



Climate Change Action Plan Report

Intermountain Region
2013

National Park Service
Resource Stewardship and Science
Landscape Conservation and Climate Change Division



About this Report

Each National Park Service Region reports annually on activities occurring in that region that implement the eight emphasis areas of the action plan. The purpose of this report is two-fold: (1) to collect information that, when combined with information from other regions and programs, paints a picture of how the National Park Service is responding to the challenge of climate change; and (2) raise awareness among NPS Intermountain Region employees, other NPS employees, and partners about the climate change activities occurring in parks.

NPS Intermountain Region Climate Change Staff and Contacts

TAMMY WHITTINGTON

Associate Regional Director for Resource Stewardship and Science
Regional Science Advisor
Regional Climate Change Contact
303-969-2700, Tammy_Whittington@nps.gov

TOM OLLIFF

Landscape Conservation and Climate Change Division Chief
Great Northern Landscape Conservation Cooperative Co-Coordinator
406-994-7920, Tom_Olliff@nps.gov

PAM BENJAMIN

Climate Change Coordinator
303-969-2865, Pam_Benjamin@nps.gov

Suggested citation:

Whittington, T., S. T. Olliff, and P. Benjamin, eds. 2013. Climate Change Action Plan Report: Intermountain Region. National Park Service, Fort Collins, Colorado.

November 2013

Contents

- Introduction 1
- 1: Enhance Workforce Climate Literacy.....3
- 2: Engage Youth and their Families.....5
- 3: Develop Effective Planning Frameworks and Guidance7
- 4: Provide Climate Change Science to Parks9
- 5: Implement the Green Parks Plan23
- 6: Foster Robust Partnerships.....27
- 7: Apply Appropriate Adaptation Tools and Options31
- 8: Strengthen Communication.....33
- Appendix A: NPS Climate Change Action Plan Emphasis Areas and Actions37
- Appendix B: Climate Change Information Quick Reference Guide41

Acknowledgements

Thank you to everyone who contributed to this report. We recognize there are many other efforts not captured in this report and hope to include them in future years.

Contributors

Tom Olliff, Pam Benjamin, Yvette Converse, Clint Muhlfeld, Mark Miller, David Thoma, Joe Giersch, Jeff Kershner, Kathy Tonnessen, David Thoma, Judy Bischoff, Andy Hansen, Tim Watkins, Nick Fisichelli, Angie Richman, Lis Cohen, Doug Parsons, Cat Hawkins Hoffman, Tara Carolin, Melissa Sladek, Dusty Perkins, Kristin Legg, Mike Britten ... others?

Editing and Design: Nina Chambers
Cover Photo: Gary Tabor

All photos are courtesy of the National Park Service unless otherwise credited.



NPS, Nancy Bockio

Introduction

THE NATIONAL PARK SERVICE (NPS) response to climate change operates within several federal directives that invoke two fundamental tactics to address climate change: (1) *mitigation*, those activities that either reduce greenhouse gas (GHG) emissions or enhance their removal from the atmosphere, and (2) *adaptation*, those activities that help people and natural systems adjust to climate change effects by moderating harm or exploiting beneficial opportunities. The 2010 NPS Climate Change Response Strategy (CCRS), coupled with two implementation plans—the Climate Change Action Plan (CCAP) and the Green Parks Plan (GPP)—put the federal directives for climate change adaptation and mitigation into practice for the NPS.

The National Park Service Climate Change Action Plan, released in September 2012, provides guidance to help park managers and staff effectively plan for and respond to climate change today and in the years ahead. The plan articulates a set of high-priority, no-regrets actions the NPS is currently undertaking, or is committed to undertake, in the next few years. The action plan also acknowledges how changing social and environmental conditions, including advances in science and information technology, will require new thinking and new approaches and suggests ways in which the NPS might prepare to meet the challenges and opportunities that lie ahead.

Each NPS region is expected to report on activities that implement the eight emphasis areas of the action plan (see these emphasis areas and actions in Appendix A). The Intermountain Region’s (IMR) climate change adaptation efforts are coordinated and facilitated by the Landscape Conservation and Climate Change Division within the Resources Stewardship and Science Directorate. We work with partners, such as the NPS Climate Change Response Program and the IMR Green Team; Department of the Interior (DOI) Landscape Conservation Cooperatives (LCC) and Climate Science Centers (CSC); and NPS programs, such as Inventory and Monitoring (I&M), Cultural Resources, the Denver Service Center, and Cooperative Ecosystem Studies Units (CESUs), universities, and other partners to connect parks to larger landscapes and understand and promote climate change adaptation, science, and communication.

The IMR initiated the Green Team in July 2012, under the Associate Regional Director for Communications and Partnerships, to coordinate and help guide the IMR toward a sustainable future using the Green Parks Plan and the Climate Change Response Strategy as foundation documents. The IMR Resource Stewardship Advisory Team Climate Change Subcommittee strengthens IMR’s capacity for leadership and technical expertise in science and integrated resource stewardship for parks. The Climate Change Subcommittee works with IMR parks and partners on climate change issues.

The purpose of this report is two-fold: (1) to compile information about IMR activities, so that when combined with information from other regions and programs, it describes how the National Park Service is responding to the challenge of climate change; and (2) to raise awareness among NPS IMR employees, other NPS employees, and partners about the climate change activities occurring in parks.

This report is organized around the eight emphasis areas of the Climate Change Action Plan:

1. Enhance workforce climate literacy
2. Engage youth and their families
3. Develop effective planning frameworks and guidance
4. Provide climate change science to parks
5. Implement the Green Parks Plan
6. Foster robust partnerships
7. Apply appropriate adaptation tools and options
8. Strengthen communication

Based on the actions identified for each of the emphasis areas, this report details the many relevant activities, products, and resources in which the IMR and its partners are engaged. We tried to include all relevant information; however, we recognize that other efforts are underway in the region that are not captured here. Thanks to everyone—NPS staff and partners—who shared their stories with us.

/s/ Tammy Whittington (we can get her signature from Nida Shaheen)

Emphasis Area #1

Enhance Workforce Climate Literacy

Workshops and Conferences

CLIMATE CHANGE WORKSHOP, IMR AND DENVER SERVICE CENTER, FEBRUARY 5-6, 2013

The workshop focused on bringing together the primary climate change staff from NPS partnerships to share information about programs, clarify shared goals and priorities across the Department of the Interior, and identify opportunities for collaboration. It included a day-long focus on climate change impacts on cultural resources. Workshop report and presentations are available at <http://ncptt.nps.gov/blog/training-in-climate-change-and-cultural-resources/>

CLIMATE CHANGE PLANNING WORKSHOP: WATERSHED FUNCTION AND COLD-WATER SYSTEMS, ROCKY MOUNTAIN PARTNER FORUM WORKSHOP, BOZEMAN, MONTANA, JUNE 4-5, 2013

The workshop brought together the Great Northern Landscape Conservation Cooperative (GNLCC) Rocky Mountain Forum partners to focus on adaptation planning and action. The focus was on how to link science, strategies, and actions and scale up to assess vulnerabilities; identify adaptation options; prioritize actions; and share information on adaptation progress and lessons among practitioners in the region. It was led by the Wildlife Conservation Society, the Center for Large Landscape Conservation, and EcoAdapt. <http://www.ecoadapt.org/workshops/GNLCC-adaptation-workshop>

GREATER YELLOWSTONE IN TRANSITION: LINKING SCIENCE AND DECISION MAKING, 11TH BIENNIAL SCIENTIFIC CONFERENCE ON THE GREATER YELLOWSTONE ECOSYSTEM, OCTOBER 8-10, 2012

The 2012 biennial conference brought together scientists, managers, and other decision makers to examine resource challenges (including climate change) in Greater Yellowstone. The series goals are to exchange science-based information relevant to management and to identify resource challenges that demand new research. <http://gyesciconf.greateryellowstonescience.org/>

CLIMATE CHANGE AND VULNERABILITY ASSESSMENT WORKSHOP

Participants in the workshops focused on identifying resources important to consider in climate change adaptation planning. These efforts are pilots for the Intermountain Region to develop a guide for park-based climate change adaptation strategies. Workshops have been held at Bent's Old Fort National Historic Site (May 21-23, 2013), Rocky Mountain National Park (November 17, 2012), and Yellowstone National Park (July 30, 2012). <http://www.greateryellowstonescience.org/vulnerability-workshop> (for Yellowstone workshop materials)

SCENARIO PLANNING WORKSHOPS, NPS CLIMATE CHANGE RESPONSE PROGRAM

The CCRP is exploring the process of scenario planning, in which managers develop several potential climate futures using recent climate data along with model projections, and then evaluate these futures in the context of management challenges and options, as a tool for park planning and management in an era of uncertainty. Scenario Planning workshops have been held in Glacier National Park (March 2010) and for western mountains (February 2011), Rocky Mountain National Park (June 2012). For more info visit: <http://www.nature.nps.gov/parkscience/index.cfm?Page=3>

Training

CLIMATE CHANGE LEADERSHIP SERIES, NPS TRAINING WEBINARS

Open to superintendents and deputy superintendents only, this series of six webinars illustrate feasible approaches to climate change issues and management responses that are relevant to parks. The series showcases lessons learned and resources available to superintendents preparing to address climate change within their parks. This monthly webinar series co-hosted by the Climate Change Response Program and the Leadership Development Program has had

30-40 participants, with 6-9 participants from the Intermountain Region. <http://nrintratest/climatechange/training.cfm>

**NATIONAL RESOURCES ACADEMY eLEARNING
MODULE**

A collaborative effort between the NPS Albright Training Center, Climate Change Response Program, and Intermountain Region, this climate change e-learning training module was developed for the Natural Resource Career Academy. Targeted at new NPS natural resources staff at GS-5, 7, and 9 levels or higher, this training provides a broad overview of climate change and the issues that face the NPS and identifies key resources. It is scheduled for completion in early 2014.

**INTRODUCTION TO CLIMATE CHANGE FOR FEDERAL
LAND MANAGEMENT EMPLOYEES IN THE GREATER
YELLOWSTONE AREA**

This slide show developed by the GYCC Adaptation Subcommittee provides background on climate change and on-the-ground examples of how climate change is already affecting resources in the Greater Yellowstone Area. It has been shown to over 300 USDA Forest Service and NPS employees.

Emphasis Area #2

Engage Youth and their Families

Climate Change Interns and George Melendez Wright Climate Change Youth Initiative

THE NPS GEORGE MELENDEZ WRIGHT CLIMATE CHANGE YOUTH INITIATIVE (CCYI) is sponsored by the National Park Service (NPS) Climate Change Response Program and managed by the University of Washington College of the Environment. This program provides opportunities for young people to work on diverse issues related to climate change and its effects in national parks either through competitive fellowships awarded to advanced graduate students (Masters and Doctorate levels) or paid internships in which undergraduate or beginning graduate students work for approximately 12 weeks on projects in research, interpretation, park operations, policy development, or other fields related to various climate change projects specific to an individual park. The Fellowship Program supports climate change research relevant to managing impacts in parks, including trans-boundary issues and comparisons to Mexican or Canadian protected areas. These are one-year awards of up to \$20,000 for students enrolled in Masters and Ph.D. programs in the U.S., Canada, and Mexico. <http://ccyi.org/>



NPS GEORGE MELENDEZ WRIGHT
CLIMATE CHANGE
YOUTH INITIATIVE

In FY2013, IMR hosted two interns through the Climate Change Youth Initiative. One intern at Bandelier National Monument is conducting research on the existing conditions of ancestral Pueblo archaeological sites. This research establishes baselines for assessing how vulnerable these unique archaeological resources are to climate change. Another intern at Grand Canyon National Park is establishing a citizen-science project focused on plant phenology to help the park track climate change impacts on plant communities and engage park visitors in scientific research. A competitive fellowship was awarded to a post-doc in Glacier, Grand Teton, and Yellowstone national parks to examine how the severity of wildfires has changed over the past 26 years in forested national parks and surrounding wilderness areas of the northern Rockies.



Emphasis Area #3

Develop Effective Planning Frameworks and Guidance

CLIMATE CHANGE SCENARIO PLANNING: A TOOL FOR MANAGING PARKS INTO UNCERTAIN FUTURE

Weeks, D., P. Malone, and L. Welling. 2011. *ParkScience* 28(1), available at http://www.cakex.org/sites/default/files/scenario-planning_0.pdf

This document describes the process of scenario planning, which the NPS Climate Change Response Program is exploring as a tool for park planning and management in an era of uncertainty; it includes park-specific case studies.

