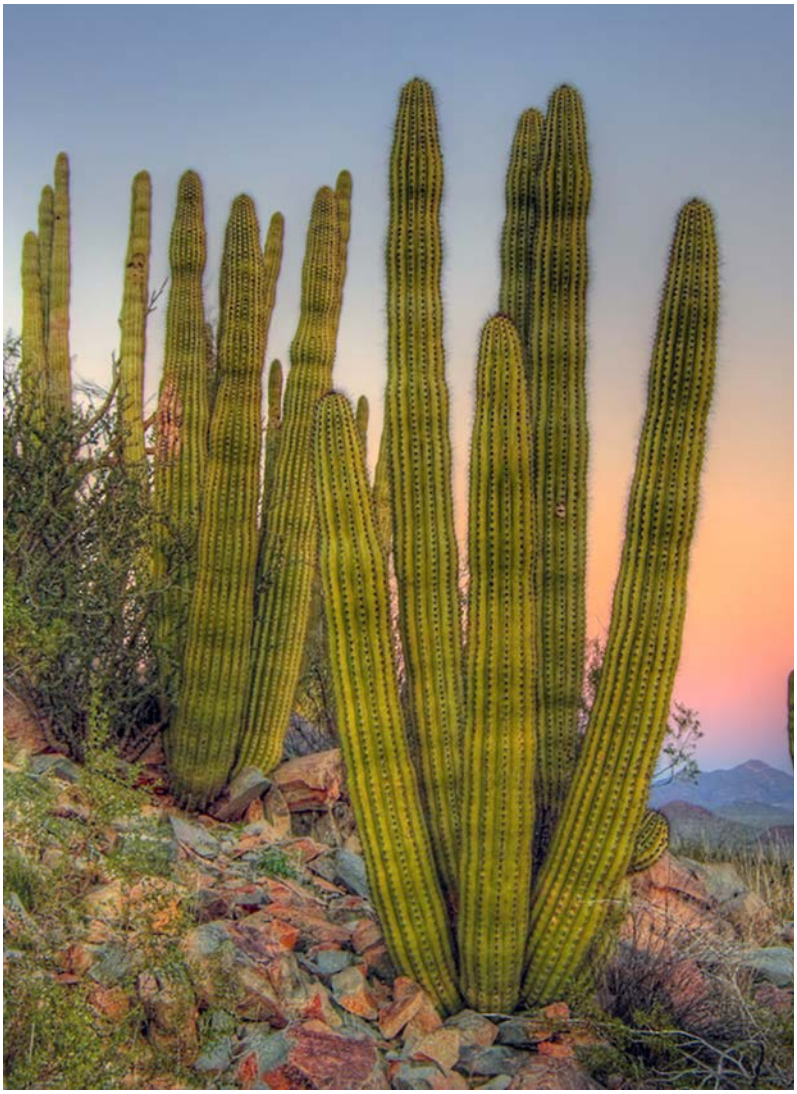
Inventory and Monitoring

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science



MEETING THE MISSION 2018

Contributions of the Intermountain Region's Inventory & Monitoring Networks to National Park Science, Management, and Stewardship

The following acronyms are used throughout this document:

National Park	NP	Chihuahuan Desert Network	CHDN
National Park and Preserve	NP&P	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

Please cite this document as:
Palumbo, J. and M. Bozek. 2019. Meeting the Mission, 2018: contributions of the Intermountain Region's Inventory & Monitoring Networks to national park science, management, and stewardship. National Park Service, Inventory & Monitoring Division, Fort Collins, Colorado.

Unless otherwise noted, all photos in this document were taken by NPS staff.

ON THIS PAGE:
Wildflowers in Rocky Mountain National Park of the Rocky Mountain I&M Network.
Photography by NPS

ON THE COVER:
Top: Organ Pipe National Monument, of the Sonoran Desert I&M Network.
Photo by J. Coprneveaux, licensed under CC by 2.0.

Bottom: Big Bend National Park.(
Photo by D. Hensley, licensed under CC by 2.0.

MEETING THE MISSION 2018

Contributions of the Intermountain Region's Inventory & Monitoring Networks to National Park Science, Management, and Stewardship

Jean Palumbo
Michael Bozek

National Park Service
Inventory and Monitoring Division
Intermountain Region

Contents

ON THIS PAGE:
Capulin Volcano NM of the Southern Plains I&M Network.
"Volcanic New Mexico," photo by Robot Brainz, licensed under CC by 2.0.

The need for science—to understand how park ecosystems function, monitor impacts of change (even from afar), inform decisions makers and their decisions, and enrich public appreciation of park values—has never been greater.

– NPS Advisory Board, in Revisiting Leopold, 2012

1 Introduction

In 1872 Ulysses S. Grant designated Yellowstone the first official national park of the United States. The 1906 Antiquities Act granted the President of the United States the power to declare public lands with historic or scientific interest as national monuments. In the years that followed, the number of national parks grew. As public interest grew, so did the number of opportunists seeking to exploit the parks for private gain. It was clear that something needed to be done to protect these special places from the excesses of visitation and exploitative businesses.

The Organic Act of 1916 established the National Park Service (NPS) and charged it with preserving the natural and cultural resources of parks, unimpaired for the enjoyment, education and inspiration of current and future generations. At the time, though, implicit in the policies of the NPS was the belief that every effort should be made to ensure maximum use by the public. As a result, management of natural resources was often focused on enhancing the visitor experience, not based on sound science, and not for the benefit of the natural resources. Examples of this included the eradication of predators, clearing of forests to create vistas, feeding of bears at garbage dumps, introduction of exotic species, and the use of herbicides and pesticides.

In 1929, a young wildlife scientist, George Melendez Wright, undertook the first ever epic survey of the wildlife and plants of the western national parks. Four years later he published his findings in an influential work entitled Fauna of the National Parks of the United States. In it Wright laid out ground rules for science-based wildlife management, and he suggested further research to inform decision-making. Appointed to head the newly established Wildlife Division of the NPS, Wright worked to implement his plans for managing wildlife in their natural environment. Tragically, he died in a car accident a few years later, and many of his ideas were then ignored for nearly 30 years.

In the early 1960s came a turning point in the debate about how to manage wildlife and landscapes in national parks. A series of reports authored by NPS scientists and outside committees echoed the recommendations made by Wright 30 years previously. Taken together, these reports advocated for extensive scientific research in parks and management for ecosystem preservation. The report "Wildlife Management in the National Parks" by the advisory committee chaired by ecologist and conservationist Aldo Leopold further proposed that a primary purpose of natural resource management in national parks was to "preserve, or where necessary to recreate the ecologic scene as viewed by the first European visitors." The report was delivered to Secretary of the Interior Stuart Udall in 1963.

If NPS managers were to take actions to preserve and protect park resources, and even restore them to pristine conditions, then they would need first, baseline data on the resources in their parks. While efforts to inventory resources had been undertaken by some parks by 1992, the type of data collected varied widely, and the quality of the data was largely unknown. Second, park managers would need long-term monitoring data of selected resources that would allow them to determine resource condition and detect or predict changes over time. Furthermore, park managers would need to be able to translate the information provided by these datasets so that the information could be used to identify alternative courses of management action, assess trade-offs of these actions, and evaluate their consequences. Finally, to be able to effectively guide natural resource management over the long-term, inventory and monitoring activities would need to be integrated with all other management functions at the park, regional and national levels. The NPS Inventory and Monitoring Division was created to accomplish this.

ON THIS PAGE:
Canyon De Chelly NM of the Southern Colorado Plateau I&M Network.
"Spider Rock Overlook at Canyon de Chelly, Arizona. Photo by Diana Robinson, licensed under CC by 2.0.

The Servicewide Inventory and Monitoring Program will chart the course and provide the leadership and information resources needed by the National Park Service to preserve and protect the natural resources placed under its trust by the American people into the 21st Century and beyond. Through its accomplishments, the Program will further enhance the National Park Service's stature as an international leader in natural resources management and stewardship.

– Natural Resources Inventory and Monitoring Guidelines. NPS-75. 1993

2 Inventory and Monitoring Networks

The Inventory and Monitoring Division of the NPS was launched after Congress passed the National Parks Omnibus Management Act of 1998. The program's purpose is to gather information about park resources that will (1) establish baseline conditions for those resources, and (2) provide information on long-term trends in their condition. Parks with significant natural resources were grouped into networks based on geography and common natural resource characteristics (please see Appendix A for Intermountain Region network summaries). Networks and parks worked together to identify key resources, or "vital signs" that indicate the health of the ecosystems in our national parks. Vital Signs Monitoring programs were designed to yield data on the condition and trends of key park resources in the context of long-term management goals. Vital signs monitored in I&M networks include:

- physical resources and processes, such as air, water, climate, fire, and erosion
- biological attributes, such as species and biological communities
- ecological processes, such as disturbance and productivity

Not all I&M networks are equal. They vary in the number of parks they serve, in the vital signs that they monitor, as well as in the size of their budgets and their staff. But they are all in the business of collecting information about the natural resources in parks, and communicating that information to park management and the public.

Incorporating new information into resource management, environmental compliance, planning, and interpretation can be challenging. Often, this information may not meet the immediate needs of parks. As networks have worked to be more responsive to park needs, two approaches for developing science information have emerged: (1) use current monitoring methods and data to provide information that parks need to maintain programs, and (2) engage in supplemental scientific research to provide the information needed for resource management decision-making.

