consultation and information to interpretive staff planting native species at ***Chamizal NMem***. CHDN staff will also conduct a baseline vegetation inventory of the park.
- Plant species of concern were identified at several network parks during vegetation monitoring. Park personnel were notified of the location of the species and of their status.
- The network provided input for ***Big Bend NP***'s Resource Stewardship Strategy.
- In collaboration with ***Big Bend NP, Guadalupe Mountains NP,*** and ***White Sands NM***, the network helped plan a U.S.–Mexico Sister Parks Vital Signs Monitoring Meeting in Ojinaga, Mexico. The objective of the meeting is to define common Chihuahuan Desert vital signs on a bi-national scale.



Rio Grande downstream from Santa Elena, Big Bend National Park.

Northern Colorado Plateau Network

- Staff at ***Capitol Reef NP*** used the network's upland vegetation data to determine desired conditions for their upcoming livestock-grazing EIS.
- Two network staff contributed talks for a climate workshop for employees at ***Colorado NM***. One spoke about the drying effects that higher temperatures have on surface water in the monument. The other explained how higher temperatures and seasonal changes in precipitation might affect grass communities.
- The network's writer-editor provided direct editorial support on a history of peregrine falcon recovery efforts at ***Dinosaur NM***, and for numerous projects at ***Glacier NP***.
- Network staff played a primary role in reviewing contributions for Natural Resource Condition Assessments of ***Black Canyon of the Gunnison NP, Bryce Canyon NP, Cedar Breaks NM, Colorado NM, Curecanti NRA, Dinosaur NM, Fossil Butte NM, Timpanogos Cave NM,*** and ***Zion NP*** and reviewed the Resource Stewardship Strategy for ***Colorado NM***.



An ecologist measures plants along a vegetation transect in Capitol Reef National Park.

SUPPORT FOR PARK PROGRAMS



The Greater Yellowstone Network supported wetland surveys at Yellowstone National Park.

PHOTO BY FLICKR USER KRISNM



Elk in Chaco Canyon, Chaco Culture National Historical Park.

Greater Yellowstone Network

- The network ecologist worked with the ***Yellowstone NP*** botanist to survey wetlands prior to a road project.
- Network staff helped ***Grand Teton NP*** prepare a proposal on wetlands and climate for the Servicewide Comprehensive Call.
- In the spring, GRYN staff helped ***Grand Teton NP*** predict the timing of high-flow runoff. Park staff are now able to use The Climate Analyzer to graphically track flows. The network also provided partial funding for the Moose gauging station.
- At ***Bighorn Canyon NRA***, the network program manager met with a university scientist and park staff to discuss opportunities to research an apparent decline in mountain mahogany. GRYN also provided information on the presence of lodgepole pine in the park to help Bighorn Canyon staff respond to a tribal request regarding pole-size trees for teepees.
- Network staff assisted Yellowstone and Grand Teton national parks with resource reports and the Yellowstone Resources Handbook, participated on an interagency team developing glacier monitoring across the Greater Yellowstone Ecosystem, and continued to assist ***Crater Lake NP*** with newt and crayfish studies.
- The GRYN data manager completed two assignments as a GIS specialist on two wildland fire Incident Command Teams in Montana.

Southern Colorado Plateau Network

- The network botanist helped staff at ***Chaco Culture NHP*** resample a series of browse transects initially sampled in 2007. Although historically present in the region, elk were extirpated in the area until a resident herd of reintroduced Rocky Mountain elk became established in the park in 2000. There is limited data on elk browse patterns and the impacts of elk foraging on vegetation communities within the park. The resample was part of a larger effort to determine trends in elk herd size and impacts that will be used to provide data to inform the development of a management plan.
- Network staff played a primary role in reviewing contributions for Natural Resource Condition Assessments of ***Aztec Ruins NM, Bandelier NM, Chaco Culture NHP, Petrified Forest NP, Petroglyph NM, Salinas Pueblo Missions NM, Sunset Crater NM, Walnut Canyon NM,*** and ***Wupatki NM***.