NATIONAL FISH, WILDLIFE AND PLANTS CLIMATE ADAPTATION STRATEGY

The National Fish, Wildlife and Plants Climate Adaptation Strategy, 2013; <http://www.wildlifeadaptationstrategy.gov/> is an interagency document that provides a unified approach reflecting shared principles and science-based practices for reducing the negative impacts of climate change on fish, wildlife, plants, and the natural systems upon which they depend.

CLIMATE CHANGE STRATEGY, NPS INTERMOUNTAIN REGION

The IMR Climate Change Response Strategy is intended to guide IMR parks and programs in implementing the NPS Climate Change Response Strategy and Action Plan, engaging with partners, and beginning to address and lessen the effects of climate change on natural and cultural resources, facilities, park operations, and the visitor experience. The DRAFT Strategy will be available for review December 2013.

GREAT NORTHERN LANDSCAPE CONSERVATION COOPERATIVE STRATEGIC CONSERVATION FRAMEWORK, 2013-2018

This strategic conservation framework articulates the rationale, approach, priorities, conservation targets, and landscape-level stressors (including climate change) for the Great Northern Landscape Conservation Cooperative (GNLCC) that reflects the unique geography and regional natural resource issues.

This landscape includes 14 National Park System units. http://greatnorthernlcc.org/sites/default/files/documents/gnlcc_framework_final_small.pdf

SCIENCE AGENDA, NORTH CENTRAL CLIMATE SCIENCE CENTER, 2012-2017

The science agenda lays out a five-year, high-level guide that describes the spatial context, primary partners, and the strategic framework the center will use (ReVamp) in applying climate science to inform management. The North Central Climate Science Center includes IMR parks in Wyoming, Montana, Colorado. <http://pubs.usgs.gov/of/2012/1265/OF12-1265.pdf>

NPS CLIMATE CHANGE PLANNING INTRANET SITE

The NPS WASO-level climate change planning intranet site was developed for NPS planners and managers, providing a variety of resources that support climate change considerations in park planning. Information made available on the site includes: (1) *Policy and Guidance* - NPS guidance that puts federal directives into practice; (2) *Science Resources* - select climate science information, data, and reference materials; (3) *Foundation Documents* - climate change science developed for specific NPS units to support Foundation projects; (4) *Scenario Planning* - an overview of this process that is designed for managing into futures with high uncertainty and used by the NPS to plan and manage for climate change; and (5) *Planning Examples* - NPS examples where climate change has been considered in planning products. <http://www1.nrintra.nps.gov/climatechange/planning>

Incorporating Climate Change into Park Plans

FOUNDATION PLANS IN IMR

Park Foundation Statements identify the fundamental resources and values a park is committed to preserving and maintaining based on legislation. Staff from the CCRP are

developing tools (such as down-scaled climate projections) and guidance for incorporating climate change into foundation documents and assisting parks at Foundation Workshops. Capulin Volcano National Monument, Black Canyon of the Gunnison National Park, Curecanti National Recreation Area, El Malpais National Monument, El Moro National Monument, Glenn Canyon National Recreation Area, Golden Spike National Historic Site, Rainbow Bridge National Monument, Yellowstone National Park, Saguaro National Park, and Zion National Park all began Foundation Plans in FY2013.

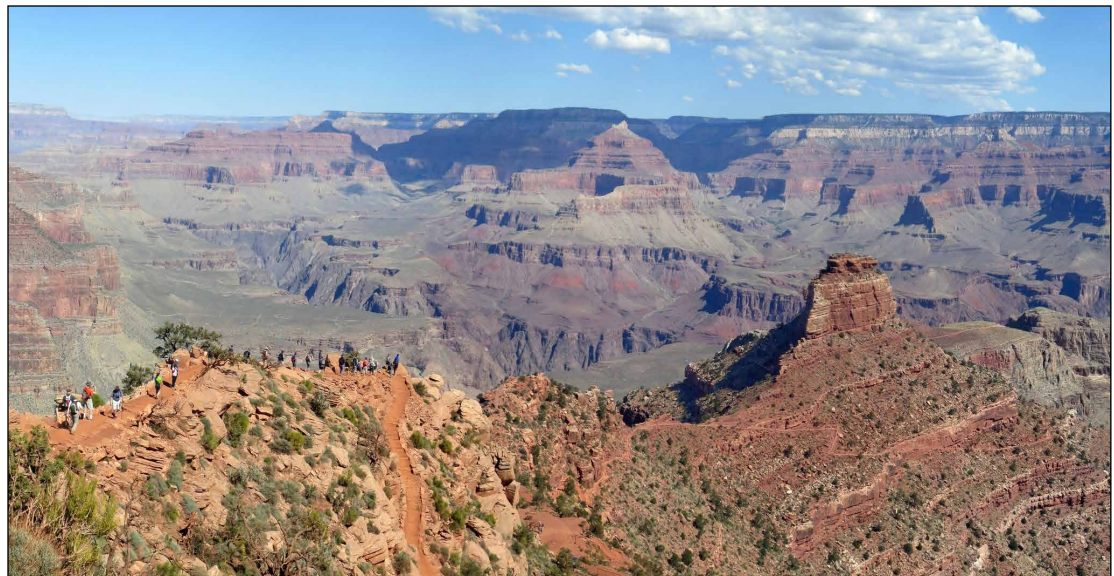
GREATER GRAND CANYON LANDSCAPE ASSESSMENT

The Landscape Conservation Initiative and Grand Canyon National Park-led Greater Grand Canyon Landscape Assessment (GGCLA)

will assess the condition of select natural and cultural resources across a 2 million ha (5 million acres) analysis area that spans beyond park borders to adjacent lands. Areas will be prioritized for conservation and management based on valued landscape attributes and perceived threats to those values. The GGCLA will inform future park planning processes and identify co-management opportunities and incorporates climate change projections into the analysis. <http://lci.nau.edu/spotlight/greater-grand-canyon-assessment.aspx>

GRAND CANYON BACKCOUNTRY MANAGEMENT PLAN

Grand Canyon National Park staff are being assisted by NPS CCRP ecologists to incorporate projected changes in climate, impacts from these changes, and potential management responses into backcountry management decisions.



Emphasis Area #4

Provide Climate Change Science to Parks

Park-based Science

CLIMATE CHANGE PHENOLOGY AND BIRDS, YELLOWSTONE NATIONAL PARK

Since 2005, Yellowstone National Park staff have tracked spring arrival dates of many common bird species migrants in northern Yellowstone, in part to understand climate change effects migration patterns, population size and distribution, and the timing of reproduction and nesting success for birds. In 2012, the scope was expanded across Yellowstone and into Gardiner and West Yellowstone, Montana.

YELLOWSTONE 2013 CLIMATE CHANGE PROGRAM

Yellowstone National Park initiated a Climate Change Program to provide leadership and technical assistance to better understand how climate change is impacting the park's cultural and natural resources, and how we can use the best available information to protect those resources into the future, including developing a tiered, climate change response strategy. We are exploring how the climate is already changing and using that knowledge to make informed predictions about likely changes in the future; anticipating the impacts of these changes and identifying which high-priority resources and infrastructure are most vulnerable; and considering and evaluating management actions that reduce the effect of human impacts on vulnerable resources. In 2013, the program devoted a special issue of Yellowstone Science to climate change in our area to summarize existing knowledge, explain current efforts, and list on-going projects; performed QA/QC analysis on existing weather station records for all stations within the park and select stations outside the park; used climate data (COOP stations, SNOTEL, USGS stream gauges) and interpolated data (PRISM) to understand how historic trends in temperature, precipitation, snowpack, and runoff are changing differently in different areas of the park and at different times of the year; used water balance calculations to understand how changing climate patterns are affecting the vegetation within different areas of the park; and participated in GYA efforts with federal, state, and local partners, including

a climate change watershed vulnerability assessment (USFS and NPS); a whitebark pine vulnerability assessment (university and federal partners); a native, cold-water fisheries vulnerability assessment (USGS, USFS, and NPS); and the effect of climate change on high-elevation ungulates (see box).

MONITORING GLACIERS IN GRAND TETON NATIONAL PARK (PI: Kathy Mellander)

This pilot, funded in part by the Greater Yellowstone Coordinating Committee and conducted with the Jenny Lake climbing rangers, resource staff, and volunteers, is piloting long-term monitoring protocols on Schoolroom, Middle Teton, and Peterson glaciers, including expanding a network of temperature sensors, updating past historic photos, and GPS mapping of glacier margins to compare with past studies.

FORECASTING SPECIES' RESPONSES TO CLIMATE CHANGE AT MANAGEMENT-RELEVANT SCALES: LIMBER PINE IN ROCKY MOUNTAIN NATIONAL PARK (PI: Bill Monahan)

Resource managers at parks and other protected areas are increasingly expected to factor climate change explicitly into their decision making frameworks; however, most protected areas are small relative to the geographic ranges of species being managed, and forecasts based solely on species' range-wide distributions often fail to deliver predictions at scales useful to making management decisions. On the other hand, niche theory suggests that species' physiological capacities to respond to environmental change may be underestimated when forecasts fail to encompass environments across all scales at which the underlying traits are conserved. This project advances a framework for conceptualizing and quantifying these scale linkages and demonstrates its applicability to limber pine in Rocky Mountain National Park.

ASSESSING FLOOD-RELATED COTTONWOOD ESTABLISHMENT AND CHANNEL NARROWING, CANYONLANDS NATIONAL PARK

The establishment and survival of riverine cottonwood stands associated with the Green

Climate Change and High Mountain Ungulates, Yellowstone National Park

A recent synthesis of weather data in the Greater Yellowstone Area (GYA) as part of Canon's Eyes on Yellowstone Program (*Through a Changing Lens*) found that Yellowstone National Park and the surrounding mountainous regions have experienced increased temperatures, changes in precipitation, snow pack and snow melt, and altered stream runoff and stream temperatures for several decades. Some of the most pronounced changes are likely to continue to occur in the high-elevation alpine and subalpine ecosystems, home of Yellowstone's charismatic mountain ungulates, bighorn sheep and mountain goats, the least studied and least understood large mammals in Yellowstone.

Park staff, with collaboration from Montana State University and other federal and state agencies, are three years into a long-term research program for bighorn sheep and mountain goats, including aggregating all distribution and population abundance data for the entire GYA and designing and implementing the first occupancy surveys for both species ever undertaken. Complementary telemetry studies provide data on animal health, body condition, reproduction, survival, movements, and habitat use throughout the GYA. Temperature data loggers record ambient air temperature at the same time the GPS receiver records the animal's location. The pairing of data from these two technologies along with the weather data from the extensive network of climate recording stations in the GYA will provide a unique opportunity to describe and contrast the "thermal niche" of each species and learn how air temperatures influence distributions and habitat selection in the heterogeneous mountainous environments of the GYA.

Canon funding will support the fourth of five years of field studies, enable a graduate student to complete the occupancy surveys and develop the first rigorous habitat models for bighorn sheep and mountain goats specifically for the GYA, and predict the range expansion of non-native mountain goats along the eastern and southern portions of the GYA. The research team will also begin a close collaboration with the team of scientists involved in *Through a Changing Lens* climate studies to use the insights about climate change in the GYA to understand and predict the impacts of temperature, precipitation, and snow-pack dynamics on the distribution, habitat selection, and demographic performance of mountain goats and bighorn sheep throughout the GYA. The project website (<http://www.gyamountainungulateproject.com>) hosts informative narrative, striking photographs, and short videos of bighorn sheep and mountain goats in pristine alpine environments, field researchers, and descriptions of the research project and the resulting scientific products so that people throughout the world can learn of our discoveries and recognize the contributions of the Yellowstone Park Foundation and Canon U.S.A., Inc.



and Colorado Rivers in Canyonlands National Park depend on stream flows that have been affected by upstream dams and water withdrawals and are expected to be further altered by climate change and additional water-development projects. This project will determine the age structure and establishment dates of cottonwood stands near Tuxedo Bottom on the Green River in Canyonlands National Park and identify sites for NPS staff to conduct long-term monitoring.