In Chapter 3 we describe how I&M networks go beyond their inventory and monitoring role to provide the science that will help park managers make defensible resource management decisions. In Chapter 4 we describe and provide examples of how the seven I&M networks of the Intermountain Region support park programs, not only with monitoring data, but in other ways as well.

ON THIS PAGE:
Black Canyon of the Gunnison National Park of the Northern Colorado Plateau I&M Network.
Fall Colour, Black Canyon of the Gunnison 2," Photo by Duncan Rawlinson, licensed under CC by 2.0.

NPS decision-making processes must adhere with precision to the law, be mindful of legislative intent, and consistently and transparently follow public policy and regulations.

– National Park System Advisory Board, Science Committee 2012

3 Science for Decision-Making

Parks often face consequential decisions about managing natural and cultural resources—decisions that deal with a changing environment, the effects of emerging technologies, and more. Decisions that have consequences, or deal with uncertainty and accountability, or involve multiple stakeholders should be made in a deliberate manner, after collecting all the pertinent facts, soliciting advice from experts and then analyzing that information. For these types of decisions, science should always play a role.

Sometimes parks require information that cannot be immediately accessed from existing I&M data. In such cases, parks may need, for example, effectiveness monitoring to assess success of resource management, or ecological modeling that can allow predictions. Although these and other efforts are not part of I&M networks' monitoring responsibilities, whenever possible, networks will work with parks and partners to address information gaps with science.

Here are some examples of how I&M networks in the Intermountain Region provide science to assist in park decision-making.

WATER QUALITY

1. Intensive sampling leads to a stream delisting and native fish reintroduction.

Greater Yellowstone Network (GRYN), Yellowstone NP (YELL)

GRYN's intensive and repeated water quality sampling was instrumental in the first delisting of a waterway from Montana's list of impaired (303d-listed) waters. Soda Butte Creek, an important water resource flowing into Yellowstone National Park, is a tributary of the Lamar River whose water quality was impaired by historical mining activity near Cooke City, Montana (Figure 1). GRYN's post-reclamation samples included chlorophyll and macroinvertebrate data used in a beneficial use assessment of the creek for the Montana Department of Environmental Quality. The delisting cleared the way for the recent successful reintroduction of fish in Soda Butte Creek. GRYN's involvement in this successful collaboration was shared in a number of publications and media outlets, including the Bozeman Daily Chronicle and the Billings Gazette.

Figure 1. Soda Butte Creek in Yellowstone NP, (left) pre-reclamation in 2008, and (right) post-reclamation in 2013.

2. Educating the public about contaminants in water.

Northern Colorado Plateau Network (NCPN)

Everywhere people go, they leave behind contaminants, especially in our streams, rivers, and lakes. That's what I&M scientists found in a study conducted in cooperation with the US Environmental Protection Agency (EPA) and the US Geological Survey (USGS). From 2012 to 2016, NCPN sampled waters across 21 sites on the northern Colorado Plateau looking for contaminants of emerging concern (CECs). These include pesticides, antibiotics, household microplastics, sunscreen and insect repellent. They found them even in the most remote areas. Armed with this evidence, parks can now educate visitors on how to help keep park waters healthy and pristine. In 2018, NCPN published its findings in the journal Science of the Total Environment, see Weissinger et al., 2018.

3. Good news and not so good news in water quality trends at Zion NP.

Northern Colorado Plateau Network (NCPN), Zion NP (ZION)

NCPN produced a 10-year trend report for ZION that found continued exceedances of state water-quality standards for fecal indicator bacteria in the North Fork Virgin River (Figure 2). This indicated that improved management was needed upstream of the park to protect public health and safety. It was also cause for continued monitoring as those management actions were implemented. Water quality in North Creek, however, appeared to be stabilizing after a 2006 wildfire burned much of the watershed. In addition, changes in La Verkin Creek are likely to be natural in origin and do not currently warrant management concern. For more information see Weissinger and Sharrow, 2018.

Figure 2. Water quality at monitored locations in Zion NP has remained relatively stable and high-quality over time.

4. Cleaning up a superfund site.

Rocky Mountain Network (ROMN), Grant-Kohrs Ranch NHS (GRKO)

GRKO is located in the middle of the largest superfund site in the U.S. The park is contaminated with elevated concentrations of arsenic, copper, cadmium, lead, and zinc from historic mining, milling and smelting operations upstream on the Clark Fork River. In 2018, the Montana Department of Environmental Quality began a clean-up and remediation project that will remoKohrs ve 400,000 cubic yards of contaminated material from the floodplain and banks of the Clark Fork River within the park. ROMN worked with GRKO staff to conduct enhanced stream monitoring in the park and the Clark Fork watershed. Long term monitoring will help to determine if restoration efforts are working, and if not, what might need to be done to restore this area to its original baseline condition.

STREAMS AND RIVERS

5. Modeling ecosystem response to changes in stream flow.

Northern Colorado Plateau Network (NCPN), Dinosaur NM (DINO)

NCPN, the University of Montana and the US Forest Service developed an eco-geomorphic model that would predict riparian ecosystem response to flow-regime changes at DINO. This model takes advantage of the linkage between plant functional traits, which are important for (a) determining a plant's response to flow regime chang-

es, and (b) predicting the impact of changing plant guilds on the flow of water and transport of sediment. River managers can use the model to assess the effects of changes in flow, whether they are from climate change on a wild river like the Yampa, or from dam regulation and human diversions on a more regulated river like the Green. For more information, see Diehl et al. 2018.

6. Developing a tool to monitor river channel response to changing flows

Northern Colorado Plateau Network (NCPN), Dinosaur NM (DINO)

Figure 3. The Green River in Dinosaur NM.

Since the completion of the Flaming Gorge Dam in 1964, managers have attempted to mimic natural flow regimes in the Green River (Figure 3) using artificial flow releases. However, the releases have promoted channel narrowing and encouraged non-native vegetation to encroach into the active stream channel in DINO. These changes have reduced the backwater habitat of four native endangered fish species: the Colorado Pikeminnow (*Ptychocheilus lucius*), Razorback Sucker (*Xyrauchen texanus*), Humpback Chub (*Gila cypha*), and Bonytail (*Gila elegans*). In order to recover populations of these endangered fishes, resource managers will need to understand the effects of past flow releases and be able to correctly predict the effects of proposed changes in flows. To help them do this, NCPN, NASA, and the Upper Colorado River Endangered Fish Recovery Program developed the River Morphology Evaluation Toolbox (RMET). This Google Earth Engine (GEE) tool will more efficiently and cost-effectively monitor changes in vegetation and hydrology across large spatial and temporal scales. The tool will predict what changes to expect in riparian habitat, and where channel narrowing will occur in response to a change, thus indicating where fish larval habitat will be degraded. The model needs to be tested and validated.

PLANTS, SOILS, AND CLIMATE CHANGE

7. How will wet and dry plant communities fare under a warmer, drier climate?

Northern Colorado Plateau Network (NCPN), Rocky Mountain Network (ROMN)

Scientists from the NCPN, ROMN, and the U.S. Geological Survey wanted to know how native plant communities would perform under varying conditions over time. To identify whether plant communities were doing well or poorly, the scientists identified "pivot points" for each plant community. The pivot point is the amount of water at which vegetation production teeters between below and above average condition. They looked at precipitation data for 520 sites in seven national parks over a 15-year period. The study revealed that plant communities in wetter regions, such as pinyon-juniper and sagebrush steppe, were more responsive to moisture, but more susceptible to drought. Plant communities in drier regions, such as blackbrush and desert grasslands, were more resistant to drought but less able to grow quickly under wetter conditions.

The authors also determined growth rates for different plant communities in droughty or moist years. Combined, this information suggests how different vegetation communities may fare in a warmer, drier climate. Thus, it can help park managers make decisions about which places and which mix of species might be best for restoration and conservation efforts. To learn more, see Thoma et al. 2018.

8. Spring on the Southern Colorado Plateau is predicted to be drier earlier, stressing plant and animal communities.

Southern Colorado Plateau Network (SCPN), Aztec Ruins NM (AZRU), Bandelier NM (BAND), Chaco Culture NHP (CHCU), Glen Canyon NRA (GLCA), Grand Canyon NP (GRCA), Mesa Verde NP (MEVE), Petrified Forest NP (PEFO), Petroglyph NM (PETR), Wupatki NM (WUPA)

How will plants in SCPN parks fare under predicted future climate conditions? SCPN teamed up with the Southwest Biological Science Center (USGS) to find out. They used soil and vegetation monitoring data from 13 ecosystems in nine network parks to model soil moisture variability under historical and future climate conditions. While the results varied among parks and ecosystems, for most, the drying of soils would happen earlier in spring, thus shortening the period when soils are wet during the growing season. The timing of this moisture stress could affect more than just the vegetation, because springtime is when many wildlife species are reproducing and need more food energy from vegetation. This knowledge will help scientists to develop strategies to anticipate ecosystem impacts and, where possible, improve long-term ecosystem resistance and resilience, thus, helping to preserve our parks for future generations. The key is to follow anticipatory management principles by defining current relationships between climate, soils, and vegetation, and then use those models and relationships to predict change in the future. Numerous communication products accompanied this project, including a peer-reviewed article (see Gremer et al. 2018), project briefs, a web article, and in-person presentations at several SCPN parks.

