The National Park Service Response to Climate Change

Climate Change Response

National Park Service
US Department of the Interior

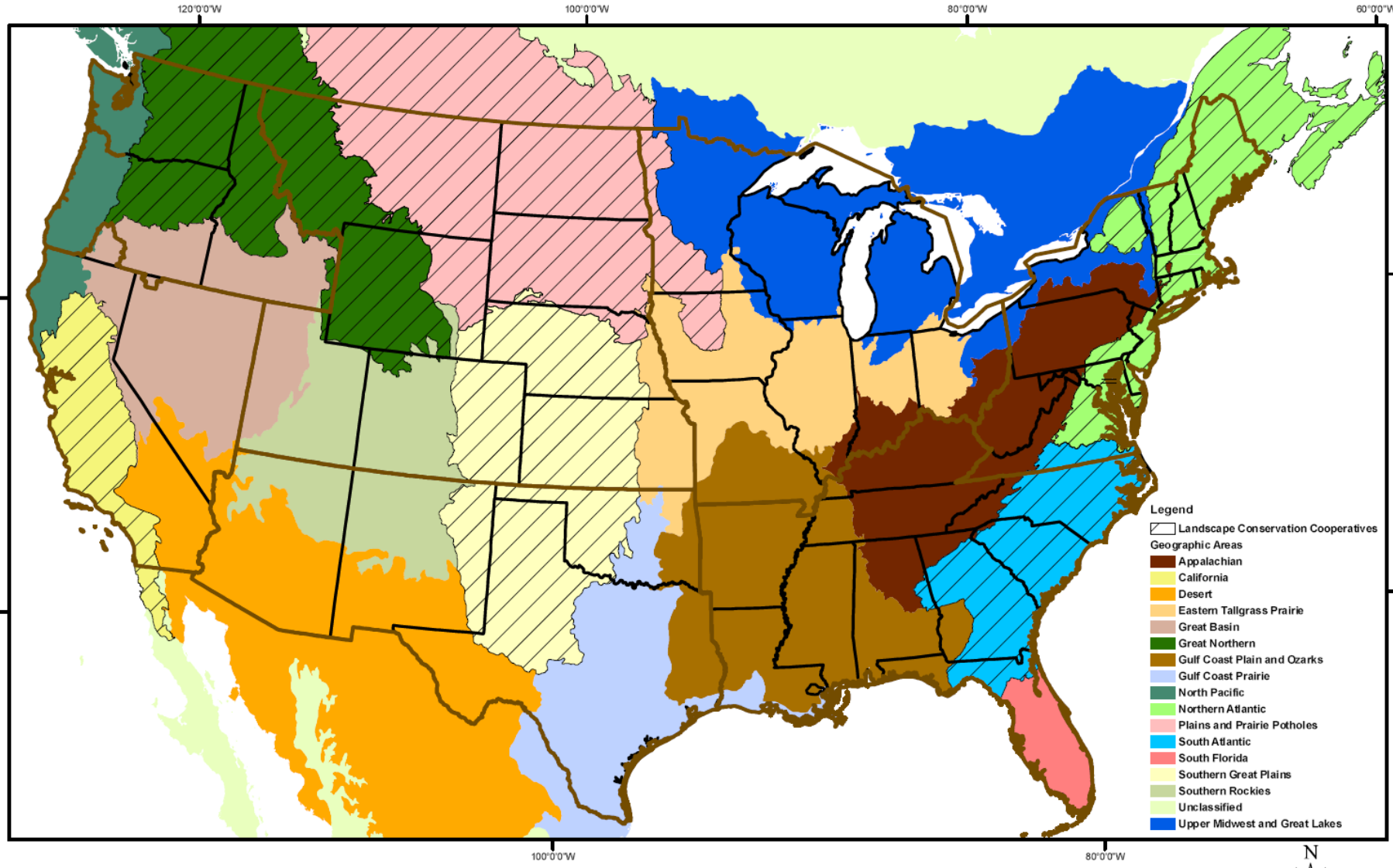
- DOI Mandate and Guidance
- NPS CC Strategy, Steering and Science Committees
- FY10 Funding
- Landscape Conservation Cooperatives
- Climate Science Centers
- Monitoring Ecological Response to Climate Change