MONITORING SENSITIVE VEGETATION AFTER THE LOOP FIRE: TRACKING CURLYLEAF MUHLY GRASSLAND RECOVERY, CARLSBAD CAVERNS NATIONAL PARK

The 2011 Carlsbad Caverns Loop Fire burned a large portion of foothill desert grassland dominated by curlyleaf muhly, an uncommon semi-desert grassland that has the center of its known distribution in the park. Following the fire, there was little summer rainfall and the 24 months between April 2011 and April 2013 have been the driest on record in southeast New Mexico. Monitoring in 2012 confirmed that curlyleaf muhly had declined on burned sites between 86% and 99% from the previous sample date (1999-2006), and that the average cover on burned sites in 2012 was 0.5% compared to 15% on unburned sites. As temperatures continue to warm, and water becomes less available, we continue to research fire frequency and intensity to answer such questions as: How much time does it take this grassland to recover to a fuel load that is fire-ready, but not extreme? Was the 2011 Loop Fire hot enough to permanently alter the structure and composition of these grasslands compared to the benchmark plots? If the combination of extreme drought and large fires are a harbinger of conditions to come, how do can we understanding current ecosystem responses to implement effective adaptive management in the future?

ASSESSING THREATS TO TRADITIONALLY BUILT HERITAGE IN PARKS OF THE ARID WEST

The Vanishing Treasures (VT) Program is partnering with the Heritage Conservation Program at The University of Arizona to

complete a multi-region, multi-park effort to develop a framework and assess the threats to the significant and unique traditionally built heritage in the parks of the arid west, identify the most at-risk sub-regions and resource types, and develop strategies to mitigate impacts. This project is focused on the American southwest, but the framework will be designed to be transferable to other regions. Phases include: (1) scope the key challenges facing IMR cultural resources through the compilation of existing data and models and identify climate parameters most destructive to the built environment; (2) develop scenario planning, adaptation, mitigation, and monitoring options based on the use of predictive models and prioritize the most at-risk resources; and (3) implement base-line assessment and long-term monitoring protocols to evaluate and refine the modeling and management strategies.

ICE PATCH ARCHEOLOGY

Accumulations of ice and snow in alpine and sub-alpine areas that have been stable for thousands of years have historically attracted big game, and thus, ancient hunters; alpine areas are also a traditional area of great importance to indigenous people. As the ice and snow melts and recedes due to changing climate, evidence of human activities and fossils is revealed. Glacier National Park won the 2012 Partners in Conservation Award for their Ice Patch Project, including mapping and documenting melting ice patches in the park; recovering paleobiological samples from melting ice; documenting, and if necessary, recovering newly exposed artifacts to protect them from theft or destruction; conducting ethnographic research with tribes to learn more about traditional use of alpine areas; providing public information; and, building a culturally sensitive protocol for cutting-edge scientific research. The Greater Yellowstone Coordinating Committee also supported a project monitoring melting ice patches above treeline for archaeological and paleoecology artifacts. The project provides information about high-elevation vegetation during a 7,000-years-ago warming period.

Climate Change Response Program-funded Science

NPS CLIMATE CHANGE RESPONSE PROGRAM

In 2007, the director of the National Park Service established the Climate Change Response Program (CCRP) under the Natural Resource Stewardship & Science (NRSS) Directorate. The CCRP is a cross-disciplinary program to provide guidance, training, technical expertise, project funding, and educational products that support action to preserve the natural and cultural resources and values of the National Park Service.

CLIMATE CHANGE TRENDS FOR PLANNING

NPS climate change scientist Dr. Patrick Gonzalez is, with the University of Wisconsin providing fine(er)-scale spatial data on historical and projected climate for all national parks (including IMR parks Bent's Old Fort National Historic Site, Capulin Volcano National Monument, Rocky Mountain National Park, Bryce Canyon National Park, and Yellowstone National Park in 2013), including spatially analyzing historical and projected climate trends; characterizing uncertainties of historical climate data and projections; and producing a consistent set of climate information at an appropriate spatial scale. Park-specific reports are available on the NPS SharePoint site at: <http://sharenrss/climatechange/Planning/Climate%20Change%20Science%20for%20Parks>

PIKAS IN PERIL

The Rocky Mountain and Upper Columbia Basin networks, Grand Teton and Yellowstone national parks, and cooperators from the University of Idaho, Oregon State, and Colorado State Universities are collaborating on a project to: (1) determine occupancy of pikas in eight national parks (Crater Lake, Lassen Volcanic, Lava Beds, Craters of the Moon, Rocky Mountain, Great Sand Dunes, Grand Teton, and Yellowstone) in two NPS regions; (2) measure gene flow and model connectivity of pika populations within five of those parks; and (3) project climate change effects on the future distribution, connectivity and vulnerability of pika populations in each park.

Publication: *The idiosyncrasies of place: geographic variation in the climate-distribution relationships of the American pika.* Jeffries,

M. R., T. J. Rodhouse, C. Ray, S. Wolff, and C. W. Epps. 2013. *Ecological Applications* 23(4):864-78. <http://www.ncbi.nlm.nih.gov/pubmed/23865236>

Cooperative Ecosystem Studies Unit-facilitated Projects

Cooperative Ecosystem Studies Units (CESU) are national consortia of federal agencies, tribes, academic institutions, state and local governments, non-governmental conservation organizations, and other partners working together to support informed public trust resource stewardship. The CESU network includes around 320 partners, including 14 federal agencies, in seventeen CESUs representing biogeographic regions encompassing all 50 states and U.S. territories. Three CESUs are within the IMR: the Northern Rockies CESU (hosted by The University of Montana); the Colorado Plateau CESU (Northern Arizona University); and the Desert Southwest CESU (University of Arizona). In FY2013, the Rocky Mountain CESU facilitated more than \$1 million of research, technical assistance, and education projects for NPS parks and programs working with our University partners. Projects range from the greenhouse gas emissions estimation for DOI employee commuters, to student internships at parks to citizen science and outreach programs for the public. There are numerous examples of projects related to the adaptation of wildlife to climate change; from musk oxen at Bering Land Bridge National Monument to elk and boreal toads at Rocky Mountain National Park. The Rocky Mountain and Colorado Plateau CESUs reviewed and facilitated the USGS Natural Resource Protection Program, which is funding seven projects in IMR parks. New research projects were started in FY2013





by USGS scientists on climate change-related topics at Grand Canyon National Park, Rocky Mountain National Park, Curecanti National Recreation Area, and Organ Pipe Cactus National Monument, including:

- *Assessing Population Status and Potential Threats for Vulnerable Desert Bighorn Sheep* (PI: Dave Mattson; Park Contact: Brandon Holten, GRCA)
- *Assessing the Vulnerability of White-tailed Ptarmigan to Climate Change* (PI: Sara Oyler-McCance, FORT; Park Contact: Mary Kay Watry, ROMO)
- *Landscape Connectivity Assessment for Gunnison Sage-Grouse* (PI: Sara Oyler-McCance, FORT; Park Contact: Theresa Childers, CURE)
- *Climate Models and Effects of Climate Variation on Sonoran Desert Vital Signs* (PI: Robert Webb, TSC; Park Contact: Peter Holm, ORPI)

Landscape Conservation Cooperative-funded Science

Established in 2009 by Interior Secretary Ken Salazar, Landscape Conservation Cooperatives (LCCs) and Climate Science Centers (CSCs) are intended to provide cutting-edge science and work with federal, state, tribal, and local governments, private landowners, and non-governmental organizations to “develop landscape-level strategies for understanding

and responding to climate change impacts” and to help managers sustain the continent’s natural and cultural resources (Secretarial Order 3289). Most IMR parks are included within the geography of four LCCs: Great Northern, Southern Rockies, Gulf Coast Prairie, and Desert. The North Central (hosted at Colorado State University), Southwest (hosted by the Southwest Climate Alliance, a consortium of six institutions), and South Central (University of Oklahoma) CSCs cover almost all IMR parks.

Desert LCC

CORRIDORS, CLIMATE CHANGE, AND CONSERVATION PLANNING IN THE DESERT SOUTHWEST (PI: Jason Kreitler, USGS)

Deliverables include: (1) a new corridor map created from regionally derived parameters and Circuitscape (<http://www.circuitscape.org>); (2) an assessment of climate stability of existing protected areas within the Desert LCC where existing data are available; and (3) a prioritization of corridors for mitigation of climate change effects.

Great Northern LCC

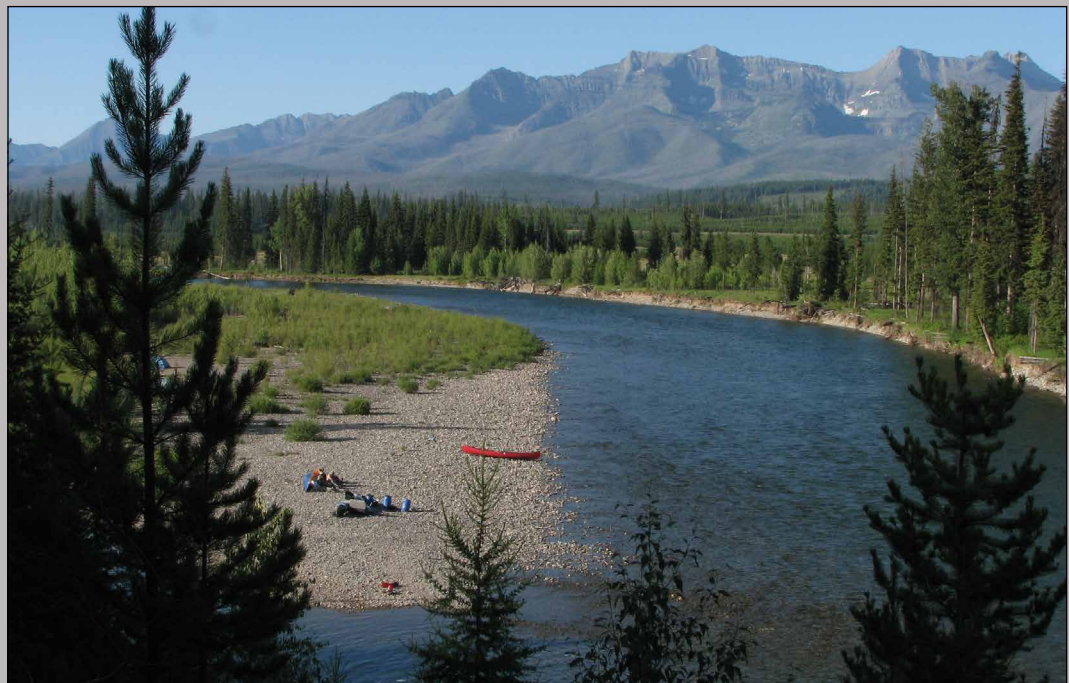
DEVELOPING MANAGEMENT GUIDELINES FOR CREATING RESILIENT WHITEBARK PINE ECOSYSTEMS IN THE NORTHERN ROCKY MOUNTAINS (PI: Bob Keane, USFS)

Landscape simulation modeling for Glacier and Yellowstone national parks will be used to develop detailed management guidelines for restoring and sustaining whitebark pine under future climates, accounting for the principal

Predicting effects of climate change on aquatic ecosystems in the Crown the Continent Ecosystem: Combining vulnerability assessments, landscape connectivity, and modeling for conservation and adaptation
(PI: Clint Muhlfeld, USGS)

Global climate change is likely to dramatically impact the structure and function of freshwater systems, yet no studies have comprehensively assessed the potential effects of climate change on aquatic ecosystems in the Great Northern Landscape. The continued research described herein aims to build on an existing climate change and transboundary research program to assess the potential hydrologic, geomorphic, and thermal effects on foodwebs (rare and endemic macroinvertebrates), native salmonids (threatened bull trout and westslope cutthroat trout), and lotic habitats in the transboundary (U.S. and Canada) Flathead River system.

The project will apply new and existing techniques for combining downscaled and regionalized climate models linked with specific spatial data, fine-scale aquatic species vulnerability assessments (invertebrates and fish), population genetic data, and remotely sensed riparian and aquatic habitat analysis. This information will be used to begin development of an aquatics adaptation plan. Results may be used to identify populations and habitats most susceptible to the impacts of climate change; develop monitoring and evaluation programs; inform future research needs; and develop conservation delivery options (e.g., Muhlfeld and Hauer GNLC Proposal 2012 adaptation strategies) in response to or in anticipation of climate change and other important cumulative stressors (e.g., habitat loss and invasive species).