9. Identifying climate refugia in alpine environments

Rocky Mountain Network (ROMN), Glacier NP (GLAC), Rock Mountain NP (ROMO), Great Sand Dunes NP (GRSA), Yellowstone NP (YELL)

Alpine communities (Figure 4) are characterized by spectacular wildflower displays and they support many iconic species of management concern (e.g. pika and ptarmigan). But they may be particularly sensitive to atmospheric pollution and climate change. The Global Research Initiative in Alpine Environments (GLORIA) is a long-term monitoring program that looks at climate change impacts on alpine plant communities around the world. ROMN contributes monitoring data for alpine vegetation and soils in GLAC, ROMO, and GRSA for GLORIA. The network also works with the GRYN to monitor sites in YELL. An early result of this study has been the identification of climate refugia within alpine environments that need to be protected from fire.

Figure 4. ROMN monitors alpine communities, like this one in Great Sand Dunes National Park and Preserve.

IMPERILED SPECIES

10. Developing a conservation strategy for whitebark pine.

Greater Yellowstone Network (GRYN)

As a participant in the interagency Greater Yellowstone Ecosystem (GYE) Whitebark Pine Monitoring Program, GRYN has been monitoring whitebark pine since 2004. Whitebark pine is a high elevation keystone species that helps to stabilize soils on subalpine slopes and produces seeds that are a high energy food source for birds and mammals. Its populations are declining due to a deadly combination of white pine blister rust, outbreaks of native mountain pine beetles, wildfire, and climate change. The network contributed data and expertise during the development of the GYE Whitebark Pine Conservation Strategy, and works with partners to publish reports and papers and conduct public outreach.

SPECIAL PROJECTS

11. Developing a model to guide cheatgrass control

Rocky Mountain Network (ROMN), Little Bighorn Battle NM (LIBI)

Each year, ROMN collects data on annual brome cover at LIBI. This data is provided to Annual Brome Adaptive Management (ABAM), a multi-network, multi-park project that seeks to identify the most effective way to control cheatgrass, an invasive grass. USGS scientists, with input from ROMN, are working on a model that will provide management recommendations for parks, based on the current state of vegetation in the park.

12. Understanding the relationships among wetland vegetation, hydrology and beavers

Rocky Mountain Network (ROMN), Rocky Mountain NP (ROMO)

ROMN and ROMO, have been working with the Wetland Aquatic Research Center (USGS) and Colorado State University to model relationships among human disturbance, ecosystem drivers and wetland health. Phase II will examine the relationships among wetland vegetation, hydrology, beaver habitat requirements and elk. Understanding these relationships will help to inform a simulated beaver dam restoration project in the park that is designed to mitigate the effects of elk and moose on wetlands and willow stands.

SUPPLEMENTAL MONITORING

13. Collaborative monitoring for a landscape perspective

Sonoran Desert Network (SODN)

SODN continued collaborative monitoring with Pima County, AZ, to extend the inference of park monitoring and improve our knowledge of landscape-scale vegetation and soil conditions (Figure 5). With funding and personnel from the county's Office of Sustainability and Conservation, staff from both programs sampled 26 new permanent plots using the SODN's terrestrial vegetation and soils protocol. Data from this collaboration supports effective park management as Pima County contains network's two largest parks: Saguaro NP and Organ Pipe Cactus NM.

Figure 5. SODN staff helped Pima County to establish and monitor permanent monitoring plots. The data provides information about vegetation and soils that supports managment of Saguaro NP and Organ Pipe Cactus NM.

ON THIS PAGE:
Grand Teton National Park of the Greater Yellowstone I&M Network.
"First light at Oxbow Bend," photo by Dave Hensley, licensed under CC by 2.0.

If we are to keep parks unimpaired, we will have to understand large-scale issues, such as fragmentation of landscapes surrounding parks, the high-stakes losses that invasive plants and animals promise, the decline in migratory species, and the all-pervasive implications of global climate change, in sufficient detail to manage them.

– Michael Soukup, 2007

4 Inventory and Monitoring to Support Park Programs

Resource inventories are point-in-time surveys to gain information about specific resources, such as plants and animals, air, water, soils, landforms, and climate. Monitoring is the repeated observation and measurement of specific natural resources and processes. The data that is collected through these efforts help us to learn many things about resources in parks. For example, it can allow us to detect changes in a resource, identify potential problems and address them before they become serious, and measure the success of natural resource management in parks.

When monitoring data alone cannot provide the answers that park managers need, I&M networks may seek out existing data related to a resource of interest. For example, the Sonoran Desert I&M Network augmented its vegetation database with floristic characteristics of plants, information that is readily available from other sources. This allowed them to identify pollinator habitat within the network's monitoring plots. Sometimes monitoring methods or sampling designs may need to be adjusted to better fit park information needs. The Rocky Mountain I&M Network added wetland monitoring plots and employed additional methods to track use by elk and bison in Rocky Mountain NP (see below).

Here are some of the ways that I&M networks in the Intermountain Region support park programs.

PROTOCOL DEVELOPMENT

1. Fine-tuning invasive exotic plant monitoring

Chihuahuan Desert Network (CHDN)

CHDN tested the Invasive Exotic Plant Monitoring Protocol developed by the NCPN to compare the results with those of the protocol the network has been using. The CHDN protocol is good for evaluating trends in exotic species infestation, but the NCPN protocol also generates point locations park managers can use to locate and readily treat infestations.

CLIMATE

2. Providing access to weather, climate and other related data

Chihuahuan Desert Network (CHDN), Greater Yellowstone Network (GRYN), Northern Colorado Plateau Network (NCPN), Rocky Mountain Network (ROMN), Southern Colorado Plateau Network (SCPN), Sonoran Desert Network (SODN), Southern Plains Network (SOPN).

Networks in the IMR continued to support and work with The Climate Analyzer, an interactive data visualizer that aggregates several different kinds of data, including weather, climate, stream flow and snow melt data. The website serves data for more than 70 NPS units across 13 I&M networks. The data is collected and maintained by numerous agencies. Aggregating it in one place makes it easier for parks, network staff, and the public to easily download regional and national climate data.

Staff from IMR I&M networks continue to provide guidance, feedback and coordination with park resource managers to expand the site. This fiscal year ROMN and SCPN helped in the creation of climate dashboards

for GLAC and GLCA, respectively. Park climate dashboards compile the data specific to a park in one location. ROMN has been working with the site to provide water balance charts and tables that allow user to compare soil moisture conditions over time.

3. As wetlands dry, amphibian breeding occupancy declines.

Greater Yellowstone Network (GRYN), Yellowstone NP (YELL), Grand Teton NP (GRTE)

How do climate and habitat variables influence wetland flooding and amphibian occupancy? Each year GRYN staff and cooperators gather data on amphibian occupancy and wetland characteristics for around 220 wetland sites in 30 small drainage areas within YELL, GRTE and John D. Rockefeller Jr. Memorial Parkway (Figure 6). This growing monitoring data set supports reports about the status and trend of amphibian occupancy and wetland condition in the parks, which are shared with park managers and resource scientists, and the coordinator of the Rocky Mountain region of the Amphibian Research and Monitoring Initiative (ARMI, https://armi.usgs.gov/).

Figure 6. GRYN collects amphibian data in wetlands of Yellowstone NP and provides it to the Amphibian Research and Monitoring Initiative.

Recently, GRYN, NCPN, Colorado State University, New Mexico State University, and the Northern Rockies Conservation Cooperative teamed up to analyze 10 years of GRYN's amphibian and wetland monitoring data in YELL and GRTE. They found that in drier years, wetland habitat was reduced, resulting in lower occupancy of breeding amphibians. See Gould et al. 2019 for results of the study.

UNIQUE COMMUNITIES

4. Unique quaking aspen community found in Bighorn Canyon NRA.

Greater Yellowstone Network (GRYN), Bighorn Canyon NRA (BICA

In 2011, during vegetation inventory field work in BICA, field crew personnel discovered an isolated and previously undiscovered stand of quaking aspen trees outside the documented range of quaking aspen in that region (Figure 7). To document resource values of the stand, and to inform possible management actions, the Colorado Natural Heritage Program is studying the genetics of trees in this unique stand with support from the NPS Vegetation Inventory Program. A report is pending.

Figure 7. Isolated stand of quaking aspen in Bighorn Canyon NRA.

WATER RESOURCES

5. Monitoring helps to rule out sources of stream contamination.

Northern Colorado Plateau Network (NCPN), Capitol Reef NP (CARE)

When a segment of the Fremont River was listed as impaired in 2014, the Utah Division of Water Quality prioritized a plan to reduce *E. coli* concentrations. Staff at CARE wanted to know where *E.coli* was entering into the water. Could it be due to park visitation and/or park management activities? After collecting samples along the impaired segment, NCPN staff found high *E. coli* concentrations at four sites in the park. Most exceedances occurred during a time frame that covers >75% of the park's annual visitation and corresponds to cattle trailing through the park and livestock grazing upstream. Samples taken above and below the park's developed area and a popular trail showed similar patterns in *E. coli* concentrations, suggesting that in Sulphur Creek, most *E. coli* contamination enters upstream of the park. For more information, see Hackbarth and Weissinger 2018.