SUPPORT FOR PARK PROGRAMS

Rocky Mountain Network

- Network staff participated in the ungulate management planning process at ***Great Sand Dunes NP&Pres***. ROMN monitoring will serve as the foundation of adaptive management of ungulates to protect wetland ecosystems in the park. The network is doing additional wetland monitoring in the park and adding methods to document site-specific wetland use by elk and bison.
- Network staff assisted with planning for resampling the Hydrologic Benchmark Network site at Swiftcurrent Creek in ***Glacier NP***.
- ROMN staff met with ***Rocky Mountain NP*** staff to explore ways to better collaborate and make network data more useful for park vegetation management needs.
- ROMN also met with staff from ***Florissant Fossil Beds NM, Rocky Mountain NP***, the Southern Plains Network, the Northern Rockies and Southwest Exotic Plant Management Teams, and the Colorado Natural Heritage Program to share information and find ways to better integrate management, network, and research activities.
- The network data manager converted 16 years' worth of citizen-science butterfly monitoring data from a legacy database into a current, usable database that meets the park's archiving needs. The data were exported into "flat files" that provide broader access. The ROMN field crew helped remove 31 wells no longer needed in ***Rocky Mountain NP***, many from designated wilderness.
- The network received the 2017 Partner Award from ***Rocky Mountain NP*** Superintendent Darla Sidles, "in recognition of their outstanding contributions and commitment to improving our understanding of park resources and resource stewardship in Rocky Mountain National Park."



Bison herd in Great Sand Dunes National Park and Preserve.



Rocky Mountain National Park Superintendent Darla Sidles (far right) and Acting Chief of Research and Resources Management John Mack (second from left) present Rocky Mountain Network staff with the 2017 Rocky Mountain National Park Partner Award at the park's biennial research conference.

SUPPORT FOR PARK PROGRAMS

MICHELLE ROGNE



Baby burrowing owl being relocated.



Grassy plain, Pecos National Historical Park.

Sonoran Desert Network

- Network scientists met with interpretive staff from ***Chiricahua NM, Coronado NMem, Fort Bowie NHS, Saguaro NM, Tonto NM, and Tumacácori NHP***. Topics highlighted the results of current findings from I&M activities and related research in the parks.
- Network staff authored a variety of funding proposals and coordinated projects and agreements for smaller park units that largely lack natural resource staff. Examples include burrowing-owl research at ***Casa Grande Ruins NM***, citizen science projects at ***Tonto NM***, bat monitoring at several small parks, and border resource studies in parks along the international border.
- SODN staff provided data, reviewed draft products, authored sections, and otherwise supported Natural Resource Condition Assessments for seven network parks. The network also contributed expertise and editorial support to the final revisions of the ***Fort Bowie NHS*** fire plan.
- The network co-hosted a biannual (October and April) conference and training for park and regional resource and interpretive staff. Staff were trained in preparing reports for the NPS Natural Resources Publication Series, presenting research findings to the public, and writing effective funding proposals.
- Network staff reviewed, edited, formatted, and shepherded reports and publications addressing important park-based research topics, including reports on historic springs information and citizen science monitoring of saguaro cactus at ***Saguaro NP***, and an integrated assessment of natural and cultural resources at ***Fort Bowie NHS***.

Southern Plains Network

- The network piloted efforts to develop a shared vision for planning and management of native vegetation and the cultural landscape at ***Pecos NHP, Fort Union NM,*** and ***Washita Battlefield NHS***.
- SOPN staff helped ***Pecos NHP*** to acquire funding for a project focused on decisionmaking about the interface of pinyon-juniper woodlands and a cultural landscape of grassland/pastures.
- Network staff met with staff from ***Bent's Old Fort NHS*** and the Environmental Quality Division to develop an environmental assessment template for vegetation management plans.