Southern Rockies LCC

stressors that threaten its persistence (exotic disease infections, mountain pine beetles, and fire exclusion policies), and building on the 2012 publication *A Range-Wide Restoration Strategy for Whitebark Pine Forests*.

THE NORWEST REGIONAL STREAM TEMPERATURE MODEL FOR MAPPING THERMAL HABITATS AND PREDICTING VULNERABILITY OF AQUATIC SPECIES TO CLIMATE CHANGE ACROSS THE GREAT NORTHERN LCC (PI: Dan Isaak, USFS)

Stream temperature data are being compiled from federal, state, tribal, and private sources (including several national parks) to develop a comprehensive regional database. Spatial statistical models for river networks will be applied to these data to develop an accurate model that predicts temperatures in all fish-bearing streams across the U.S. portion of the GNLCC. Predictions of historic and future stream temperatures will be used to assess the vulnerability of sensitive fish species to thermal habitat shifts. <http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html>

HELPING MANAGERS DEVELOP AND IMPLEMENT A CONSISTENT METHOD TO PRIORITIZE CONSERVATION AND IDENTIFY CLIMATE ADAPTATION STRATEGIES (PI: Robert Al-Chokhachy, USGS; Brad Shepherd, WCS)

This project integrates existing information on Yellowstone cutthroat trout status and limiting factors in a spatially explicit conservation priority framework adapted from a financial portfolio concept aimed at maximizing species persistence in the face of adversity. Using this portfolio concept, the project will help managers prioritize conservation actions and then evaluate potential climate adaptation strategies for Yellowstone cutthroat trout by linking high-priority conservation populations and actions with existing GNLCC partners (e.g., NorWeST

temperature modeling, Western Native Trout Initiative, and regional partnerships).

IDENTIFICATION OF FIRE REFUGIA IN ROCKY MOUNTAIN ECOSYSTEMS OF THE U.S. AND CANADA: DEVELOPMENT AND APPLICATION OF THE REFUGIUM CONCEPT FOR BIODIVERSITY CONSERVATION OVER LARGE SPATIAL AND TEMPORAL SCALES (PI: Geneva Chong, USGS)

This project will develop an approach to identify fire refugia in Rocky Mountain ecosystems of the U.S. and Canada then test the function of refugia for biodiversity conservation under current and future climate/fire scenarios. Products will inform decision making in land/easement acquisition, identify critical areas for maintaining landscape and process connectivity, and extend the temporal context for spatial conservation decision making.

Southern Rockies LCC

THE INFLUENCE OF CHANGING CLIMATE ON WATER CYCLING AND TERRESTRIAL WATER AVAILABILITY IN THE SOUTHERN ROCKIES REGION (PI: John Bradford, USGS)

This project provides scientific insight into the potential consequences of climate change for water cycling and water availability in the southern Rocky Mountains.

MODELING LOW STREAMFLOWS AND ASSESSING THE ECOLOGICAL IMPACTS OF POTENTIAL STREAM DRYING UNDER CLIMATE CHANGE IN THE UPPER COLORADO RIVER BASIN (PI: Colorado State University)

The project will address the questions: (1) how will small stream (1st-3rd order) low-flow hydrology be impacted by predicted longer, drier summers in the Upper Colorado River Basin under climate change? and (2) what will be the resulting impacts on riparian plant communities? The project will model stream

low-flow metrics on un-gauged streams in the Upper Colorado River Basin, and sample riparian plant communities along a hydrologic gradient (perennial to intermittent) to develop statistical relationships between flow parameters and biotic responses that can be used to help predict biotic changes under climate change-driven stream drying.

VULNERABILITY, RESILIENCE & CONNECTIVITY OF LANDSCAPES & RIPARIAN HABITAT IN THE SRLCC (PI: Colorado State University)

Land managers have incorporated threats into biodiversity conservation planning for nearly two decades, but very few efforts have included threats from future conditions, and fewer still have assessed vulnerability to climate change. This project will provide foundational information about habitat fragmentation and connectivity, and identify the degree of vulnerability of key habitats to climate change.

SOIL VULNERABILITY TO FUTURE CLIMATE CHANGE IN THE SOUTHERN ROCKIES (PI: Conservation Biology Institute)

This project will develop a spatially explicit soil vulnerability index for the Southern Rockies Landscape Conservation Cooperative that can be used to forecast short-term response of plants to current drought conditions and test a vegetation model of plant response to drought. The data and soil vulnerability maps will be available via the Data Basin website. <http://databasin.org/>

COMPREHENSIVE VULNERABILITY ASSESSMENT, GUNNISON BASIN (PI: The Nature Conservancy with the Gunnison Climate Working Group)

This vulnerability assessment identifies species and ecosystems most at risk from climate change and develops habitat adaptation strategies for priority species, such as the Gunnison Sage-Grouse. These strategies were implemented as local demonstration, including construction of over 100 rock structures on private lands to improve or restore wet meadows, which function as brooding habitat for the Gunnison Sage-Grouse. The tools, methods, and findings of the vulnerability assessment build ecosystem resilience and support the Gunnison Basin agricultural and recreational economies. The vulnerability assessment provides a scientific foundation for a robust decision-making process that can be carried out over a larger landscape

to inform and direct conservation delivery mechanisms for use by multiple partners.

Climate Science Center-funded Projects

ADAPTIVE CAPACITY AND DECISION MAKING FRAMEWORK (PI: Dennis Ojima, Colorado State University)

This research will determine and assess key factors affecting the capacity of social-ecological systems to adapt to climate change. Moreover, this study will analyze the decision-making framework of related and ongoing research efforts and will examine current vulnerability and risk assessment methodologies in the region. Results from this project will help to address natural resource management decisions dealing with climate change dynamics.

PROJECTING CLIMATE CHANGE EFFECTS ON COTTONWOOD AND WILLOW SEED DISPERSAL PHENOLOGY, FLOOD TIMING, AND SEEDLING RECRUITMENT IN WESTERN RIPARIAN FORESTS (PI: Dr. Patrick Shafroth, USGS)

This project aims to predict the effects of climate change on cottonwood and willow tree regeneration in western forests by linking models of seed dispersal timing, streamflow hydrology, and seedling establishment, focusing on the upper South Platte River Basin as a study area. Results will help land managers anticipate future changes in riparian wildlife habitat quality, and potentially to respond to these changes by actively re-vegetating high-priority areas, or by working with water-management agencies to schedule dam releases that favor cottonwood and willow establishment.

TRANS-SPECIFIC DRIVERS OF VARIATION IN FORECASTED DISTRIBUTIONAL CHANGES OF SOUTHWEST BIRDS AND REPTILES (PI: David J. Mattson, USGS)

This research will address three main questions of relevance to the use of species distribution models in forecasting the extent and locations of species' vulnerability to climate change: (1) What explains differences in forecasts of species distributions, and how do these explanations relate to species characteristics? (2) What are the relations of our forecasts based on species distribution models to the results of assessments of species' vulnerability that are based on common vulnerability assessment methods?

(3) What bird and reptile species, currently common or not of conservation concern, will be at risk under the forecasted climate change in the southwestern United States, and why?

IMPROVING UNDERSTANDING OF THREATS TO WHITEBARK PINE IN THE WESTERN U.S.: QUANTIFYING CLIMATE CHANGE EFFECTS ON MOUNTAIN PINE BEETLE OUTBREAKS (PI: Jeffrey A. Hicke, University of Idaho)

Studies show that climate warming is an important factor in the outbreak occurrence of mountain pine beetle in whitebark pine. This project will develop a model of mountain pine beetle outbreaks in whitebark pine using observations of beetle-killed trees, climate, and general tree conditions. The model will be used to map the probability of outbreaks in current climate conditions, as well as in future climate-change scenarios. <https://www.sciencebase.gov/catalog/item/5006c438e4b0abf7ce733f44>

SAGEBRUSH ECOSYSTEMS IN A CHANGING CLIMATE (PI: Matthew J. Germino, USGS)

This project will assess the resistance and resilience of sagebrush to climate variability and examine how existing sagebrush habitat has responded to experimental manipulations of climate across the Snake River Plain, including warming scenarios and shifts in the amount and timing of precipitation, then relate the results to the effects of natural climate variability on post-wildfire regeneration and seeding success to landscape-scale models of sagebrush and climate. <https://www.sciencebase.gov/catalog/item/5006eb3ee4b0abf7ce733f5a>

PROJECTING FUTURE EFFECTS OF LAND MANAGEMENT, NATURAL DISTURBANCE, AND CO₂ ON WOODY ENCROACHMENT IN THE NORTHERN GREAT PLAINS IN A CHANGING CLIMATE (PI: Amy Symstad, USGS)

This project will use a dynamic vegetation model to simulate vegetation type (grassland, shrubland, woodland, and forest) for the Northern Great Plains for a range of projected future climates and relevant management scenarios. Comparing results of these simulations will illustrate the sensitivity of woody encroachment projections to climate change factors.

REGIONAL SHORT- AND LONG-TERM CLIMATE IMPACTS ON NORTHERN ROCKY MOUNTAIN'S AND GREAT PLAIN'S ECOSYSTEMS: NASA DEVELOP PROGRAM CENTRAL U.S. NODE (PI: Jeffrey Morisette, USGS)

With joint funding from the North Central Climate Science Center (NC CSC) and NASA's Applied Sciences Program, the NC CSC is supporting resource managers and their decision process through its Resource for Vulnerability Assessment, Adaptation, and Mitigation Planning (ReVAMP), a collaborative research and planning effort supported by high-performance computing and modeling resources. The NC CSC is focused primarily on climate data as input to the ReVAMP; however, the NASA DEVELOP program is being used to evaluate how remote sensing datasets can contribute to the ecological response models that will be implemented in the ReVAMP system. The use of remote sensing products are helping to scale ground-based measurement collected on managed lands to larger regions more suitable for analysis against climate modeling grids. <https://www.sciencebase.gov/catalog/item/5012b3a8e4b05140039e0347>

VULNERABILITY ASSESSMENT OF ECOLOGICAL SYSTEMS AND SPECIES TO CLIMATE AND LAND-USE CHANGE WITHIN THE NORTH CENTRAL CLIMATE SCIENCE CENTER AND PARTNER LANDSCAPE CONSERVATION COOPERATIVES (PI: Andrew Hansen, Montana State University)

This project will assess the vulnerability of ecosystems to climate and land-use change in order to inform the development and implementation of management options. Outcomes from this research include (1) a framework for modeling vegetation type and species response to climate and land-use change, (2) an evaluation of existing alternative vegetation and species response models, and (3) a presentation of vulnerability assessments for managers for incorporation into climate adaptation strategies. In conjunction with the LCC-VP Project team (see box), this project focuses on whitebark pine in the Greater Yellowstone Area and includes extended paleoclimate analysis and valuation of ecosystem services.

INTEGRATING CLIMATE SCIENCE AND MANAGEMENT: CLIMATE ADAPTATION PLANNING IN THE NORTHERN ROCKIES THROUGH THE LANDSCAPE CLIMATE CHANGE VULNERABILITY PROJECT (LCC-VP)

The LCC-VP (<http://www.montana.edu/lccvp>) tests the steps of a climate adaptation planning in parks and partner federal lands within the Great Northern and Appalachian Landscape Conservation Cooperatives (LCCs) using National Aeronautics and Space Administration (NASA) and other data and models. This project provides a basis for assessing which resources are most vulnerable to climate change and selecting effective management strategies. Dr. Andrew Hansen, Montana State University, leads the project; John Gross and Bill Monahan (NPS I&M) and Tom Olliff (NPS IMR) are co-PIs. Focal parks include Yellowstone, Grand Teton, Rocky Mountain, Great Smoky, Shenandoah, and Delaware Water Gap. NASA and the North Central Climate Science Center are major funders.

To date, the team has assessed the needs of collaborators; synthesized current knowledge on climate change and ecological response; and hindcast and forecast ecosystem processes and vegetation response under climate and land-use change. As the project continues, we will convene expert panels to assess ecological vulnerability to these changes, evaluate management alternatives, recommend strategies for implementation, and provide decision-support resources.