6. Providing a benchmark for assessing streams.

Rocky Mountain Network (ROMN), Glacier NP (GLAC)

ROMN staff continued sampling the Hydrologic Benchmark site at Swiftcurrent Creek in GLAC for the National Rivers and Streams Assessment. The Hydrologic Benchmark Network was established in 1963 to provide long-term measurements of streamflow and water quality in areas that are minimally affected by human activities. These data serve as a means for separating natural from artificial changes in other streams.

7. Water quality monitoring led to a stream clean-up. Now there are fish.

Sonoran Desert Network (SODN), Tumacácori NHP (TUMA)

A decade ago, monitoring by SODN and TUMA staff detected poor water quality in the Santa Cruz River at TUMA (Figure 8). The discovery prompted upgrades at the Nogales International Wastewater Treatment Facility, a few miles upstream of the park. Continued monitoring has documented dramatic improvements in water quality and, in 2018, detected recolonization of park waters by a healthy population of the endangered Gila topminnow. This exciting success story was extensively covered by local media and has become a topic of great interest to park visitors and neighbors.

Figure 8. Water quality monitoring of the Santa Cruz River in Tumacácori NHS documented improvements in water quality after upgrades were made to a wastewater treatment facility upstream of the park.

MANAGEMENT PLANS

8. Determining a sustainable level of wildlife grazing

Rocky Mountain Network (ROMN), Great Sand Dunes NP&P (GRSA)

ROMN's long-term wetlands monitoring in GRSA has provided a foundation for developing the Ungulate Management Plan (UMP) and EIS. By linking the condition of wetlands to the level of use by bison and elk the park can identify what level of grazing would be sustainable. ROMN added wetland plots where ungulate use will be monitored with cameras, and track and pellet monitoring. Network staff provided reviews for the UMP and EIS.

9. Developing a Comprehensive River Management Plan

Rocky Mountain Network (ROMN), Glacier NP (GLAC)

ROMN, GLAC, and the U.S. Forest Service are developing a Comprehensive River Management Plan (CRMP) for the Flathead River, a Wild and Scenic River (https://rivers.gov/) that flows through the park (Figure 9).

Figure 9. ROMN monitors sentinel sites on the Flathead River, a Wild and Scenic River, in Glacier NP. Monitoring will inform the Comprehensive River Management Plan.

ROMN monitors stream health by conducting surveys every few years and monitoring sentinel sites four times a year. The network established two additional sentinel sites on the Flathead River to collect data that will inform the CRMP and identify desired conditions.

10. Upland vegetation and soils data inform livestock management plan.

Northern Colorado Plateau Network (NCPN), Capitol Reef NP (CARE)

The NCPN has monitored vegetation and soils in CARE since 2007. These data were incorporated into rangeland health assessments the park conducted in 2015, to provide a rigorous dataset for decisions made in developing the park's Livestock Grazing and Trailing Management Plan. In October 2018, the park completed an environmental assessment and found no significant impact, which allowed the plan to be implemented.

EXPANDED MONITORING

11. Beavers, elk and moose, oh my!

Rocky Mountain Network (ROMN), Rocky Mountain NP (ROMO)

At ROMO, elk and moose are creating problems for the park's wetlands and willow stands. The park has come up with creative ways to deal with these problems. To counteract the effects of elk browsing on willows, ROMO is building structures that will simulate beaver dams and raise the water table. The park hopes this will encourage the willows to start growing again. ROMO has identified three potential sites for these simulated beaver structures, which ROMN will monitor. This will help to establish a baseline for measurement in advance of the actual placement.

To ascertain the effects of nonnative moose on ROMO's wetlands, ROMN has set up and monitors a site in the Wild Basin wetlands. This data will establish a baseline for high quality wetlands.

12. Monitoring the effects of fire in mixed conifer ecosystems.

Southern Colorado Plateau Network (SCPN), Grand Canyon NP (GRCA)

Following an extremely busy prescribed fire season on the North Rim of GRCA, SCPN worked cooperatively with the GRCA Fire Effects program to monitor a subset of shared plots. This will help resource managers to better understand the effect of fire on mixed conifer ecosystems (Figure 10).

Figure 10. Monitoring plots shared with the SCPN upland monitoring program and the GRCA Fire Effects program.

OTHER SUPPORT

13. Monitoring Bison Impacts on the North Rim.

Southern Colorado Plateau Network (SCPN), Grand Canyon NP (GRCA)

SCPN is working with GRCA wildlife staff to design a vegetation monitoring program for bison-impacted grasslands on the North Rim. The project is designed to be implemented as a week-long experiential program for volunteers presented by the Grand Canyon Field Institute.

14. Literature reviews for park ecosystems.

Southern Colorado Plateau Network (SCPN), Bandelier NM (BAND), Grand Canyon NP (GRCA), Mesa Verde NP (MEVE), and Petrified Forest NP (PEFO)

SCPN prepared literature reviews for GRCA mixed-conifer, GRCA pinyon-juniper, PEFO grassland, BAND pinyon-juniper woodland and MEVE pinyon-juniper woodland ecosystems. The literature reviews will provide context for the upland vegetation and soils trend reports.

15. Prioritizing treatment of invasive exotic plants.

NCPN has been monitoring invasive exotic plant (IEP) infestations at BLCA for 15 years. The network mapped the infestations they found in the park in 2017, and compared them to data collected from 2003–2015. The results are reported in Washuta et al. 2018, which documents the changes in several consistently detected IEPs in the park. Network staff also developed a "patch management index" to quantify the extent and density of an IEP patch into a single value. This index helps identify the scale of the problem. Park managers can use this tool to prioritize treatment.

ON THIS PAGE:
Glacier National Park in the Rocky Mountain I&M Network.
Photo by Seth King, licensed under CC by 2.0.

By communicating the results and practices of science, the NPS makes informed stewardship decisions, and, by supporting place-based, free-choice science learning experiences, increases the nation's science literacy and inspires the public's commitment to preserve our nation's heritage.

– NPS Natural Resource Stewardship and Science Directorate Science Communication Vision Statement

5 Communicating Science for Diverse Audiences

The Inventory and Monitoring Division (IMD) Communication Strategy focuses on four principal audiences. In this chapter, we describe the four audiences and our objectives for communicating with each. We also report on the science communication accomplishments of I&M networks in the Intermountain Region (IMR).

Management and Staff of NPS Units

Networks will communicate the scientific information they collect to staff and management of parks in order to increase the role of sound science in decision-making. In the IMR, I&M networks have accomplished this through diverse methods, including

- writing and publishing Natural Resource Reports and Data Summary Reports to IRMA
- writing and publishing project briefs and articles to NPS.gov
- contributing to the effort to gather and communicate climate information for parks
- publishing water resource data to NPSTORET and other resource data to IRMA
- convening Board and Technical Advisory Committee meetings to discuss natural resource issues in network parks

Scientific Community

I&M networks communicate IMD science to the broader scientific community to promote greater understanding of natural resources and garner recognition for the work of NPS scientists. In addition to the contributions listed above, networks do this by

- publishing articles in peer reviewed journals and books
- presenting papers and posters at conferences and symposia

Colleagues in the IMD, NRSS, and other NPS entities

I&M networks will create pathways for information sharing, partnerships, and teamwork by promoting communications among networks within the IMD, across Natural Resource Stewardship and Science Directorate (NRSS) divisions, and with NPS leadership. I&M networks in the IMR do this by

- contributing to NPS internal publications such as InterCOMM, the Intermountain Region's e newsletter, the I&M Quarterly Update, and the NRSS Weekly Outlook Report.
- publishing network newsletters
- presenting in NRSS and I&M webinars
- participating in working groups
- attending and participating in trainings and meetings

- publishing web content to network and subject sites on NPS.gov

The general public and park staff, including public facing staff (interpreters/rangers)

I&M networks can help to make parks places where the public can learn about science and why it plays an important role in protecting our natural and cultural heritage. Networks can help to tell the stories of our parks, their significance for our development as a nation, the stunning landscapes, the diversity of wildlife, and more. In doing so, they can help to nurture a science literate public that supports the NPS' continuing efforts to protect park resources and help them become resilient in the face of the many environmental changes and challenges. I&M networks do this by

- creating multimedia products about monitoring and research in parks, results of such research, and other stories about parks
- posting interesting facts, photos and media on social media
- participating in special events where staff can directly interact with the public
- publishing articles in popular media, including newspapers
- publishing web content to network sites on NPS.gov
- engaging with volunteers and citizen scientists who contribute their time to learn about and work in parks

SCIENCE COMMUNICATIONS ACCOMPLISHMENTS - Fiscal Year 2018

Here are highlights of public engagement and science communication by I&M staff in 2018.

Working with Schools and Universities

- CHDN staff gave a talk about native Chihuahuan Desert vegetation to schoolchildren attending summer camp at La Semilla Food Center, a local nonprofit dedicated to fostering a healthy, sustainable food system in southern New Mexico and El Paso, Texas.
- GRYN participated in the following activities:
  - ◊ Data manager and program manager participated in a Science Olympiad at a local grade school.
  - ◊ Vegetation ecologist led special programs at a local grade school STEAM night and Earth Day celebrations.
  - ◊ Data manager gave a lecture to Montana State University (MSU) students in the Spatial Sciences Technology and Application course on geospatial technology in the NPS.
  - ◊ Aquatic ecologist co-led a lecture on mining reclamation and clean water to MSU students in an Environmental Biogeochemistry course (ENSC 353).
  - ◊ The network worked with interns from MSU, Utah State University, the NPS MOSAICS in Science Diversity program, and the Geoscience in the Parks program to gather data for all field-based vital signs monitoring.
  - ◊ Co-led Discovering Yellowstone Field Course on amphibians, July 7 – 9, 2018, during Yellowstone Forever at Lamar Buffalo Ranch.
- SODN presented monitoring results to classes from local schools at eight Desert Research Learning Center programs.