OUTREACH FOR THE PUBLIC

Citizen Science

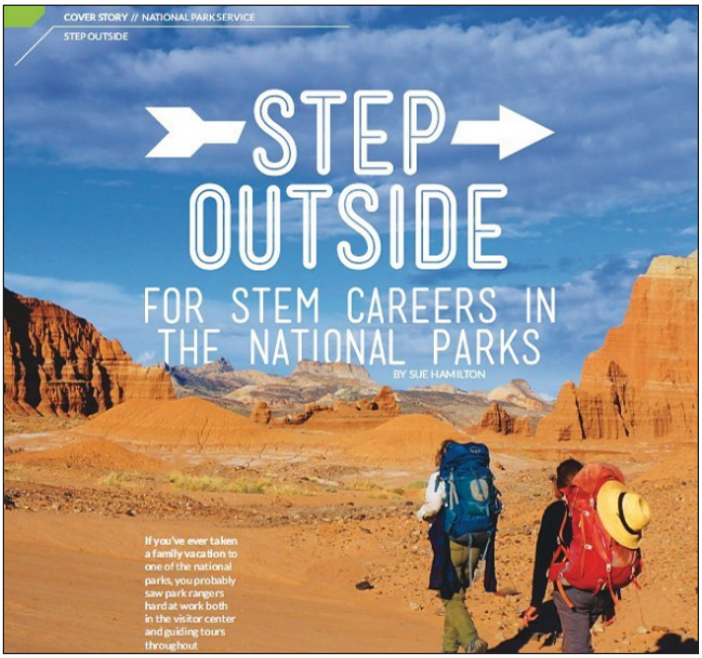
A total of 485 people participated in science outreach programs through the Desert Research Learning Center (DRLC, operated by the **Sonoran Desert Network**). Participants learned about scientific findings, protocols, and field methods. Interns, students, and volunteers completed 9,157 hours of citizen science in support of core network and DRLC projects. Interns were supported through the NPS Volunteer in Parks (VIP) program, International VIP program, NextGen Rangers, and the Tucson Audubon Society. The **Rocky Mountain Network** consulted with the Estes Park Environmental Center on a citizen-science student project on water quality monitoring in ***Rocky Mountain NP*** and in and around Estes Park, Colorado. The network also provided training in raptor monitoring and identification for Rocky Mountain NP's citizen science-based raptor management monitoring program. The **Greater Yellowstone Network** hosted two Mosaics in Science interns who assisted with a number of projects in ***Yellowstone NP***.



Interns and volunteers are a key to success for the Sonoran Desert Network.

Ecosphere Special Feature

The online ecology journal, *Ecosphere*, celebrated the NPS Centennial with a special feature devoted to I&M research. Nine Intermountain Region I&M staff contributed to six of the issue's 24 articles. From strategic bat conservation to research-based coral reef management to spring arriving earlier across the National Park System, "Science for our National Parks' Second Century" described challenges in natural resource conservation and the pivotal role that science and research play in influencing management decisions. Billy Schweiger, of the **Rocky Mountain Network**, received the Director's Centennial Award for leading the committee of I&M scientists who initiated and coordinated the issue.



The Northern Colorado Plateau Network's vegetation crew was featured in STEM Jobs magazine.

Other Web-Based Publications

The **Northern Colorado Plateau Network's** vegetation monitoring crew leader was featured in STEM Jobs magazine in FY2017. STEM Jobs, an online publication aimed at high school students, is sent to over 20,000 schools across the country. The eight-page spread included a lesson plan for a classroom activity, "Engineering a Drought Solution." A network ecologist was featured in The Citizen's Guide to Research: A Practical Guide to Understanding Research in the Era of Big Data, a weekly email series and book scheduled to be published in fall 2017.

OUTREACH FOR THE PUBLIC



The Science of the American Southwest subject site was launched in FY2017.