We expanded on the core approach of Glick et al. (2011) to provide an approach highly relevant to federal land managers, particularly the National Park Service. We predicted exposure by using down-scaled Coupled Model Intercomparison Project-Phase 5 (CMIP5) climate models to ~800 m) and are actively developing habitat distribution models and projections for community types and tree species, including pilot models for limber pine, whitebark pine, and spruce-fir forests. The team will work with collaborators to develop, evaluate, and implement management strategies aimed at maintaining vulnerable resources across multiple federal jurisdictions. The test case is whitebark pine management in Greater Yellowstone Area, including Yellowstone and Grand Teton national parks as well as five national forests and Bureau of Land Management lands.

We have additionally assessed past and potential-future change in climate, land use, invasives, and vegetation for 57 national park units and associated protected area-centered ecosystems (PACEs) across the United States. PACEs delineate the areas around parks that are essential to maintain native species within parks. Changes within the PACE offer insights into how park resources may be affected by broad-scale environmental change. In the lower 48 states, most PACEs for large national parks experienced substantial change in climate and land use over the 20th century and projections suggest that many of these trends will continue at similar or increasing rates. Park PACEs exhibit considerable geographic variation with respect to their past and future climate and land-use exposure, but groups of parks were identified with similar combinations of trends and these similarities can help develop broadly effective adaptation strategies and policies.

Glick, P., B. A. Stein, and N. A. Edelson, editors. 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation, Washington, D.C.

TERRESTRIAL CONNECTIVITY ACROSS THE SOUTH CENTRAL UNITED STATES: IMPLICATIONS FOR THE SUSTAINABILITY OF WILDLIFE POPULATIONS AND COMMUNITIES (PI: Kristen A. Baum, Oklahoma State University)

The goal of this project is to use a systematic and comprehensive approach to evaluate terrestrial connectivity across the South Central United States. Models will be used to predict patterns of connectivity for species that vary in habitat preferences, methods of habitat selection, and responses to the area between habitats. Researchers will evaluate the implications of predicted land-use change across the study area, including a focus on climate change and dominant land uses within the region. The results of this project will include spatially explicit connectivity maps that can be used for making informed management decisions about terrestrial connectivity within this region. <https://www.sciencebase.gov/catalog/item/5012ddb7e4b05140039e03c2>

U.S. Geological Survey Science Centers

USGS Science Centers develop and disseminate science-based information and tools needed for understanding the Nation’s biological resources in support of effective decision making. Three of the 17 Science Centers—the Northern Rockies (Bozeman, Montana); Fort Collins, Colorado; and Southwest (Flagstaff, Arizona)—serve IMR parks.

Northern Rocky Mountain Science Center (NOROCK) <http://www.nrmsc.usgs.gov/>

IMPACTS OF CLIMATE CHANGE ON WILDLIFE IN THE NORTHERN ROCKY MOUNTAINS

NOROCK scientists and collaborating scientists from the Wyoming Cooperative Fish and Wildlife Unit at the University of Wyoming, the USGS Earth Resources Observation and Science (EROS) Data Center, Pennsylvania State University, and Humboldt State University, will study how global climate change may impact ungulate species.

CLIMATE CHANGE IN MOUNTAIN ECOSYSTEMS

NOROCK has been monitoring, conducting research, and modeling ecosystem responses to climatic variability since 1991, first at Glacier National Park, and eventually throughout

the western U.S. in collaboration with other scientists. Now coordination with scientists around the world has led to mountain research networks to expand our understanding of how mountain ecosystems respond to climate change.

LEVERAGING MODERN CLIMATOLOGY TO INCREASE ADAPTIVE CAPACITY ACROSS PROTECTED AREAS

This project intends to develop a method to assess regional protected area networks across biophysically important climatic gradients often linked to biodiversity and ecosystem function. Land of the southwestern United States is plotted across axes of historical climate space, and landscapes are identified that may serve as strategic additions to current protected area portfolios. The resulting maps identify lands that are climatically distinct from existing protected areas, and may be used in combination with other ecological and socio-economic information essential to collaborative landscape-scale decision making.

THE UNUSUAL NATURE OF RECENT SNOWPACK DECLINES IN THE NORTH AMERICAN CORDILLERA

This project uses tree rings to reconstruct snowpack over several centuries for three key, high-mountain watersheds: the Upper Colorado River basin, the Upper Missouri River basin, and the headwaters of the Columbia River.

CLIMATIC CONTROLS ON THE SNOWMELT HYDROLOGY OF THE NORTHERN ROCKY MOUNTAINS

This project builds upon previous work by investigating the oceanic and atmospheric controls underlying changes in timing, variability, and trends documented across the entire hydroclimatic monitoring system within critical northern Rocky Mountain watersheds. This study was motivated, in part, by increasing pressure on state and federal resource management agencies to incorporate this type of climate information into sustainability- and adaptation-planning efforts.

IS CLIMATE CHANGE EXACERBATING IMPACTS FROM ENERGY DEVELOPMENT?

This project studies how natural resource development (such as wind, oil, and gas production) is impacting vegetation and groundwater resources, and if these impacts have greater implications on wildlife (such

as bats) and wildlife habitat of threatened species (such as sage grouse) or if they will be exacerbated by existing climate change conditions.

USGS Southwest Biological Center
<http://sbsc.wr.usgs.gov/research/>

SOUTHWEST INVASIVE AND EXOTIC SPECIES STUDIES

This project addresses the increasing homogenization of ecosystems due to effects of invasive exotic species and climate change. Objectives include (1) Develop and apply approaches for predictive modeling of the establishment and spread of invasive exotic species in Southwestern ecosystems; (2) Develop methods for early detection of newly established invasive exotic species; (3) Determine effects of exotic species' invasions on ecosystem structure and functioning, and on native plant and animal communities; (4) Develop methods for mitigating adverse ecological effects of invasive exotic species and for restoring the integrity of native Southwestern ecosystems and biotic communities; and (5) Develop and provide outreach materials and other forms of technical assistance to DOI land managers to support their efforts to minimize the effects of invasive exotic species on native ecosystems and communities.

TERRESTRIAL ECOSYSTEMS IN THE SOUTHWEST

Ecosystems, including the full suite of abiotic and biotic components that they encompass, are the fundamental resources that sustain human society in its many forms. Given the vast diversity of life on Earth and our poor knowledge of most species and their functional roles, the best approach for conserving ecosystems and the services they provide is to ensure that ecosystems maintain their overall structure, function, and resilience to environmental change. Included are modeling studies that predict future ecosystem changes in relation to climate dynamics and human activities.

NPS Inventory & Monitoring Program

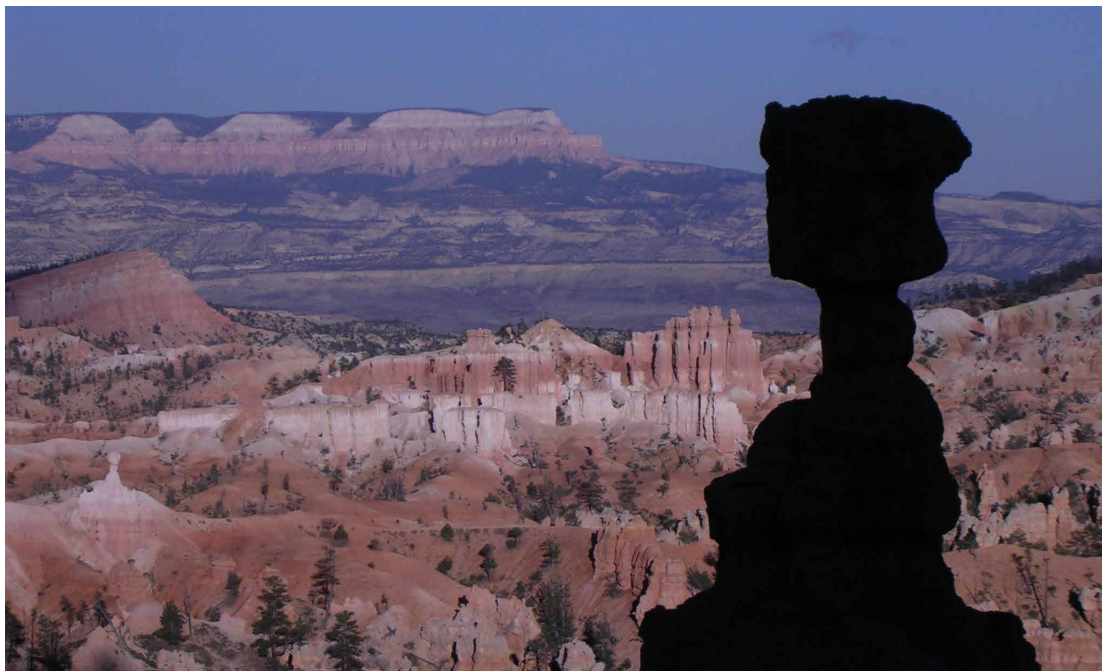
More than 270 parks with significant natural resources have been grouped into 32 inventory and monitoring (I&M) networks. Parks within each of the 32 networks work together and share funding and professional staff to plan, design, and implement an integrated long-term monitoring program. Eight networks serve parks in the IMR: the Greater Yellowstone, Rocky Mountain, Northern Colorado Plateau, Southern Plains, Southern Colorado Plateau, Sonoran Desert, and Chihuahuan Desert.

The table below summarizes the monitoring efforts among the I&M Networks in the

	CHDN	GRYN	NCPN	ROMN	SODN	SCPN	SOPN
Climate		X	X	X	X		
Snowpack, Snow Chemistry		X	X	X			
Water Resources		X	X				X
Seeps, Springs, and Tinajas	X		X		X	X	
Wetlands, Amphibians		X		X	X		
Aquatic Macroinvertebrates						X	
Groundwater	X				X		
Rivers and Streams	X		X	X	X	X	
Alpine Vegetation		X		X			
Upland Vegetation	X	X	X	X	X	X	X
Whitebark Pine		X					
Vegetation Phenology		X	X			X	
Invasive Exotic Plants	X		X		X		X
Landbirds	X		X		X		X

CHDN – Chihuahuan Desert Network
 GRYN – Greater Yellowstone Network
 NCPN – Northern Colorado Plateau Network
 ROMN – Rocky Mountain Network

SODN – Sonoran Desert Network
 SCPN – Southern Colorado Plateau Network
 SOPN – Southern Plains Network



NPS, David Thoma

Intermountain Region that are linked to climate change; following are some descriptions of specific projects.

Chihuahuan Desert Network

CHIHUAHUAN DESERT PLANT RESPONSES TO CLIMATE CHANGE

Determining the impact of climate on vegetation is especially important in desert regions that are prone to land degradation, which may include (1) transitions from grass to shrub dominance, (2) risks of losing total perennial vegetation cover, and (3) susceptibilities to invasion by non-native species. These vegetation changes can dramatically change the productive capacity and diversity of a site, alter habitat for wildlife, and affect soil erosion, carbon, and nutrient cycling.

Northern Colorado Plateau Network

CLIMATE CHANGE AND VULNERABILITY ANALYSIS FOR FOUR SPECIES IN THREE SOUTHWESTERN UTAH NATIONAL PARKS/MONUMENTS

This vulnerability assessment includes three parks (Zion National Park, Bryce Canyon National Park, and Cedar Breaks National Monument) and four target species (American pika, Desert tortoise, Shivwits Milk-vetch, and Great Basin bristlecone pine). Results are presented in: Thoma, D. and H. Shovic. 2012. Using landscape patterns, climate projections, and species distribution models to map future

habitats for Desert Tortoise, Shivwits Milk-Vetch and American Pika in Zion National Park, Utah. *ParkScience*, July 2012.

PLANT RESPONSES TO CLIMATE CHANGE

To address how past climate variability has affected plant species cover and make predictions of plant community composition under future climate change, scientists from the USGS and NPS examined the relationship between climate and vegetation using monitoring data for the last 20 years from Arches National Park, Canyonlands National Park, and Natural Bridges National Monument. Data were analyzed for grasslands, shrublands, and woodlands. The results of this research found that during the past 20 years, regional mean annual temperature in the study area has increased by 0.05°C per year. Although there was high inter-annual variability in precipitation, evapotranspiration rates increased with rising temperatures, limiting plant water availability. The mean annual temperature in the previous year was the best predictor of canopy cover of perennial plant cover in this study.