Outreach Events

- SCPN worked with Walnut Canyon National Monument staff to stage an interactive event as part of the Flagstaff Festival of Science in September 2018. Visitors to the park learned about the NPS Inventory and Monitoring Program and opportunities to participate in citizen science projects. Three plots demonstrating how SCPN monitors vegetation, trees, and phenology were set up along the park's main trail. SCPN and WACA staff explained to visitors the importance and purpose of long-term monitoring, and helped them to collect

The Flagstaff Festival of Science is an annual free event for the public held over several weeks in the fall. Many organizations and agencies participate in the festival including several NPS entities. The Southern Colorado Plateau Network and Walnut Canyon NM hosted an interactive monitoring demonstration during the 2018 event.

data from the plots and enter them into a datasheet. Visitors who turned in datasheets received a commemorative citizen scientist pin.

- SODN staff operated a booth and presented activities at
  - La Fiesta de Tumacácori (Dec. 1–2, 2017)
  - Arizona National Parks Festival (Oct. 28, 2018

Special Projects

Cross-border Collaboration
The CHDN program manager described the network's work at the U.S.–Mexico Sister Park Monitoring Workshop in Ojinaga, Mexico.

Working with Citizen Scientists
SODN worked with forty citizen scientists and interns, who contributed 7,123 hours of volunteer support for research and monitoring activities. They included international volunteers from Slovakia, Germany, the Czech Republic, Australia, and the United Kingdom. Citizen scientists from the University of Arizona Fish and Wildlife Society and Environmental Awareness Society deployed 219 remote wildlife cameras in eight SODN parks in support of mammal monitoring. These efforts reflect SODN's growing emphasis on public engagement in park science.

A Story Map - Petrified Forest National Park: A Place for Birds
SCPN worked with Petrified Forest NP (PEFO) to create a story map that described how national parks protect habitat for birds, how we study birds in national parks, where and what birds can be found in PEFO, and how the park is working on bird conservation.

Science Communication Awards

The following individuals and projects were recognized for their excellence in public engagement and science communication:

- Alice Wondrak Biel, writer-editor for NCPN and SODN, received the IMD Communication Award for her

exceptional writing and editing work, and for her leadership role in harnessing social media to promote IMD science. Under her leadership, the SODN and NCPN websites had almost 50,000 hits in FY2017, accounting for almost a quarter of all IMD traffic nationwide. The Facebook pages she established (SODN, NCPN) have reached over 480,000 people and have more than 7,000 followers.

Alice Biel, Writer/Editor, NCPN and SODN

- Alice Wondrak Biel and Mark Biel received the servicewide Achieving Relevance in Public Engagement and Resource Stewardship Award for their collaboration on Glacier NP's wildlife shepherding program. To keep park visitors and wildlife a safe distance apart Resource Manager Mark Biel uses his professionally trained border collie, Gracie, to move bighorn sheep and mountain goats out of areas of high visitor use. In winter, they move deer out of populated areas to minimize the presence of mountain lions. Writer-Editor Alice Wondrak Biel creates and manages the program's interpretive content, including an Instagram account with 19,000+ followers, a website, and a popular set of wildlife safety trading cards. The program also relies on audience-driven informal contacts and formal presentations to promote human and wildlife safety.

Rebecca Weissinger, Aquatic Ecologist, NCPN

- Rebecca Weissinger, NCPN aquatic ecologist, was awarded the IMD Most Influential I&M Scientific Product Award. Weissinger worked with the Environmental Protection Agency (EPA), U.S. Geological Service (USGS), and NPS park staff to develop a program to examine the extent of contaminants of emerging concern (CECs) in waters of 11 NCPN parks. CECs—compounds such as pesticides, pharmaceuticals, personal care products, and wastewater indicators—are pollutants that have not traditionally been tested for during routine water quality sampling and may not be adequately cleansed by current wastewater treatment methods. Weissinger was lead author for 9 publications related to this project.
- "Taking the Pulse of a Wild River," an episode of the series Outside Science (Inside Parks), won a silver Telly award in the Non-broadcast General Nature/Wildlife category. The video about the Green River in Dinosaur National Monument was produced in cooperation with the NCPN. The Telly Award is the premiere award for video and television on all screens, with 12,000 entries from all 50 states and five continents.

ON THIS PAGE:
Rainbow Bridge National Monument in the Southern Colorado Plateau I&M Network.
Rainbow Bridge, by thaths, licensed under CC by 2.0.

By communicating the results and practices of science, the NPS makes informed stewardship decisions, and, by supporting place-based, free-choice science learning experiences, increases the nation's science literacy and inspires the public's commitment to preserve our nation's heritage.

– NPS Natural Resource Stewardship and Science Directorate Science Communication Vision Statement

6 Publications and Presentations

NRR Reports and Protocols, and other NPS publications

Biel, M. J., and A. W. Biel. Bark Ranger Gracie reports for duty: Use of a specially trained wildlife shepherding dog to manage habituated wildlife in Glacier National Park. Crossroads in Science. Spring: 23–30. Available at: https://www.nps.gov/articles/upload/CROSSROADS_Gracie508_compliant.pdf

Blythe, M., and Others. 2018. Vegetation and exotic plant management: 2017 annual report for Washita Battlefield NHS. Natural Resource Data Series. NPS/SOPN/NRDS—2018/1174. National Park Service. Fort Collins, Colorado.

Daley, R. 2018. Data Quality Tips using Survey123 for ArcGIS. Article published in February/March 2018 issue of NPS Geospatial Insights.

Dyer M. 2017. Water quality monitoring for the Chinle Wash and Tsaile Creek in Canyon de Chelly National Monument: 2014 Summary report. Natural Resource Data Series. NPS/SCPN/NRDS—2017/1131. National Park Service. Fort Collins, Colorado

Dyer, M. and S. Stumpf. 2017. Water quality monitoring for the Mancos River in Mesa Verde National Park: 2014 Summary report. Natural Resource Data Series NPS/MEVE/NRDS—2017/1132. National Park Service, Fort Collins, Colorado.

Dyer, M. and S. E. Stumpf. 2017. Water quality monitoring for Bright Angel, Garden, Pipe, and Hermit Creeks in Grand Canyon National Park: 2014 Summary report. Natural Resource Data Series NPS/SCPN/NRDS—2017/1135. National Park Service, Fort Collins, Colorado.

Dyer, M., S. A. Monroe, and S. E. Stumpf. 2017. Water quality monitoring for the Escalante River and Coyote Gulch in Glen Canyon National Recreation Area: 2014 Summary report. Natural Resource Data Series NPS/SCPN/NRDS—2017/1134. National Park Service, Fort Collins, Colorado.

Dyer, M., S. A. Monroe, and S. E. Stumpf. 2017. Water quality monitoring for Rito de los Frijoles and Capulin Creek in Bandelier National Monument: 2014 summary report. Natural Resource Data Series NPS/SCPN/NRDS—2017/1133. National Park Service, Fort Collins, Colorado.

Filippone, C., and Others. 2018. Status of climate and water resources at Tumacácori National Historical Park: Water year 2017. Natural Resource Report. NPS/SODN/NRR—2018/1671. National Park Service. Fort Collins, Colorado.

Filippone, C., and K. Raymond. 2018. Status of climate and water resources at Casa Grande Ruins National Monument: Water year 2016. Natural Resource Report. NPS/SODN/NRR—2018/1629. National Park Service. Fort Collins, Colorado.

Folts-Zettner, T., and Others. 2017. Grassland monitoring protocol for the Southern Plains I&M Network and Fire Group: Narrative Version 1.00. Natural Resource Report. Natural Resource Report NPS/SOPN/NRR—2017/1568. National Park Service. Fort Collins, Colorado.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2018. Monitoring whitebark pine in the Greater Yellowstone Ecosystem: 2017 annual report. Natural Resource Report. NPS/GRYN/NRR—2018/1689. National Park Service. Fort Collins, Colorado.

Gwilliam, E., and Others. 2018. Streams monitoring protocol for the Sonoran Desert and Southern Plains networks: Version 1.0. Natural Resource Report. NPS/SODN/NRR—2018/1787. National Park Service. Fort Collins, Colorado.

Gwilliam, E., and Others. 2018. Status of climate and water resources at Gila Cliff Dwellings National Monument: Water year 2016. Natural Resource Report. NPS/SODN/NRR—2018/1615. National Park Service. Fort Collins, Colorado.

Gwilliam, E., and Others. 2018. Status of climate and water resources at Montezuma Castle and Tuzigoot national monuments: Water year 2017. Natural Resource Report. NPS/SODN/NRR—2018/1692. National Park Service. Fort Collins, Colorado.

Gwilliam, E., and Others. 2017. Status of climate and water resources at Montezuma Castle and Tuzigoot national monuments: Water year 2016. Natural Resource Report. NPS/SODN/NRR—2017/1551. National Park Service. Fort Collins, Colorado.

Gwilliam, E., and Others. 2017. Status of climate and water resources at Tumacácori National Historical Park: Water year 2016. Natural Resource Report. NPS/SODN/NRR—2017/1552. National Park Service. Fort Collins, Colorado.