Science of the American Southwest Website

The Learning Center of the American Southwest website was transitioned to an nps.gov subject site, Science of the American Southwest. This will allow better integration with park websites and other pages on nps.gov. The new website was featured in the Explore Nature section of nps.gov. A postcard and posters were produced and distributed to the parks and the public to announce the change. This is a project by the **Chihuahuan Desert, Southern Colorado Plateau, Southern Plains, and Sonoran Desert** networks.

Social Media

Posts from the Facebook pages of the **Northern Colorado Plateau Network** and **Sonoran Desert Network** were seen 482,761 times in fiscal year 2017. Almost 30,000 people engaged with a post. Together, these networks have 7,396 followers on Facebook and 4,720 on Instagram. The Northern Colorado Plateau Network vegetation monitoring crew was featured on the Department of the Interior's blog and Instagram account this year. These networks use social media to help public audiences understand and appreciate the role and importance of science in protecting and preserving the landscapes that inspire them.

STAN HONDA



Peñasco Blanco, Chaco Culture National Historical Park, under a night sky with Jupiter.

Video

The last Centennial webisode of Outside Parks, Inside Science followed the **Northern Colorado Plateau Network** down the Yampa River as they monitored big rivers. **Greater Yellowstone Network** staff were highlighted in a webisode of Yellowstone InDepth devoted to water resources. A webisode of Stay Curious, a series in which scientists explain how their curiosity as children led them to science careers, featured a **Rocky Mountain Network** ecologist. *Starry Nights at Chaco Culture NHP* premiered at the park's Second Annual Astronomy Festival. The video was created by the **Southern Colorado Plateau Network** and a videographer from Northern Arizona University.

OUTREACH FOR THE PUBLIC

Publications, Presentations, and Posters

Altogether, the seven Intermountain Region networks contributed 49 peer-reviewed journal articles and National Park Service reports to the scientific literature and made 17 posters and presentations for professional meetings (see Appendix B).

Network staff gave presentations at the:

- Climate-Friendly Parks Workshop (Jackson, WY),
- Tularosa Basin Science & Scenario Planning Workshop (Las Cruces, NM),
- 13th Biennial Greater Yellowstone Science Conference for the Greater Yellowstone Ecosystem (Mammoth, WY),
- Southeast Utah Group Darwin Days (Moab, UT),
- Utah Division of Water Quality Cooperators meeting (Salt Lake City, UT),
- Science of the Santa Cruz River (Tucson, AZ),
- Fiesta de Tumacácori (Tubac, AZ), and
- Arizona Parks Chiefs of Interpretation Meeting (Grand Canyon, AZ)

Lectures on water quality, climate, and geospatial technology, and NPS science and resource management were delivered to students from Missouri State University, Montana State University, and the University of Arizona. I&M staff also participated in a Science Olympiad and programs for STEAM night and Earth Day at a grade school. Sonoran Desert Network staff alone gave presentations to 12 local schools, two remote schools, and about six organizations ranging from Boy Scouts to the National Organization of Professional Hispanic Natural Resources Conservation Service Employees.



Young visitor examines macroinvertebrates from the Santa Cruz River at Fiesta de Tumacácori.

Appendix A
Network Summaries



White Sands National Monument, New Mexico.

Chihuahuan Desert Network

Overview

The Chihuahuan Desert Network (CHDN) includes seven national park units in New Mexico and west Texas. Together, the parks cover approximately 1,141,627 acres of predominantly Chihuahuan Desert grasslands and shrublands. Also included are the Guadalupe, Davis, and Chisos mountains, which contain relic coniferous forests and lush canyons.

The CHDN parks protect many unique geologic and biologic resources, including one of the country's largest bat colonies and near-pristine desert riparian habitats. Geologic resources include one of the world's largest gypsum dune fields (White Sands NM) and the world's most significant fossilized reef outcrop of Permian-age limestone, known as the Capitan Reef in Guadalupe Mountains NP. Carlsbad Caverns NP protects 120 caves, including Lechuguilla Cave, which is the seventh-longest known cave in the world and second-deepest limestone cave in the United States. Two CHDN parks have special designations: Big Bend NP is a U.S. Biosphere Reserve and Carlsbad Caverns NP is a World Heritage Site. White Sands NM was nominated as a World Heritage Site in 2007 because of its unique biological and geological resources.