Rocky Mountain Network

ALPINE VEGETATION

The Rocky Mountain Network is part of the Global Observation Research Initiative in Alpine Environments (GLORIA), an international effort to monitor climate and vegetation changes

at high elevations. GLORIA sites have been established at Glacier, Great Sand Dunes, and Rocky Mountain national parks. In 2011, the network partnered with the Colorado Natural Heritage Program and the Greater Yellowstone Network to install and monitor a GLORIA site in Yellowstone National Park. During the summer of 2009, Glacier National Park became one of the first sites to be revisited after five years. The length of the vegetation growing season has increased an average of two days per decade since 1950 with most of the increase resulting from earlier spring warming.

Greater Yellowstone Network

DEVELOPING A MECHANISTIC UNDERSTANDING BETWEEN RECENT CLIMATE PATTERNS AND AQUATIC VITAL SIGNS IN THE GREATER YELLOWSTONE NETWORK (PIs: Adam Sepulveda, USGS and David Thoma NPS I&M)

This project will (1) synthesize historical trends in aquatic resources across parks using disparate, long-term data sets and a simple water balance modeling approach; (2) develop empirically based models that will link contemporary aquatic vital sign data with recent climatic patterns to establish vital sign-climatic linkages; and (3) provide the ability to use within-year conditions to forecast near-term aquatic vital signs conditions and the probability that stream temperatures will meet criteria for fishing closures.

Southern Colorado Plateau Network

INVENTORY OF UNIQUE PLANT COMMUNITIES IN SOUTHERN COLORADO PLATEAU NETWORK PARKS IN ADVANCE OF CLIMATE CHANGE, PHASE 1

The Southern Colorado Plateau Network (SCPN), in cooperation with Northern Arizona University, is conducting a baseline inventory of unique plant communities across the SCPN. These unique plant communities occupy restricted habitats, such as high-elevation areas, unique edaphic environments, ecotones, and climatic micro-refuges and thus are susceptible to constriction or other disruptions due to climate change. Collectively these communities contribute biodiversity disproportionately to

their area. Results from this project will be publicly available through the SCPN website (<http://science.nps.gov/im/units/scpn/index.cfm>) and the Learning Center of the American Southwest website (<http://www.southwestlearning.org/>) and will help managers understand similar ecosystems across the Colorado Plateau.

Other Partners

U.S. Global Change Research Program

PAST, RECENT, AND 21ST CENTURY VEGETATION CHANGE IN THE ARID SOUTHWEST (PIs: Kenneth Cole and Samantha Arundel)

In order to study the effects predicted by climatic shifts, data are needed on climate changes of similar magnitude during the last 50,000 years. The purpose of this research project is to document vegetation change in the arid lands of the southwestern United States. The project compiles data on past and present plant distributions. These plant distributions are combined with data on past, present, and future climates to predict future plant distributions. The project requires four major research efforts (1) macrobotanical digital library; (2) Digitized Range Maps for modern plants of the arid Southwest; (3) fossil packrat midden database; and (4) modern climates of North America.

NATIONAL CLIMATE ASSESSMENT

The third draft National Climate Assessment, based on findings of the U.S. Global Change Research Program (USGCRP), analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years. The assessment focuses in-depth analysis on eight regions of the U.S., including the Great Plains and the Southwest, which cover the entire IMR. <http://www.globalchange.gov/what-we-do/assessment>

Emphasis Area #5

Implement the Green Parks Plan

IMR Green Team

In late 2012, the Intermountain Region established an inter-disciplinary “Green Team” to assist the region in the coordination of climate change and sustainability efforts. This team is represented by members from all regional programs and by park/field staff across all divisions. The mission of the Green Team has been defined as:

coordinate and help guide the Intermountain Region toward a sustainable future using the NPS Green Parks Plan and the Climate Change Response Strategy as foundation documents. The Green Team will support regional and park staff with gaining a better understanding of sustainability and climate change, as well as facilitate meaningful conversations across disciplines and levels of authority. The Green Team will strive to provide regional staff with the necessary tools, knowledge, and policy support in an integrated effort to ensure we are consistently taking steps forward to preserve our resources and those of the world unimpaired for future generations.

The Green Team has also been charged with several specific tasks, including:

- Develop a prioritized list of sustainability/ climate change response actions from both the Green Parks Plan and the Climate Change Action Plan for IMR.
- Develop a yearly work plan that is both achievable and tangible with assigned deliverables and metrics to monitor progress.
- Develop task groups and allocate the staff time needed to accomplish the yearly work plan.
- Advise the regional management team on sustainability and climate change topics.
- Address budget and personnel constraints that have been identified as barriers to sustainability.
- Coordinate and communicate effectively within IMR to provide staff with a clear, concise sustainability message and mission.



NPS, David Thoma

- Collaborate with NPS national and other regions' sustainability and climate change efforts.
- Share Green Team news and information with all IMR employees quarterly via newsletter, memo, or webinar.

Green Parks

The NPS released the Green Parks Plan in 2012 (<http://www.nps.gov/greenparksplan/>). This document defines a collective vision for integrating environmental stewardship into facility management and for educating park staff and visitors about climate change and sustainability in a manner consistent with the mission of the NPS, as well as all relevant laws, executive orders, and Secretarial and Director's Orders.

The NPS has identified nine strategic goal categories that make up the Green Parks Plan. Each goal category has a number of identified goals and associated targets. The scope of the plan is centered on the impact of facilities on the natural environment, human welfare, and productivity. It is designed with the expectation that it will be incorporated into a Service-wide plan encompassing all NPS functions. Goal categories are:

- Environmental Compliance
- Climate Change Mitigation and Facility Adaptation
- Energy Management
- Water Management
- Environmental Purchasing and Waste Reduction/Management
- Healthy Indoor Environments
- Outdoor Environmental Quality and Sustainable Sites
- Best Practices in Sustainable Facility Management and Use

Sustainable Operations and Climate Change

The Sustainable Operations and Climate Change (SOCC) Branch, a part of the WASO Park Facility Management Division, seeks to ensure the sustainable management of national parks through the development of comprehensive and high-quality programs. The SOCC oversees NPS progress under the Green Parks Plan. In addition, the branch also assists parks in implementing sustainable best practices throughout NPS operations, with efforts focused in the following four areas:

- Energy and Water Conservation
- Climate Change Mitigation and Facility Adaptation
- Sustainable Building Design and Operation
- Pollution Prevention

It is the job of the SOCC to ensure that parks consider the effects of climate change before building, renovating, or making significant capital investments into NPS facilities. The branch is developing guidance and tools to assist park planners in identifying the risks posed by climate change to proposed projects, and to make educated and calculated adaptation, siting, construction, and repair and rehabilitation decisions.

The NPS has developed a Project Sustainability Checklist for building and non-building projects based on the LEED version 2009. This checklist is organized around the LEED NC v3, 2009 checklist and also accounts for progress in meeting federal sustainability requirements (Guiding Principles) for federal leadership in high-performance and sustainable buildings that include:

1. Employ Integrated Design Principles
2. Optimize Energy Performance
3. Protect and Conserve Water
4. Enhance Indoor Environmental Quality
5. Reduce Environmental Impact of Materials

Climate Friendly Parks

The Climate Friendly Parks (CFP) program is a partnership between the National Park Service's Park Facility Management Division and the Air Resources Division that provides national parks with management tools and resources to address climate change. The program aims to provide national parks with comprehensive support to address climate change both within park boundaries and the surrounding community. The Climate Friendly Parks program can assist parks by providing the following kinds of support:

- *Inventory Support* - Our technical experts help guide parks through conducting a GHG emissions inventory using our Climate Leadership in Parks (CLIP) Tool.
- *Action Planning Support* - Our technical experts help parks develop a strategic plan forward to address climate change and sustainability challenges. The CFP Program recently transitioned from requiring a stand-alone plan (Climate Action Plan) to encouraging parks to integrate CFP action items into their Environmental Management Systems (EMS).
- *Education and Outreach Support* - The CFP team and our regional partners help parks create outreach strategies to promote climate change efforts and to educate visitors about their contributions to emissions reduction goals.

The Intermountain Regional Office and programs actively work with parks to identify their needs, and to provide support, for becoming fully certified climate friendly parks. To learn more about the Climate Friendly Parks Program, including specific information on how to apply to the program as well as program guidance go to the following link: <http://www.nps.gov/climatefriendlyparks/explore/wcfppi.html>

Environmental Management Program

The IMR Environmental Management Program provides and facilitates services to Intermountain parks that enable them to meet their responsibilities under the major environmental laws, regulations, Executive Orders, and Department and Bureau policy statements. These mandates include the Comprehensive Environmental Response, Compensation and Liability Act, the Resource Conservation and Recovery Act, the Oil Pollution Act, the Toxic Substances Control Act, the Pollution Prevention Act, pertinent sections of the Clean Air Act and the Clean Water Act, as well as the Occupational Health and Safety Act, and the recently signed Executive Order to promote a Green Government.

The program also assists parks in formulating and implementing pollution prevention and other green solutions that go beyond compliance mandates and illustrate how parks can be wise stewards of the land. The Green initiatives are providing a growing set of tools, including the Green Purchasing CD-ROM, the Self-Audit CD-ROM, Integrated Solid Waste Planning Guide, green training, and other resources. The program further assists parks through budget support and the identification of appropriate technical support, including contractors, USEPA technical experts, State contacts, and university researchers.



Emphasis Area #6

Foster Robust Partnerships

Climate change adaptation is a partner-based program. Most of the science-based partnerships were highlighted in Emphasis Area 4 and the sustainability partnerships were highlighted in Emphasis Area 5. Some of the other important IMR park partners are included here.

Climate and Culture

The IMR Office of Indian Affairs and American Culture (IAAC) promotes constructive working relationships between national parks and diverse cultural communities within the Intermountain Region. The office assists parks, Indian tribes, park-affiliated communities, and other Federal and state agencies by implementing policies and projects that increase mutual cooperation and support the mission of the National Park Service. In 2012, this program added a position to assist tribal partners with identifying and addressing issues associated with climate change. Opportunities exist for greater partnership between the IAAC Program the IMR Landscape Conservation and Climate Change Program, Landscape Conservation Cooperatives, and our tribal partners.

Specifically, Traditional Ecological Knowledge, the primary indigenous way of understanding relationships among species, ecosystems, and ecological processes, can play a vital role in climate change assessment and adaptation efforts that bridge human and environmental systems. The IMR will work to enhance our existing partnerships in leveraging resources to assist tribal associations in addressing climate change issues related to impacts to traditional use species (plants and animals) and to culturally significant sites.

National Park Service Research Learning Centers

National Park Service Research Learning Centers (RLCs) are places where science and education come together to preserve and protect areas of national significance. In particular, “citizen scientists” can assist park

and partner specialists as they conduct scientific tasks, such as observations or measurements, and engage visitors or local communities in education efforts. Parks should consider the use of citizen scientists to assist in monitoring, research, and visitor education efforts related to climate change.

The IMR has four Research Learning Centers:

1. Crown of the Continent RLC <http://www.nps.gov/glac/naturescience/ccrlc.htm>
2. Greater Yellowstone Science Learning Center <http://www.nature.nps.gov/rlc/gyslc.cfm>
3. Continental Divide RLC <http://www.nature.nps.gov/rlc/cdrlc.cfm>
4. Learning Center of the American Southwest <http://www.nature.nps.gov/rlc/lcas.cfm>

Events such as Bioblitzes, and programs such as the Archaeology Stewards program also provide opportunities for use of citizen science to better understand resources and associated climate change effects.

Western Water Assessment

The Western Water Assessment (WWA) is a university-based applied research program that addresses societal vulnerabilities related to climate, particularly in the area of water resources. WWA works across the Intermountain West. The mission is to identify and characterize regional vulnerabilities to and impacts of climate variability and change, and to develop information, products, and processes to assist decision makers.

Crown Managers Partnership

Several cross-jurisdictional partnerships are well established at the ecosystem. For example, the Crown Managers Partnership seeks to demonstrate leadership in addressing the environmental management challenges in the Crown of the Continent region by adopting



transboundary collaborative approaches to environmental management. The voluntary partnership seeks to build common awareness of Crown interests and issues, shape relationships, and identify collaborative and complementary tasks that the various participating jurisdictions can pursue. The CMP (including Glacier National Park) hosted a Climate Change Scenario Planning workshop in March 2010 and is planning another in 2014.