Hackbarth, C., and R. Weissinger. 2018. Escherichia coli concentrations in Fremont River tributaries at Capitol Reef National Park, 2008–2017. Natural Resource Report NPS/NCPN/NRR—2018/1698. National Park Service, Fort Collins, Colorado.

Hubbard, J. A., and Others. 2018. Status of terrestrial vegetation and soils at San Bernardino National Wildlife Refuge. Natural Resource Report. NPS/SODN/NRR—2018/1649. National Park Service. Fort Collins, Colorado.

Levandowski M. 2019. Water quality summary for the Lamar River, Yellowstone River, and Madison River in Yellowstone National Park: Preliminary analysis of 2016 data. Natural Resource Report. NPS/GRYN/NRR—2019/1873. National Park Service. Fort Collins, Colorado. https://irma.nps.gov/DataStore/Reference/Profile/2259210 .

McIntyre, C. L., and Others. 2018. Status and trends of terrestrial vegetation and soils at Casa Grande Ruins National Monument, 2008–2016. Natural Resource Report. NPS/SODN/NRR—2018/1800. National Park Service. Fort Collins, Colorado.

Monroe SA and Soles ES. 2018. Hydrologic monitoring in El Morro National Monument: Water years 2012 through 2014. Natural Resource Data Series. NPS/SCPN/NRDS—2018/1162. National Park Service. Fort Collins, Colorado. Revised Version.

National Park Service, Yellowstone National Park. 2018. Yellowstone Resources and Issues Handbook: 2018. Yellowstone National Park, WY. (GRYN provided content and reviews).

Patla, D. and A. Ray. 2018. Greater Yellowstone Network Amphibian and Wetland Monitoring: Status Report for 2014, 2015, and 2016. Natural Resource Report. NPS/GRYN/NRR—2018/1638. National Park Service. Fort Collins, Colorado.

Perkins, D. W. 2017. Invasive exotic plant monitoring at Fossil Butte National Monument: 2016 field season. Natural Resource Report NPS/NCPN/NRR—2017/1555. National Park Service, Fort Collins, Colorado.

Perkins, D. W., M. Scott, G. Auble, M. Wondzell, C. Holmquist-Johnson, E. Wahlig, H. Thomas, and A. Wight. 2018. Big river monitoring on the Colorado Plateau. Crossroads in Science. Spring: 11–16. Available at https://irma.nps.gov/DataStore/Reference/Profile/2259949 .

Perkins, D. W., M. Scott, G. Auble, M. Wondzell, C. Holmquist-Johnson, E. Wahlig, H. Thomas, and A. Wight. 2018. Big rivers monitoring protocol for park units in the Northern Colorado Plateau Network: Version 1.01. Natural Resource Report NPS/NCPN/NRR—2018/1707. National Park Service, Fort Collins, Colorado.

Perkins, D. W., R. Weissinger, M. Moran, Steve Monroe, H. Thomas, L. McCoy, and E. Soles. 2018. Springs monitoring protocol implementation plan for park units in the Southern Colorado Plateau Network. Natural Resource Report NPS/SCPN/NRR—2018/1771. National Park Service, Fort Collins, Colorado.

Perkins, D. W., R. Weissinger, D. Witwicki, H. Thomas, A. Wight, K. Lund, M. Van Grinsven, L. McCoy, and E. Soles. 2018. Riparian Monitoring Protocol Implementation Plan for park units in the Southern Colorado Plateau Network. Natural Resource Report NPS/SCPN/NRR—2018/1766. National Park Service, Fort Collins, Colorado.

Raymond, K. and C. Filippone. 2018. Status of climate and water resources at Casa Grande Ruins National Monument: Water year 2017. Natural Resource Report. NPS/SODN/NRR—2018/1691. National Park Service. Fort Collins, Colorado.

Roberts, A., and Others. 2018. Vegetation and exotic plant management: 2017 annual report for Bent's Old Fort NHS. Natural Resource Data Series. NPS/SOPN/NRDS—2018/1173. National Park Service. Fort Collins, Colorado

Roberts, A., and Others. 2018. Vegetation and exotic plant management: 2017 annual report for Sand Creek Massacre NHS. Natural Resource Data Series. NPS/SOPN/NRDS—2018/1172. National Park Service. Fort Collins, Colorado

Roberts, S. G., E. L. Tymkiw, Z. S. Ladin, and W. G. Shriver. 2018. Landbird monitoring in the Northern Colorado Plateau Network: 2017 field season. Natural Resource Report NPS/NCPN/NRR—2018/1605. National Park Service, Fort Collins, Colorado.

Schweiger, E. W., and others. 2018. Glacier National Park stream ecological integrity: 2007–2009 status report. Natural Resource Report. NPS/ROMN/NRR—2018/1699. National Park Service. Fort Collins, Colorado.

Scott, M. L., D. W. Perkins, D. M. Merritt, J. A. Scott, and D. J. Cooper. 2018. Big rivers monitoring within Dinosaur National Monument: A summary of monitoring results to detect change in channel condition. Natural Resource Report NPS/NCPN/NRR—2018/1635. National Park Service, Fort Collins, Colorado.

Studd, S., and Others. 2017. Vegetation inventory, mapping, and characterization report, Tonto National Monument. Natural Resource Report. NPS/SODN/NRR—2017/1498. National Park Service. Fort Collins, Colorado.

Thoma, D., J. Norris, and P. Lauck. 2017. Satellite-based Vegetation Condition and Phenology, and Snow Cover Extent Monitoring Protocol for the Northern and Southern Colorado Plateau Networks. Natural Resource Report NPS/SCPN/NRR—2017/1533. National Park Service, Fort Collins, Colorado.

Washuta, A., D., W. Perkins, and L. Gommermann. 2018. Invasive exotic plant monitoring at Black Canyon of the Gunnison National Park, 2003–2017. Natural Resource Report NPS/NCPN/NRR—2018/1674. National Park Service, Fort Collins, Colorado.

Washuta, A., D., W. Perkins, and L. Gommermann. 2018. Invasive exotic plant monitoring at Dinosaur National Monument: Yampa River and the Echo Park and Mitten Park extra area, 2017 field season. Natural Resource Report NPS/NCPN/NRR—2018/1729. National Park Service, Fort Collins, Colorado.

Weissinger, R., and D. Sharrow. 2018. Status and trends of water quality at Zion National Park: Water years 2006–2016 (rev. June 2018). Natural Resource Report NPS/NCPN/NRR—2018/1670. National Park Service, Fort Collins, Colorado.

Weissinger, R., D. Witwicki, H. Thomas, A. Wight, K. Lund, and M. Van Grinsven. 2018. Riparian monitoring of wadeable streams protocol for park units in the Northern Colorado Plateau Network: Version 1.05. Natural Resource Report NPS/NCPN/NRR—2018/1636. National Park Service, Fort Collins, Colorado.

Witwicki, D., H. Thomas, R. Weissinger, A. Wight, S. Topp, S. L. Garman, and M. Miller. 2017. Upland vegetation and soils monitoring protocol for park units in the Northern Colorado Plateau Network: Version 1.07. Natural Resource Report NPS/NCPN/NRR—2017/1570. National Park Service, Fort Collins, Colorado.

Yellowstone Center for Resources. 2018. The State of Yellowstone Vital Signs and Select Park Resources, 2017. YCR–2018–01. Yellowstone Center for Resources. Yellowstone National Park, Wyoming, USA.

Self-published on the NPS Integrated Resource Management Application (IRMA)

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Limy Upland Shrubland Community in Aztec Ruins National Monument. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Mesa-Top Pinyon-Juniper Woodland Community in Bandelier National Monument. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Sandy loam upland grassland Community in Chaco Culture National Historical Park. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Desert Sand Shrubland Community in the Bullfrog Region of Glen Canyon National Recreation Area 2018. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Desert Sand Shrubland Community in the Escalante Region of Glen Canyon National Recreation Area. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Pinyon-Juniper Woodland Community in Grand Canyon National Park. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in Loamy Mesa-Top Pinyon-Juniper Woodland Community in Mesa Verde National Park. 2018. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Shallow Loamy Mesa-Top Pinyon-Juniper Woodland at Mesa Verde National Park. Project Brief. National Park Service. Fort Collins, Colorado. SCPN 2018 AAR 7

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Malpais Grassland Community in Petroglyph National Monument. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Sandy Loam Upland Grassland Community in the Volcanic Upland Grassland Community in Wupatki National Monument. Project Brief. National Park Service. Fort Collins, Colorado.

Andrews, C., J. Bradford, J. Norris, J. Gremer, M. Duniway, S. Munson, L. Thomas, and M. Swan. 2018. Describing Past and Future Soil Moisture in the Sandy Loam Upland Grassland Community in the Loamy Upland Shrubland Community in Wupatki National Monument. Project Brief. National Park Service. Fort Collins, Colorado.

Peer Reviewed Journal Articles

Daw, S., and C. Turner. Checking Rocky's Vital Signs: Rocky Mountain Network Science in the Park. Rocky Mountain Conservancy Quarterly. Winter 2018. (available from ROMN staff)

Diehl, R. M., A. C. Wilcox, D. M. Merritt, D. W. Perkins, J. A. Scott. 2018. Development of an eco-geomorphic modeling framework to evaluate riparian ecosystem response to flow-regime changes. Ecological Engineering 123:112–126.