U.S. Fish and Wildlife Service

Geographic Areas with Regional and State Boundaries

Conterminous United States

Proposed Landscape Conservation Cooperatives - FY 2010



0 150 300 600 900 1,200 Miles

N W E S

Meters

0 370,000 740,000 1,480,000 2,220,000 2,960,000

Albers Equal Area Conic

Produced by IRTM, Denver, CO
Map Date: 11042009

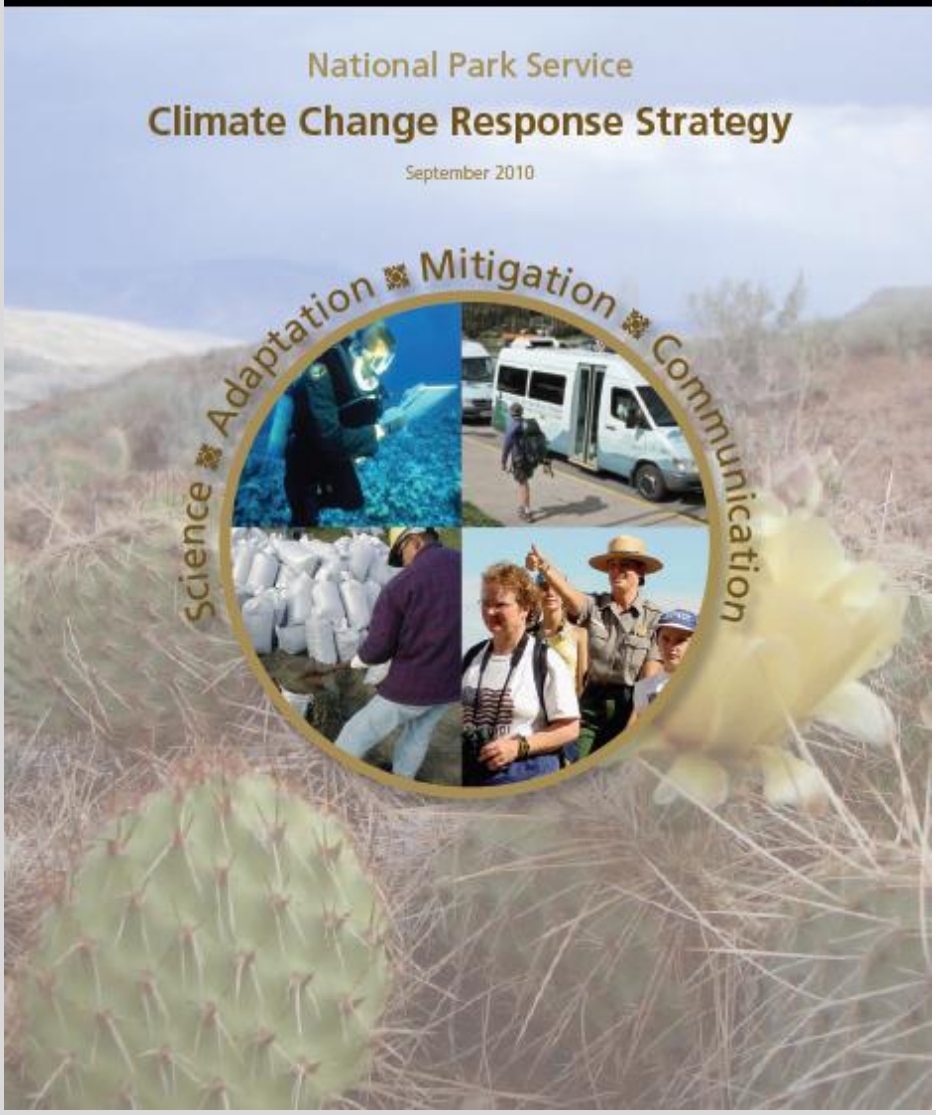
National Park Service
U.S. Department of the Interior

Climate Change Response Program

National Park Service

Climate Change Response Strategy

September 2010



STRATEGY COMPONENTS

Science:
Conduct scientific research and vulnerability assessments necessary to support NPS adaptation, mitigation, and communication efforts. Collaborate with scientific agencies and institutions to meet the specific needs of management as it confronts the challenges of climate change. Learn from and apply the best available climate change science.

Mitigation:
Reduce the carbon footprint of the NPS. Promote energy efficient practices, such as alternative transportation. Enhance carbon sequestration as one of many ecosystem services. Integrate mitigation into all business practices, planning, and the NPS culture.

Adaptation:
Develop the adaptive capacity for managing natural and cultural resources and infrastructure under a changing climate. Inventory resources at risk and conduct vulnerability assessments. Prioritize and implement actions, and monitor the results. Explore scenarios, associated risks, and possible management options. Integrate climate change impacts into facilities management.

Communication:
Provide effective communication about climate change and impacts to the public. Train park staff and managers in the science of climate change and decision tools for coping with change. Lead by example.

Executive Summary

In 2016, the National Park Service (NPS) will begin its second century of preserving the Nation's natural and cultural heritage, a stewardship that now includes protection of more than 84 million acres within the National Park System. Global climate change threatens the integrity of our national parks. It challenges the NPS mission to leave park resources unimpaired for future generations unlike any threat in our history.

The NPS is moving rapidly beyond the question of whether the Earth is warming and is focused on what to do about it. This crisis is daunting, but national parks can provide redemption. For one of the most precious values of the national parks remains their ability to teach us about ourselves and how we relate to the natural world. How we move forward in the era of climate change is up to each of us, at all levels of the NPS, and as citizens of the United States.