Greater Yellowstone Coordinating Committee

The Greater Yellowstone Coordinating Committee (GYCC) was formed to allow representatives from the National Park Service, USDA Forest Service, the U.S. Fish and Wildlife Service, and the Bureau of Land Management to pursue opportunities of mutual cooperation and coordination in the management of core federal lands in the Greater Yellowstone Area. The Greater Yellowstone Coordinating Committee (including Yellowstone and Grand Teton national parks, and John D. Rockefeller scenic byway) hosted a Science Agenda workshop in November 2009, subsequently published an ecosystem science agenda in response to large landscape stressors, and currently sustains a Climate Change Adaptation Subcommittee.

Gunnison Basin Climate Change Adaptation Project

The Nature Conservancy, in partnership with the Gunnison Climate Working Group, is working to design and implement an on-the-

ground climate adaptation project to help the riparian areas/wet meadows retain water over the long term, thereby enhancing the resilience of this critical habitat and long-term viability of the Gunnison Sage-Grouse in the face of a changing climate. This group is collaborating with the Southwest Climate Change Initiative to share climate science information and practical tools with natural resource managers and conservation practitioners in vulnerable landscapes of Arizona, Colorado, New Mexico, and Utah. Colorado's Gunnison Basin is one of four landscapes developing and testing ways to sustain natural resources in a changing climate.

Big Bend-Rio Bravo Initiative

The Big Bend-Río Bravo Collaboration for Transboundary Landscape Conservation/North American Invasive Species Network, was funded (2011-2013) by the Commission for Environmental Cooperation (CEC) to complete a bi-national (U.S. and Mexico) conservation assessment for a large portion of the northern Chihuahuan Desert and development a bi-national strategy for managing invasive riparian plants along the Rio Grande. The second CEC-sponsored phase, North American Collaboration for Conservation of Transboundary Protected Areas, has been accepted by the CEC. Additional partnerships that will supplement the CEC funding include:

- With the National Conservation Training Center, bring together the core group, including Mexican partners (climate change coordinator for CONANP, the Mexican Commission for Parks and Protected Areas),

to a Structured Decision Making workshop on Climate Change Decision Analysis.

- With the Desert Landscape Conservation Cooperative, NOAA, USFWS, CLIMAS—Climate Assessment for the Southwest at the University of Arizona, and International Boundary and Water Commission, bring a North American Climate Service Partnership - Drought Adaptation Workshop to our region.
- With NOAA and other partners, seek funding from the NOAA-Sectoral Applications Research Program for Scenario Planning.

Sustainable Sites Initiative

The Sustainable Sites Initiative™ (<http://www.sustainablesites.org/>; SITES™) is an interdisciplinary partnership led by the American Society of Landscape Architects (ASLA), the Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the United States Botanic Garden to transform land development and management practices through the nation's first voluntary guidelines and rating system for sustainable landscapes, with or without buildings. The guidelines

and rating system represent years of work by dozens of the country's leading sustainability experts, scientists, and design professionals and incorporate public input from hundreds of individuals and dozens of organizations to create this essential missing link in green design.

Climate Assessment for the Southwest

Climate Assessment for the Southwest (CLIMAS) is housed at the University of Arizona's Institute of the Environment, was established in 1998 as part of the National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences and Assessments (RISA) program to help address these concerns. The CLIMAS program brings together researchers who study the processes and effects of climate on the Southwest with individuals and organizations that need climate information to make informed decisions. The program promotes the exchange of ideas and information among members of the public, private, nonprofit, and academic communities. <http://www.climas.arizona.edu/about>.

Emphasis Area #7

Apply Appropriate Adaptation Tools and Options

The IMR Landscape Conservation and Climate Change Program is working with partners to develop a Handbook that further refines strategies from the NPS Climate Change Response Strategy and guidance in the NPS Climate Change Action Plan by outlining a seven-step process for parks to develop Climate Change Adaptation Strategies for key resources.

The Handbook will provide park managers specific guidance to use the science and tools available that can support science-based, adaptive park management in response to climate change, including scenario planning; resource vulnerability (or risk) assessments; climate data, models, and projections; ecological and cultural resource response models; and others. Applying these tools within a network of parks will lead to enhanced capacity of IMR parks to successfully adapt to or mitigate for the numerous impacts associated with climate change.

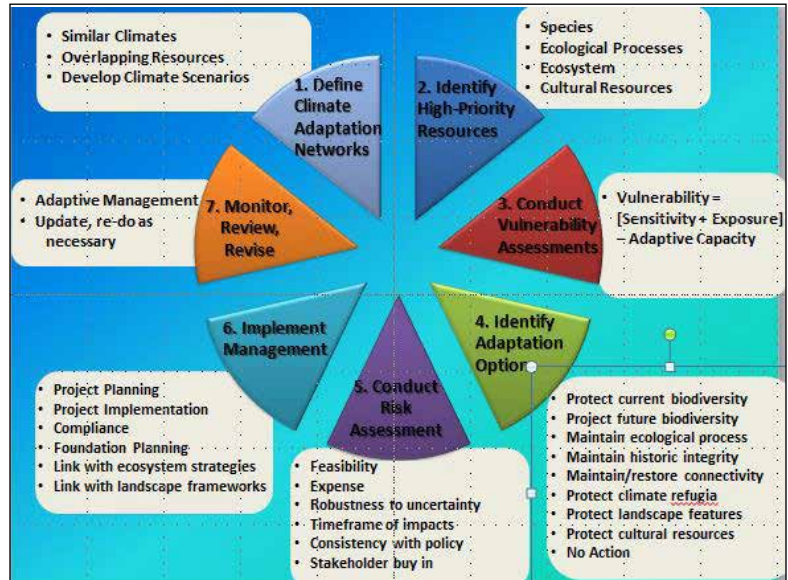
Revisiting Leopold

Two Revisiting Leopold listening sessions were conducted specifically for IMR staff by Dr. Gary Machlis, Science Advisor to the Director, one in-person session at the Lakewood Regional Office, February 4 and a video session for Yellowstone Park and Greater Yellowstone I&M staff. Two IMR employees, Darla Sidles (Supt, Saguaro National Park) and Tom Olliff (Chief, LC&CC) were selected as members of the Revisiting Leopold Implementation Team.

Interactive Tools

CLIMATE ANALYZER

The Climate Analyzer creates custom graphs and tables from historical weather station data. These summaries are calculated dynamically; the user request the years or months they are interested in and it calculates averages, totals, or other summaries to fit your needs. New graphs and tables are added to the site all the time, check the website for updates. <http://www.climateanalyzer.org/>



GREATER YELLOWSTONE AREA CLIMATE EXPLORER

The GYA Climate Explorer allows users to compare the average of historical (1916-2006) climate values to a future projection for the mid-century (Ensemble Mean 2030-2059 values) for variables including temperature, precipitation, snowpack, snow water equivalent, and streamflow. Outputs include stacked historical and mid-century maps with a slider bar to compare pixel values between the two, a delta map showing change for each pixel value, and a bar graph or pie chart showing a comparison of the historical and mid-century values. http://www.greateryellowstonescience.org/files/Climate_program/index.html

ATLAS OF THE GREAT NORTHERN LANDSCAPE CONSERVATION COOPERATIVE

The Great Northern LCC partnered with Headwaters Economics to produce an on-line interactive tool that federal and state public land managers, local elected officials, regional planners, state agencies, conservation groups, and interested citizens can use to access economic and climatic trend data (using USGS researcher Steve Hostetler's dynamically downscaled climate models), at the regional and county level. <http://headwaterseconomics.org/interactive/atlas---gnlcc>

Emphasis Area #8

Strengthen Communication

Interpretation

INTERPRETING CLIMATE CHANGE TRAINING, MAY 7-10, 2013

This course provided an overview of the practical knowledge and skills that will enable interpreters to develop effective, engaging climate change programming for both natural and cultural sites. Read the entire course description on DOI Learn at: <http://www.doi.gov/doilearn/index.cfm>

Workshops

CLIMATE CHANGE TEACHER WORKSHOP, GLACIER NATIONAL PARK AND GLACIER INSTITUTE, JUNE 24-27, 2013

The Glacier National Park Crown of the Continent Research Learning Center, in partnership with the Glacier Institute, hosted a four-day climate change teacher workshop with Glacier National Park. The workshop was for pre-registered middle and high school teachers from across the country. Teachers learned about climate change and the complexity of the issue and how to incorporate it into classroom curriculum. <http://www.nps.gov/glac/forteachers/professionaldevelopment.htm>

GLACIER NATIONAL PARK INTERPRETERS TRAINING

Teagan Tomlin and Melissa Sladek presented a training on climate change communication for Glacier's Interpretive Division during seasonal interpretive training. Teagan has been a seasonal interpretive ranger at Glacier for about six years and is working toward her PhD in climate change communication. They created a video, which was shown at the beginning of the presentation. The training included information about climate change communication and its importance in the National Park Service's climate change response strategy, and about resources available to interpreters. A presentation was also given to all Glacier National Park employees that provided an overview of climate change research and issues at the park, and the support for NPS staff to talk to visitors about climate change. Glacier has also:

- Developed wayside exhibits at key locations, such as Logan Pass
- Given Interpretive presentations (evening programs, guided hikes, etc.) with Ranger Naturalists

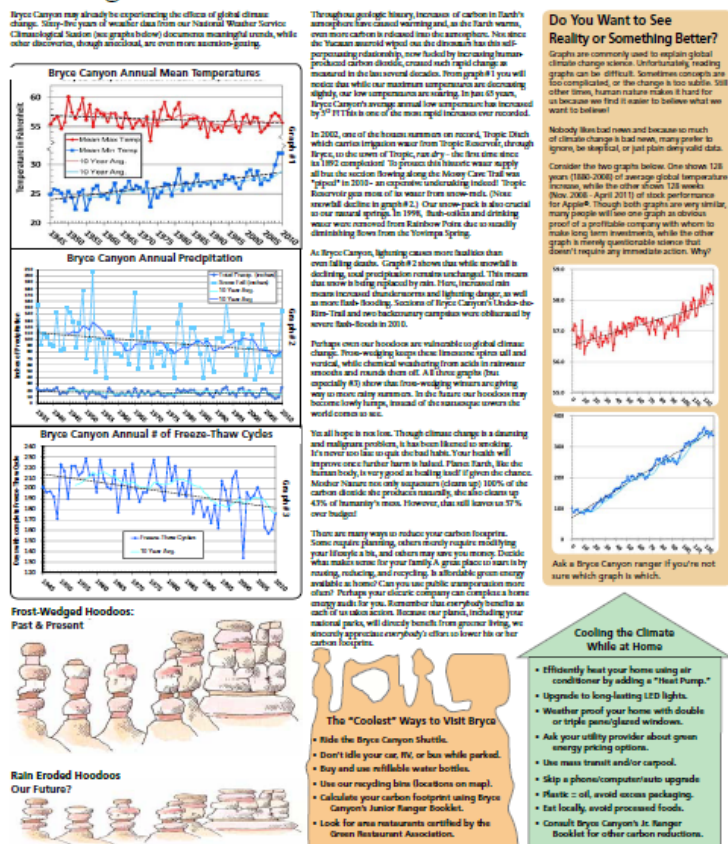


- Developed a site bulletin brochure
- Has PowerPoint presentations and guided hikes offered to special groups upon request
- Written climate change articles for the park guide and other newsletters
- Proudced climate change web content, including audio and video podcasts
- Presents a Brown Bag Seminar Series on science and research in the park (often related to climate change)

Publications

Bryce Canyon Visitor Newsletter article: *Charting the Past & Present to Avoid an Unwanted Future*. This full-page article in the Summer 2013 newsletter prompts visitors to understand changes in climate, what it means for park resources, and how they can reduce their carbon footprint (see below).

Charting the Past & Present to Avoid an Unwanted Future



Yellowstone Resources and Issues 2013. This compendium, edited annually, intended to help staff and visitors understand the important concepts about Yellowstone National Park's many resources, contains information about the park's history, natural and cultural resources, and issues. The 2013 Volume has chapters on climate change in the Greater Yellowstone and Sustainable and Greening Practices.