Girdner, S. F., A. M. Ray, M. W. Buktenica, D. K. Hering, and J. W. Umek. 2018. Replacement of a unique population of newts (Taricha granulosa mazamae) by introduced signal crayfish (Pacifastacus leniusculus) in Crater Lake, Oregon. Biological Invasions 20:721–740.

Gould, W. R., A. M. Ray, L. L. Bailey, D. Thoma, R. Daley, and K. Legg. 2019. Multistate occupancy modeling improves understanding of amphibian breeding dynamics in the Greater Yellowstone Area. Ecological Applications 29(1):e01825. 10.1002/eap.1825.

Gremer, J., J. B. Bradford, C. Andrews, J. Norris, L. P. Thomas, S. M. Munson, and M. C. Duniway. 2018. Predicted future increases in temperature seasonality overwhelm changes in cool-season soil moisture to favor shrub over grass dominance in the southwestern US. Oecologia. 188:1195–1207.

Henderson, T., A. Ray, P. Penoyer, A. Rodman, M. Levandowski, A. Yoder, Shane Matolyak, Mary Beth Marks, and A. Coleman. 2017/2018. Mine-tailings reclamation project improves water quality in Yellowstone's Soda Butte Creek. Park Science 34:9-21.

Ireland, K., A. Hansen, R. Keane, K. Legg, and R. Gump. 2018. Putting climate adaptation on the map: developing spatial management strategies for whitebark pine in the Greater Yellowstone Ecosystem. Environmental Management: 1-21.

McKernan, C., D. J. Cooper, and E. W. Schweiger. 2018. Glacial loss and its effect on riparian vegetation of alpine streams. Freshwater Biology 63:518-529 (available from ROMN staff).

Miller, D. A. W. and others. 2018. Quantifying Climate Sensitivity and Climate Driven Change in North American Amphibian Communities. Nature Communication 9:3926(2018).

Preston, T. M., M. J. Borgreen, and A. M. Ray. 2018. Effects of brine contamination from energy development on wetland macroinvertebrate community structure in the Prairie Pothole Region. Environmental Pollution 239:722-732.

Ray, A., T. Henderson, P. Penoyer, A. Coleman, and K. Legg. 2018. Recovery of Soda Butte Creek, Post-reclamation. Yellowstone Science 26:73-75.

Ray, A. M., A. Sepulveda, K. Irvine, S. Wilmoth, D. Thoma, and D. Patla. XXXX. Wetland drying linked to variations in snowmelt runoff across Grand Teton and Yellowstone national parks. Science of the Total Environment, in revision.

Ray, A., A. Sepulveda, D. Thoma, M. Tercek, R. Al-Chokhachy, and R. Diehl. 2018. Sneak Peek: Vital Signs Issue. Yellowstone Science 26:97-98.

Rodhouse, T. R., M. R. Jeffress, K. Sherrill, and others. 2018. Geographical variation in the influence of habitat and climate on site occupancy turnover in American pika (Ochotona princeps). Diversity and Distributions: 2018: 24:1506–1520.

Sepulveda, A. J., A. M. Ray, and A. M. McKee. 2017. Adding value to monitoring efforts with environmental DNA. The Wildlife Society Wetlands Working Group Newsletter, December 2017. http://wildlife.org/wwg/newsletters/

Sepulveda, A .J. and A. M. Ray. 2017. Guest Editorial: Aquatic science in the Northwest. Northwest Science 91:230-233.

Hubbard, A., A Wondrak-Biel, and S. Studd. 2018. Taking the Long View: Ecological Monitoring Helps National Parks, and All of Us, Prepare for Change. Sonorensis 38: 21-27. Arizona-Sonora Desert Museum. Tucson, Arizona.

Thoma, D. P., S. M. Munson, and D. L. Witwicki. 2018. Landscape pivot points and responses to water balance in national parks of the southwest US. Journal of Applied Ecology DOI: 10.1111/1365-2664.13250.

Treanor, H. B., A. M. Ray, M. Layhee, B. J. Watten, J. J. Gross, R. E. Gresswell and M. A. H. Webb. 2017. Using carbon dioxide in fisheries and aquatic invasive species management. Fisheries 42:621-628.

Weissinger, R. H., B. R. Blackwell, K. Keteles, W. A. Battaglin, and P. M. Bradley. 2018. Bioactive contaminants of emerging concern in national park waters of the northern Colorado Plateau, USA. Science of the Total Environment 636:910–918.

General Publications

French, B. 2018. Once-contaminated creek flowing into Yellowstone may be clean enough for removal from impaired waters list. Billings Gazette. September 12, 2018

Legg, K. and K. Ireland. 2018. Managing whitebark pine in the Greater Yellowstone Ecosystem. Climate Change Response Program Communications Corner. On line publication. Fort Collins, Colorado.

Painter, J. 2018. New report takes vital signs of Yellowstone National Park. Idaho State Journal. September 22, 2018.

Wright, M. 2017. State to remove Soda Butte Creek from list of impaired streams. Bozeman Daily Chronicle. December 10, 2017.

Published to the Web

- GRYN published the following briefs and articles (https://www.nps.gov/im/gryn/reports-publications.htm):
  - Amphibian and Wetland Monitoring in GRYN Parks.
  - Continuous Spring Monitoring Data for Bighorn Canyon National Recreation Area.
  - Greater Yellowstone Network Vital Signs Resource Brief.
- NCPN published 5 information briefs and 8 articles (https://www.nps.gov/im/ncpn/publications.htm):
- ROMN staff published the following briefs and articles (https://www.nps.gov/im/romn/reports-publications.htm):
  - Borgman E. 2018. Wetland Well Removal Project at Rocky Mountain National Park: 2018 Status Update.
  - Hubbard, T., E. W. Schweiger and others. 2018. Glacier Loss Affects Alpine Stream Vegetation. Resource Brief.
  - Schweiger EW. 2018. Effects of human disturbance and ungulate use on wetland ecological integrity at Great Sand Dunes National Park and Preserve. Resource Brief. NPS Rocky Mountain Network.
  - Schweiger, E. W. 2018. Stream Ecological Integrity Resource Brief Condition Status (2007-2009) Glacier National Park.
- SCPN published the following project briefs and media (https://www.nps.gov/im/scpn/reports-publications.htm):
  - Post-1935 Changes in Pinyon-Juniper Persistent Woodland on the South Rim of Grand Canyon National Park.
  - Modeling Past and Future Soil Moisture in Southern Colorado Plateau National Parks and Monuments.
  - Story Map: Petrified Forest National Park: A Place for Birds.

Presentations

Greater Yellowstone I&M Network

Daley, R. Geospatial technology in the NPS. Montana State University students in the Spatial Sciences Technology and Application course. Spring 2018.

Daley, R. 2018. Demonstrated GRYN's use of Survey123 for ArcGIS during the February IMD Data Manager's Webinar.

Daley, R. 2018. Presented a lightning talk highlighting how the NPS Greater Yellowstone Inventory and Monitoring Network accomplishes time-of-survey data quality assurance using Survey123 for ArcGIS. FWS-NPS Geospatial Training Workshop Plenary. NCTC, Virginia.

Gould, B., A. Ray, D. Patla, and D. Thoma. 2018. Leaping forward in assessing amphibian dynamics using multistate models. Poster presented at Statistical Ecology Conference, Scotland and University Research and Creative Activities Fair at New Mexico State University, Las Cruces, NM.

Hansen, A., J. Hilty, A. Ray, K. Legg, and D. Diamond. 2018. Vital Sign Monitoring Framework for the Greater Yellowstone Ecosystem. Panel discussion at 14th Biennial Conference on the GYE, Big Sky, Montana.

Ibarra, V. 2018. Inventory and Monitoring in the Greater Yellowstone Ecosystem. Poster for the Mosaics in Science Internship Training Session. Fort Collins, Colorado.

K. Irvine. 2017. Presented BLM R-shiny tools for summarizing annual data collections. GYCC, Whitebark Pine Subcommittee Fall Meeting. West Yellowstone, Montana. (GRYN partner)

K. Irvine. 2018. Exploiting the latent beta distribution for modeling plant abundance. Topic contributed session: Presentation at the Joint Statistical Meetings, Vancouver, BC (GRYN Partner)

K. Irvine and T Rodhouse. 2018. Untangling species distribution and abundance patterns from ordinal data. NPS Training for Inventory and Monitoring Scientists, Grand Canyon NP. (GRYN Partner)

Sherill, K., S. Caskey, K. Legg, and A. Rodman. 2018. Ideas on how to use climateanlayzer in a park setting. Presented at Intermountain Region Resource Managers Workshop. Lakewood, Co

Legg. K for the Greater Yellowstone Whitebark Pine Subcommittee. 2018. Whitebark Pine Conservation under a Changing Climate. Presented at a workshop for the Custer Gallatin National Forest on how to address projected vegetation change in a Forest Management Plan. Bozeman, MT

Legg, K. and M. Levandowski. 2018. Presentations on GRYN, Water Quality and Amphibians at Yellowstone Interp Orientation. Mammoth, Wyoming.

Legg, K., A. Keegan, G. Bowser, A. Zale, and E. Shanahan. 2018. The Future of the Greater Yellowstone Ecosystem can be as diverse as we make it. A panel discussion on human diversity. 14th Biennial Conference on the GYE, Big Sky, Montana.