Habitats

Chihuahuan Desert grasslands and shrublands

Monitoring

Upland vegetation and soils, exotic plants, landbirds, groundwater, springs, river channel morphology

Collaborators

Southern Plains Network, Sonoran Desert Network, Arizona-Sonora Desert Museum, Utah State University, University of Arizona, Tucson Audubon Society, Auburn University, New Mexico State University, University of New Mexico, Comisionado Nacional de Comision Nacional de Areas Naturales Protegidas, Áreas de Protección de Flora y Fauna Maderas del Carmen, Cañón de Santa Elena, Reserva de la Biósfera La Michillia, Áreas de Protección de Flora y Fauna Cuatrociénegas, Protección de Flora y Fauna Ocampo, Monumento Natural Río Bravo del Norte

Amistad National Recreation Area

Big Bend National Park

Carlsbad Caverns National Park

Fort Davis National Historic Site

Guadalupe Mountains National Park

Rio Grande Wild and Scenic River

White Sands National Monument

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Network Summaries



Grand Teton National Park, Wyoming.

Greater Yellowstone Network

Bighorn Canyon National Recreation Area

Grand Teton National Park

John D. Rockefeller, Jr. Memorial Parkway

Yellowstone National Park

Overview

The Greater Yellowstone Network (GRYN) was established in 2000 to serve the inventory and monitoring needs of four park units located within and around the Greater Yellowstone Ecosystem of Wyoming, Montana, and Idaho. Bighorn Canyon NRA is situated at the northern end of the Great Basin Desert and provides a unique natural environment with the convergence of the desert, the Rocky Mountains, and the northern Great Plains. Portions of the Pryor Mountain Wild Horse Range and Yellowtail Wildlife Habitat Management Area fall within the boundaries of the recreation area. Grand Teton NP, the John D. Rockefeller, Jr. MP, and Yellowstone NP create the core of the 23 million-acre Greater Yellowstone Ecosystem, one of the largest relatively intact ecosystems in the contiguous United States, with over 15 million acres of largely contiguous federal land.

The network actively collaborates with the parks as well as other agencies and organizations, and seeks to extend its collaborative relationships with governmental and non-governmental partners depending on needs.

Habitats

Montane, alpine, desert

Monitoring

Amphibians, climate, land use, upland vegetation, water resources, whitebark pine

Collaborators

U.S. Forest Service, U.S. Geological Survey, Bureau of Land Management, Montana State University Institute on Ecosystems, Great Northern Landscape Conservation Cooperative, Greater Yellowstone Coordinating Committee

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Bryce Canyon National Park, Utah.

Northern Colorado Plateau Network

Overview

The Northern Colorado Plateau Network (NCPN) covers a geologically and biologically diverse region, comprising 16 parks in Utah, western Colorado, southwest Wyoming, and northern Arizona. Network parks range in size from 40 to more than 337,500 acres and occur between 3,600 and 10,500 feet in elevation. The network benefits from active collaborations with network parks, other I&M networks, and several other agencies and organizations.

Habitats

Desert grasslands, shrublands, forests, caves, large rivers, perennial streams, seeps, and springs. Parks in the network occur between 3,600 and 10,500 feet in elevation.

Monitoring

Uplands, riparian, big rivers, springs and seeps, invasive plants, landbirds, water quality, climate, air quality, land surface phenology, landscape dynamics

Collaborators

U.S. Geological Survey (Colorado Plateau Research Station, Colorado Water Science Center, Columbia Environmental Research Center, Fort Collins Science Center, Grand Canyon Research and Monitoring Center, South Atlantic Water Science Center, Southwest Biological Science Center), Northern Rockies Landscape Conservation Cooperative, U.S. Department of Agriculture (Agricultural Research Service Southwest Watershed Research Center), Environmental Protection Agency (Mid-Continent Ecology Division, National Exposure Research Laboratory, Region 8 Laboratory), Cooperative Ecosystem Studies Units, Utah State University, University of Montana, State of Utah Division of Water Quality, National Park Service Water Resources Division, University of Arizona, University of Delaware, Brigham Young University, Institute for Wildlife Studies, NASA Langley Research Center (Virginia).