Videos, Webinars, and Newsletters

SCIENCE MINUTE MOVIES

The Greater Yellowstone I&M Network produced two Science Minute Movies, one on pikas and the other about climate change, that accessible on the home page of the Greater Yellowstone Science Learning Center website at: <http://www.greateryellowstonescience.org>

NCCWSC 2013 CLIMATE CHANGE SCIENCE AND MANAGEMENT WEBINAR SERIES

A partnership between the U.S. Geological Survey's National Climate Change and Wildlife Science Center (NCCWSC) and the U.S. Fish and Wildlife Service's National Conservation Training Center (NCTC) <https://nccwsc.usgs.gov/webinars>

INSTITUTE FOR TRIBAL ENVIRONMENTAL PROFESSIONALS (ITEP)

Tribal Climate Change Newsletter monthly newsletter provides news items, resources, announcements relevant to tribal climate change issues http://www4.nau.edu/itep/climatechange/tcc_newsletters.asp

Landscape Conservation Cooperatives

DESERT LANDSCAPE CONSERVATION COOPERATIVE

Desert LCC webinars are available at <http://www.usbr.gov/dlcc/resources/webinars.cfm>

Desert LCC newsletters are available at: <http://www.usbr.gov/dlcc/news/newsletters.cfm>

GREAT NORTHERN LANDSCAPE CONSERVATION COOPERATIVE

GNLCC shares scientific findings and project updates using webinars. GNLCC webinars are recorded and placed on the GNLCC YouTube channel, which has more than 31 videos <http://greatnorthernlcc.org/webinars>

The Great Northern LCC produces a newsletter three times/year with announcements about landscape conservation science, management, and events with the GNLCC area <http://greatnorthernlcc.org/newsletter>

SOUTHERN ROCKIES LANDSCAPE CONSERVATION COOPERATIVE

SRLCC shares scientific findings and project updates using webinars, available at <http://southernrockieslcc.org/products/webinars/>

The SRLCC updates about landscape conservation science, management, and events within the Southern Rockies are available at <http://southernrockieslcc.org/>

Annual reports and other publications and presentation are available at <http://southernrockieslcc.org/products/publications/>

NATIONAL PARK SERVICE CLIMATE CHANGE RESPONSE PROGRAM

NPS CCRP Newsletter is a bimonthly forum to share the latest actions relating to NPS efforts to manage our parks in a changing climate. <http://www.nature.nps.gov/ClimateChange/assets/newsletters>

CCRP MONTHLY CLIMATE CHANGE WEBINAR SERIES

This webinar series explores all facets of climate change science and management; it is presented on the 2nd Thursday of each month, 12:00-1:30 (MT).

Appendix A: NPS Climate Change Action Plan Emphasis Areas and Actions

EMPHASIS AREA 1. ENHANCE WORKFORCE CLIMATE LITERACY

- Conduct vulnerability and risk assessment training
- Develop framework for Interpreting Climate Change competency; make broadly available online
- Identify existing NPS training curricula; develop and insert appropriate climate change and sustainability content (e.g., superintendents, resource professionals, interpreters)
- Create innovative videos and online training modules for use in numerous training forums

EMPHASIS AREA 2. ENGAGE YOUTH & THEIR FAMILIES

- Continue George Melendez Wright climate change fellowship and internship opportunities to support parks
- Leverage climate change through other youth and diversity programs (i.e.SCA, webrangers, diversity program)
- Provide mentorship opportunities for youth interested in climate change management and policy issues

EMPHASIS AREA 3. DEVELOP EFFECTIVE PLANNING FRAMEWORKS & GUIDANCE

- Require all projects submitted to Development Advisory Board (DAB) address climate change impacts; provide reviews
- Implement climate change guidance for Long-Range Transportation Plans (LRTPs); conduct prototypes

- Conduct prototypes for incorporating climate change into a range of park planning processes and stewardship activities (e.g., GMPs 7, RSSs 8, FMPs 9, LRIPs 2)
- Review all GMPs to ensure climate change is being considered and appropriately addressed
- Provide scenario planning guidance and training; maintain “community of practice” Develop guidance and incorporate climate change into Foundation Documents (FDs) Create regional climate change strategies
- Develop and implement strategy for cultural resource climate change core program
- Provide guidance for considering climate change under the National Environmental Policy Act

EMPHASIS AREA 4. PROVIDE CLIMATE CHANGE SCIENCE TO PARKS

- Monitor change and resource condition at parks
- Participate in international and national climate change science and adaptation synthesis and assessment studies (i.e., Intergovernmental Panel on Climate Change [IPCC] and the National Climate Assessment [NCA])
- Analyze historical and projected climate trends for NPS units; link to park planning and provide guidance for how to use the reports
- Incorporate climate change into State of the Parks reporting
- Assess vulnerability of park resources and ecosystems
- Establish vulnerability assessment framework for consistency and comprehensive coverage for NPS units

EMPHASIS AREA 5. IMPLEMENT THE GREEN PARKS PLAN (SELECTED ACTIONS)

- Increase the number of Climate Friendly Parks (CFP)
- Use the Climate Leadership In Parks (CLIP) tool to assess greenhouse gas operational emissions
- Conduct energy audits at parks and implement Energy Conservation Measures (EMCs)
- Conduct water audits at parks and implement Water Conservation Measures (WMCs)
- Pursue fleet optimization opportunities to “right-size” NPS fleet
- Finalize NPS Sustainable Buildings Implementation Plan; begin assessment at selected parks
- Issue “no idling” policy for non-law enforcement or emergency vehicles
- Use Energy Star Portfolio Managers to understand and improve energy efficiency for high-consumption parks and facilities
- Deploy “My Green Parks” web tool to facilitate sustainable practices at each employee’s worksite

EMPHASIS AREA 6. FOSTER ROBUST PARTNERSHIPS

- Strengthen regional partnerships with DOI Landscape Conservation Cooperatives (LCCs) & Climate Science Centers (CSCs) to ensure NPS climate change science and adaptation needs are addressed
- Engage NOAA Regional Integrated Science and Assessment (RISA) teams in science and adaptation planning for parks
- Coordinate Clean Cities NPS Partnership with the Department of Energy to fund transportation efficiencies
- Maintain and strengthen relationships within the air quality community (state, federal and tribal regulators; industry; interest groups; air quality science

community) to influence GHG emission reductions

- Build communities of practice with gateway communities in cooperation with non-profit organizations
- Expand new relationship with Department of Education to include climate change literacy
- Identify landscape conservation goals and adaptation strategies with adjacent jurisdictions

EMPHASIS AREA 7. APPLY APPROPRIATE ADAPTATION TOOLS & OPTIONS

- Create director’s memo to provide management guidance on policies related to the effects of climate change on cultural resources
- Create director’s memo to provide management guidance on policies related to the effects of climate change on facilities
- Conduct “listening sessions” with NPS employees on Revisiting Leopold recommendations and next steps
- Pilot adaptation planning processes and actions that connect vulnerability assessments and scenarios to park planning; report to DOI and communicate widely
- Complete Renewable Energy Installation Siting Guidance
- Initiate decision framework for navigating various resource adaptation options and practices
- Create risk screening tool for assessing risk to facilities; extend to cultural resources

EMPHASIS AREA 8. STRENGTHEN COMMUNICATION

- Link new interpretive exhibits using social networking tools to present climate change issues common to many parks (e.g., sea level rise, phenology)
- Include climate change in national social media strategy

- Create a “network of champions” throughout parks to share compelling stories and messages of hope to empower other parks and visitors to take action
- Disseminate successful internal communication products to public audiences
- Continue regular climate change webinars for employees
- Develop internal website to share planning, adaptation, and communication guidance and products; include park stories and an online forum to support communities of practice
- Develop and release a national interpretive plan for climate change
- Coordinate climate change and cultural resource community of practice

Appendix B: Climate Change Information Quick Reference Guide

Internal NPS Climate Change Resources

NPS Climate Change Response Program internal sharepoint
<http://www1.nrintra.nps.gov/climatechange>

Climate Change Planning Internal Website
<http://www1.nrintra.nps.gov/climatechange/planning.cfm>

Climate Change Guidance and Information

NPS Climate Change Response Program external site (including bioregional talking points)
<http://www.nature.nps.gov/climatechange/>

NPS Climate Change Response Program external site (including bioregional talking points)
<http://www.nature.nps.gov/climatechange/>

NPS Climate Change Response Strategy
http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf

NPS Climate Change Action Plan
http://www.nature.nps.gov/climatechange/docs/NPS_CCActionPlan.pdf

NPS Climate Friendly Parks Program (including Climate Leadership in Parks [CLIP] Tool)
<http://www.nps.gov/climatefriendlyparks>

CEQ Draft Guidance on Climate Change
<http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf>

EPA Climate Change website
<http://www.epa.gov/climatechange>

NOAA Office of Ocean and Coastal Resource Management
<http://coastalmanagement.noaa.gov/climate.html>

USGS Climate and Land Use Change
http://www.usgs.gov/global_change/

USFS Climate Change Resource Center
<http://www.fs.fed.us/ccrc>

US Global Change Research Program
<http://www.globalchange.gov>

NPS Submerged Resources Center
<http://www.nps.gov/submerged/>

National Climate Assessment
<http://ncadac.globalchange.gov/>

NOAA Regional Integrated Science and Assessment Programs (RISA)
<http://cpo.noaa.gov/ClimatePrograms/ClimateSocietalInteractionsCSI/RISAProgram.aspx>

CAKE Climate Adaptation Knowledge Exchange (CAKE)
<http://www.cakex.org/>

Climate Change Webinars, Calls, and Newsletters

NPS Planner's Chat
<http://inpniscsfern2:7000/sites/WASO/PPFL/PSS/PC/default.aspx>

Climate and Culture Monthly Phone Call (contact Marcy Rockman: Marcia_Rockman@nps.gov)
<http://sharenrss/climatechange/cultural/default.aspx>

Climate Change Monthly Update (hosted by Leigh Welling, NRPC)

Climate Change Webinars (hosted by John Morris, AKSO)

Climate Change and Indigenous People

Intergovernmental Panel on Climate Change
<http://www.ipcc.ch/>

Secretarial Order #3289: Addressing the Impacts of Climate Change on America's Water, Land, and Other Cultural and Natural Resources
<http://www.wilderness.net/toolboxes/documents/climate/DOI%20-%20SecOrder3289.pdf>

Tribal Climate Change Project
<http://tribalclimate.uoregon.edu/network/>

Center for Climate and Health, Alaska Native Tribal Health Consortium
<http://www.anthc.org/chs/ces/climate/>

Native American Rights Fund, Alaska Office.
801 B Street, Suite 401, Anchorage, AK 99501.
Phone: (907) 276-0680.
<http://www.narf.org>

Climate Change and Planning

Foundations for Planning and Management
Climate Change Guidance
<http://www1.nrintra.nps.gov/climatechange/foundationdocs.cfm>

Climate Change Scenario Planning in Alaska
<http://www.nps.gov/akso/nature/climate/scenario.cfm>

Scanning the Conservation Horizon
(Vulnerability Assessments)
<http://www.nwf.org/What-We-Do/Energy-and-Climate/Climate-Smart-Conservation/Assessing-Vulnerability.aspx>

Climate Change Adaptation Strategies and Frameworks

Yale Framework
<http://www.databasin.org/yale>

U.S. Climate Change Science Program (CCSP)
Science Assessment Product 4.4
<http://www.climate-science.gov/Library/sap/sap4-4/final-report/>

National Fish, Wildlife, and Plant Adaptation Strategy
<http://www.wildlifeadaptationstrategy.gov/>

Climate Change Partnerships

Landscape Conservation Cooperatives
<http://www1.nrintra.nps.gov/climatechange/foundationdocs.cfm>

Great Northern LCC
<http://greatnorthernlcc.org/>

Southern Rockies LCC
<http://www.doi.gov/lcc/Southern-Rockies.cfm>

Gulf Coast Prairie LCC
<http://gulfcoastprairielcc.org/>

Desert LCC
<http://www.doi.gov/lcc/Desert.cfm>

Great Plains LCC
<http://www.greatplainslcc.org/>

Prairies, Plains, and Potholes LCC
<http://www.plainsandprairiepotholeslcc.org/>

Great Basin LCC
<http://www.doi.gov/lcc/Great-Basin.cfm>

DOI Climate Science Centers
<http://www.doi.gov/csc/index.cfm>

North Central Climate Science Center
<http://www.doi.gov/csc/northcentral/index.cfm>

South Central Climate Science Center
<http://www.doi.gov/csc/southcentral/index.cfm>

South West Climate Science Center
<http://www.doi.gov/csc/southwest/index.cfm>

Western Water Assessment
<http://wwa.colorado.edu/>