Levandowski, M., A. Litt, and K. Legg. 2018. Acoustic monitoring in wetlands offers opportunities for partnership, citizen science, and research on climate change. 14th Biennial Conference on the GYE, Big Sky, Montana.

Patla, D. Contibuting author on amphibian chapter in Clark, F.H and C. Riginos. 2018. State of Wildlife in the Jackson Hole Area. Jackson Hole Conservation Alliance. https://jhalliance.org/campaigns/stateofwildlife/ (GRYN Partner through NRCC).

Patla, D. and C. R. Peterson. 2018. The slow decline of a historic frog population in Yellowstone National Park. Joint meeting of the Northwest Partners of Amphibian and Reptile Conservation (PARC), Society for Northwestern Vertebrate Biology (SNVB) and the Washington and Oregon Chapters of The Wildlife Society. Feb 13, 2018 – Feb 16, 2018 in Portland, OR(GRYN Partner through NRCC).

Ray, A. and others. 2018. Collaborative Connections: Building a culture of collaboration in the National Park Service. GOAL Academy final project presentations. Washington D.C. and via webinar.

Ray, A. and M. Shilling. 2018. Presentation and discussion on the stellar science and integrating science and management reports for IMD and the importance of defining our vision in IMD. Ecologist Training. Grand Canyon, Arizona.

Ray, A. and T. Henderson. 2017. MSU Environmental Biogeochemistry class (ENSC 353) regarding Soda Butte Creek clean up and post clean up monitoring.

Ray, A. 2018. Water quality trends following mine-tailings restoration on Yellowstone's Soda Butte Creek. Presentation at the NRSS all hands workshop. Fort Collins, CO.

Ray, A. and T. Henderson. 2018. Water quality trends following mine-tailings restoration on Yellowstone's Soda Butte Creek. Pub Talk Series – Central Rockies Chapter of the Society of Ecological Restoration. Jackson, Wyoming.

Ray, A. T. Henderson, A. Coleman, K. Legg, and A. Rodman. 2018. Soda Butte Creek: Clean Water Act Delisting Summary and Ongoing Monitoring Activities. 14th Biennial Conference on the GYE, Big Sky, Montana.

Rodman, A. and K. Legg for A. Ray, T. Henderson, P. Penoyer, A. Coleman. 2018. Soda Butte Creek: A partnership and restoration success story. Presented at Intermountain Region Resource Managers Workshop. Lakewood, Co.

Shanahan, E. 2018. USGS Ecolunch presentation: Hornets from Hell and Turning Science into Cash with Hornet Vomit. Bozeman, Montana.

Shanahan, E. 2018. Science Showcase modules: Monitoring trends in white pine blister rust infection in the Greater Yellowstone Ecosystem. Ecologist Training. Grand Canyon, Arizona.

Shanahan, E. 2018. Science Showcase modules : Identifying Stakeholders and building partnerships: Case study-Greater Yellowstone Ecosystem Coordinating Committee. Ecologist Training. Grand Canyon, Arizona.

Shanahan, E. 2018. One minute elevator speech on blister rust transition. Ecologist Training. Grand Canyon, Arizona.

Shanahan, E. 2018. Climate Smart model using whitebark pine. Climate Smart Conservation Course. Grand Teton, Wyoming.

Thoma, D. 2018. Water balance: The importance to understanding long-term vegetation change and adaptive management. Presented at a workshop for the Custer Gallatin National Forest on how to address projected vegetation change in a Forest Management Plan. Bozeman, MT

Thoma, D., A. Rodman, T. Olliff, and M. Cross. 2018. Climate Smart Conservation comes to the Greater Yellowstone Ecosystem. 14th Biennial Conference on the GYE, Big Sky, Montana.

Thoma, D., A. Rodman, T. Olliff, and M. Cross. 2018. Three day course on Climate Smart Conservation to land managers in the GYE. Grand Teton, Wyoming.

Northern Colorado Plateau I&M Network

Hackbarth, C., T. Fisk, D. Witwicki. On the Trail of Understanding and Managing the Effects of Cattle Grazing and Trailing in Capitol Reef National Park using I&M Data Collected by the Northern Colorado Plateau Network. IMR Resources Training Workshop, Golden, CO. April018.

Thomas, H. 2018. Data Processing Level /Certification and Workflow in the NCPN Springs Database. Presentation at IMD Data Management Training, Fort Collins, CO, March 2018.

Weissinger, R. and D. VanderMeulen. Bioactive contaminants in national park waters: case studies from the Great Lakes and the Colorado Plateau. IMD webinar series. Moab, UT. August 2018.

Weissinger, R. Non-point source monitoring in Utah's national parks. Utah Division of Water Quality cooperator's

meeting. Salt Lake City, UT. March 2018.

Weissinger, R. Water quality trend analysis: the good, the bad, the ugly. IMD Ecologists training, Grand Canyon, AZ. January 2018.

Witwicki, D. Climate Tools 2: the Climate Analyzer. IMD Ecologists training, Grand Canyon, AZ. January 2018.

Witwicki, D., E. Borgman, C. McIntyre, and M. Swan. Trends in upland vegetation and soils with Bayesian hierarchical models. IMD Ecologists training, Grand Canyon, AZ. January 2018.

Witwicki, D. Drought and grasses on the northern Colorado Plateau: soils, precipitation, and timing. Darwin Days-SEUG interpretation and resources staff training, Moab, UT. February 2018.

Rocky Mountain Network

Sherrill, Kirk. An Access Database for Wildlife Photo Processing - Data Manager Training, Fort Collins CO - IMD Data Managers, March 2018.

Sherrill, Kirk. The Climate Analyzer - Inter Mountain Region Resource Manager Training Denver CO - NPS Resource Managers, April 2018.

Southern Colorado Plateau Network

McCoy, L.M and M. C. Swan. 2018. Automated Data Summaries. Inventory and Monitoring Scientist Training, January 31, Albright Training Center, Grand Canyon National Park.

McCoy, L. M. 2018. Exploring Automated Data Summaries. Inventory and Monitoring Scientist Training, February 1, 2018, Albright Training Center, Grand Canyon National Park.

McCoy, L. M. 2018. Introduction to Team Foundation Server. Inventory and Monitoring Data Management Fireside Chat, January 9, 2018.

McCoy, L. M. and L. Nelson. 2018. Creating Automated Data Summaries in R. Training, Inventory and Monitoring Data Management Training, March, 5, 2018, NPS NRSS Offices, Fort Collins, Colorado.

Norris, Jodi. 2018. Reproducible Reporting: Why and an Overview. Presentation at the Inventory and Monitoring 2018 National Scientists Training. Albright Training Center, Grand Canyon National Park.

Norris, Jodi. 2018. Using Phenology to Support Monitoring. Presentation at the Inventory and Monitoring 2018 National Scientists Training. Albright Training Center, Grand Canyon National Park.

Norris, Jodi 2018 Training on reproducible and automated reporting. Session Chair, Inventory and Monitoring 2018 National Scientists Training. Ahlbright Training Center, Grand Canyon National Park.

Witwicki, D., E. Borgman, C. McIntyre and M. Swan. 2018. Trends in upland vegetation and soils with Bayesian hierarchical models. IMD Ecologist Meeting, February.

Sonoran Desert I&M Network

Buckisch, A., J. McGarey, and J.A. Hubbard. Monitoring terrestrial wildlife in Sonoran Desert parks. Oral Presentation at the Sonoran Symposium, March 7-10, 2018.

Goodrum, G., L. Palacios, and E. Gwilliam. Monitoring springs in Sonoran Desert Parks: initial findings and new directions. Oral presentation at the Sonoran Symposium, March 7-10, 2018.

APPENDIX A

National Park Service
Inventory and Monitoring Networks
of the Intermountain Region

NETWORK SUMMARIES

Chihuahuan Desert Network

Greater Yellowstone Network

Northern Colorado Plateau Network

Rocky Mountain Network

Sonoran Desert Network

Southern Colorado Plateau Network

Southern Plains Network

ON THIS PAGE:
Old Faithful, Yellowstone National Park
"Old Faithful Again 4," by Yi Su, licensed under CC by 2.0

White Sands National Monument, New Mexico

Chihuahan 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

Parks in the Chihuahuan Desert Network:

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

Grand Teton National Park, Wyoming

Greater Yellowstone Network

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

Parks in the Greater Yellowstone Network:

Bighorn Canyon National Recreation Area

Grand Teton National Park

John D. Rockefeller, Jr. Memorial Parkway

Yellowstone National Park

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)

Parks in the Northern Colorado Plateau Network:

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

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

Parks in the Rocky Mountain Network:

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

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

Parks in the Sonoran Desert Network:

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

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)

Parks in the Southern Colorado Plateau Network:

Aztec Ruins National Monument

Bandelier National Monument

Canyon de Chelly National Monument

Chaco Culture National Historical Park

El Malpais National Monument

El Morro National Monument (ELMO)

Glen Canyon National Recreation Area

Grand Canyon National Park

Hubbell Trading Post National Historic Site

Mesa Verde National Park

Navajo National Monument

Petried Forest National Park

Petroglyph National Monument

Rainbow Bridge National Monument

Sunset Crater Volcano National Monument

Salinas Pueblo Missions National Monument

Walnut Canyon National Monument

Wupatki National Monument

Yucca House National Monument

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

Parks in the Southern Plains Network:

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

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.
2018

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

www.nature.nps.gov