Arches National Park

Black Canyon of the Gunnison National Park

Bryce Canyon National Park

Canyonlands National Park

Capitol Reef National Park

Cedar Breaks National Monument

Colorado National Monument

Curecanti National Recreation Area

Dinosaur National Monument

Fossil Butte National Monument

Golden Spike National Historic Site

Hovenweep National Monument

Natural Bridges National Monument

Pipe Spring National Monument

Timpanogos Cave National Monument

Zion National Park

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Network Summaries



Glacier National Park, Montana.

Rocky Mountain Network

Overview

The Rocky Mountain Network (ROMN) comprises six national park units located in the central and southern Rocky Mountain Cordillera, roughly along a NNW–SSE axis that follows the Continental Divide through Montana and Colorado. Together, these parks cover approximately 1,373,463 acres. Although this is an extremely diverse region, all six parks share ecological similarities and have a tradition of working together. Network parks protect some of the premier wilderness remaining in the continental US; easily accessible and spectacular alpine communities; diverse wildlife communities (including a complete assemblage of native carnivores in Glacier NP); the largest dune complex in North America (Great Sand Dunes NP&Pres); nationally significant cultural landscapes (Grant-Kohrs NHS and Little Bighorn Battlefield NM); and an internationally significant paleoecological community protected in the paper shales of Florissant Fossil Beds NM.

Habitats

Montane, alpine, dunefield

Monitoring

Snow chemistry, wetland ecological integrity, stream ecological integrity, upland vegetation and soils, alpine vegetation and soils, climate

Collaborators

U.S. Geological Survey (Colorado Water Science Center, Fort Collins Science Center, National Wetlands Research Center, West Glacier Field Station) Environmental Protection Agency Region 8 Laboratory, Colorado Department of Public Health and Environment, Montana Department of Environmental Quality, Rhithron Associates, Crown Managers Partnership, University of Calgary, Colorado Natural Heritage Program, Colorado State University, University of Colorado, Natural Resources Conservation Service, U.S. Forest Service, University of Montana Herbarium, Northern Rockies Conservation Cooperative

Florissant Fossil Beds National Monument

Glacier National Park

Grant-Kohrs Ranch National Historic Site

Great Sand Dunes National Park and Preserve

Little Bighorn Battlefield National Monument

Rocky Mountain National Park

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Organ Pipe Cactus National Monument, Arizona.

Sonoran Desert Network

Overview

The Sonoran Desert Network (SODN) comprises 11 national park units in southern Arizona and western New Mexico. Ranging from 46 to 330,688 acres, SODN parks contain all major biomes of the Sonoran Desert and Apache Highlands Ecoregions. The parks include characteristic ecosystems and iconic species of those biomes, as well as unique natural and cultural resources. Network parks include some of the most impressive cliff dwellings and other prehistoric centers of habitation in the American Southwest, all associated with key perennial water resources, including reaches of the Salt, Gila, Verde, and Santa Cruz rivers and their major tributaries. Historic cultural locations include a strategic frontier fort, 17th century colonial missions, and Coronado's entry route into the future United States during his exploration of North America.

Habitats

Desert, thornscrub, semi-desert grassland, Madrean evergreen woodland, interior chaparral, temperate forest

Monitoring

Landbird monitoring, integrated streams and washes, groundwater, terrestrial vegetation and soils, air quality, climate, springs, mammals, and reptiles

Collaborators

Southern Plains Network, Chihuahuan Desert Network, University of Arizona, Tucson Audubon Society, U.S. Fish and Wildlife Service, Arizona-Sonora Desert Museum, Pima County, Arizona

Casa Grande Ruins National Monument

Chiricahua National Monument

Coronado National Memorial

Fort Bowie National Historic Site

Gila Cliff Dwellings National Monument

Montezuma Castle National Monument

Organ Pipe Cactus National Monument

Saguaro National Park

Tonto National Monument

Tumacácori National Historical Park

Tuzigoot National Monument

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Mesa Verde National Park, Colorado.

Southern Colorado Plateau Network

Overview

The Southern Colorado Plateau Network (SCPN) is composed of 19 parks located in the diverse landscapes of northern Arizona, northwestern New Mexico, southwestern Colorado, and southeastern Utah. Most units lie within the southern Colorado Plateau ecoregion, but a few are allied with the Arizona–New Mexico Mountains and Southern Rocky Mountains ecoregions. Ranging in size from 35 to more than 1,235,527 acres, the parks encompass approximately 3.06 million acres, with over half of that area managed as wilderness. The network includes many parks established to protect the cliff dwellings, great houses, and other archeological resources associated with the cultures of Ancestral Puebloan people. Many SCPN parks also preserve significant geologic resources, ranging from Late Triassic paleontological resources found in Petrified Forest NP to the volcanic features and landscapes of Sunset Crater and El Malpais NMs. Several parks preserve the history of early contact between American Indians and Europeans. With scenic vistas known throughout the world, Grand Canyon NP includes a 277-mile stretch of the Colorado River and thousands of miles of tributary side-canyons.

Habitats

Montane forests, semi-arid woodlands, semi-arid grasslands and shrublands

Monitoring

Climate, upland vegetation and soils, habitat-based bird communities, aquatic macroinvertebrates, water quality, integrated riparian (stream flow and depth to groundwater, channel morphology, riparian vegetation), spring ecosystems, and land surface phenology

Collaborators

Northern Arizona University, Utah State University, University of New Mexico, U.S. Geological Survey (National Water Quality Laboratory, Flagstaff Science Center)

Aztec Ruins National Monument
Bandelier National Monument
Canyon de Chelly National Monument
Chaco Culture National Historical Park
El Malpaís National Monument
El Morro National Monument
Glen Canyon National Recreation Area
Grand Canyon National Park
Hubbell Trading Post National Historic Site
Mesa Verde National Park
Navajo National Monument
Petrified Forest National Park
Petroglyph National Monument
Rainbow Bridge National Monument
Salinas Pueblo Missions National Monument
Sunset Crater National Monument
Walnut Canyon National Monument
Wupatki National Monument
Yucca House National Monument

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Pecos National Historical Park, New Mexico.

Southern Plains Network

Overview

The Southern Plains Network (SOPN) includes 11 park units in Colorado, Kansas, New Mexico, Oklahoma, and Texas. Together, these parks comprise approximately 74,132 acres. Most network parks were established primarily for cultural and recreational reasons, but all contain significant natural resources. SOPN parks have some of the only representatives of short- and mixed-grass ecosystems in protected status in the National Park System.

Habitats

Shortgrass prairie, mixed-grass prairie, riparian, pinyon-juniper

Monitoring

Grasslands, exotics invasive plants, landbirds, streams, groundwater, climate, grassland fire effects

Collaborators

Sonoran Desert Network, Chihuahuan Desert Network, Southern Plains Fire Group, Southwest Exotic Plant Management Team, Auburn University, New Mexico State University, Oklahoma State University, U.S. Fish and Wildlife Service, Tucson Audubon

Alibates Flint Quarries National Monument

Bent's Old Fort National Historic Site

Capulin Volcano National Monument

Chickasaw National Recreation Area

Fort Larned National Historic Site

Fort Union National Monument

Lake Meredith National Recreation Area

Lyndon B. Johnson National Historical Park

Pecos National Historical Park

Sand Creek Massacre National Historic Site

Washita Battlefield National Historic Site

Appendix B
Publications & Presentations

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Appendix B
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Appendix B
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