The NPS Climate Change Response Strategy provides direction to our agency and employees to address the impacts of climate change. It describes goals and objectives to guide our actions under four integrated components: ***science, adaptation, mitigation, and communication.*** The NPS will collaborate with partners to identify and monitor climate change effects in parks and to apply accurate and relevant science to management and policy decisions. In a changing climate, the NPS will adapt through the development of feasible and actionable scenarios and create a flexible framework for dealing with impacts[1]. We will reduce the National Park Service carbon footprint (the amount of greenhouse gases emitted through NPS activities) through energy-efficient and sustainable practices and integrate these practices into planning and operations. Finally, through clear directed communication, the NPS will raise employees' and the public's awareness of the implications of climate change and inspire them to take steps to address this challenge.

The four integrated components throughout the strategy call for an overarching legal and policy framework that will ensure the legality, consistency and appropriateness of management decisions. As climate change is likely to create conditions and ecosystems unlike any found today, upholding our mission may require updating interpretations of policy, mandates, and approaches to resource stewardship.

This is an ambitious coordinated strategy to understand, communicate, and respond to the impacts of rapid climate change. This issue's complexity and pervasiveness demand a scientific approach and an unprecedented level of cooperation, collaboration, and partnership across all directorates and divisions within the National Park System, partner organizations, other government agencies, and neighboring communities. A legacy of inspirational heritage hangs in the balance.

[1]The terms "effect" and "impact" are often used interchangeably to describe changes to physical, chemical, biological, or human systems as a result of climate change. In this document, a climate change effect refers to a consequence that may or may not be detrimental, while a climate change impact refers to an outcome that is unfavorable for park resources or visitor experience.

Climate Change Response Strategy

National Park Service
US Department of the Interior

Mitigation

- Create ongoing efforts to reduce emissions of park and concessions operations.
- Develop sustainable green practices using the best science available.

Adaptation

- Use the best science available to develop feasible and actionable scenarios to adapt to rapid climate change.
- Create infrastructure for dealing with fire, invasives, species loss and change and other immediate challenges.

Communication

- Develop strategies to communicate climate change impacts and actions being taken to reduce them.
- Educate employees and visitors on the state of climate change knowledge and appropriate actions.

Science

- Use best available science to inform CC decisions.
- Work with partners to develop, test and distribute climate models.
- Enhance monitoring of ecological response to climate change.

Strategy to Enhance Monitoring of Ecological Response to Climate Change

- Modest increase to I&M base – 10 to 15%
- Focus on most vulnerable resources in parks
  - Arid Lands
  - Coastal
  - High Elevation
  - High Latitude

Enhance existing monitoring, information integration, data analysis, reporting and collaboration

Build on Existing Monitoring

Mojave Desert Network
Climate Change Resource Brief

Pacific West Regi
Inventory & Moni
National Park Ser
U.S. Department o

Climate Change and the Mojave Desert
Desert ecosystems are sensitive indicators of climate change because small changes in temperature and precipitation (quantity, timing, frequency, and distribution) can have significant effects on physical resources and biological communities. Mojave Desert Network is currently developing protocols to monitor several Vital Signs that may reflect current and future impacts of climate change.

Groundwater and Springs Monitoring
Within Mojave Desert Network parks, significant biodiversity may be found at springs, which range from small, ephemeral mountain-front springs to large, perennial springs fed by carbonate-rock aquifers. Because the quantity of water (discharge) flowing from small mountain-front springs is affected by precipitation patterns, climate change may affect these springs and the associated plant and animal communities that depend on each spring's discharge patterns. At a selected subset of these springs, this network will monitor discharge, water quality, and the associated macroinvertebrate, riparian plant, and bird communities.

Streams and Lakes Monitoring
Diverse landscapes within the Mojave Desert Network also encompass high mountain streams and alpine lakes. Continuous measurements of lake level and stream discharge at Great Basin National Park may reflect changes in the amount and timing of precipitation and snow-melt. We will also monitor stream and lake water temperatures, lake ice-out and ice-over dates, and water quality, all of which may be affected by changes in air temperature and/or snow melt processes and all of which are important ecological variables.

Vegetation Communities and Invasive Plants
The Mojave and Great Basin deserts support a wide range of upland vegetation communities from desert scrub to subalpine forest. Changing patterns in precipitation and temperature have the potential to shift the latitudinal and elevational distribution of some communities and threaten the persistence of others (e.g. Joshua tree, bristlecone pine). Changes in climate, combined with anthropogenic effects such as nitrogen deposition, may also result in the displacement of native plants by exotics, range expansions of new plant species into network parks, and the establishment of new ecological processes such as the grass-fire cycle, which is detrimental to many native plant species. The network will monitor structure and composition of selected vegetation communities and biological soil crusts to identify long-term changes which may be caused by climate change. In addition, network parks will implement early detection procedures to identify range expansions and contractions of invasive exotic plants.

Contact Information
Penny Latham, PWR Regional I&M Program Manager, PWRO-Seattle, 909 First Ave., 5th floor, Seattle, WA 98104; Penny_Latham@nps.gov; phone, 206-220-4267.

Alice Chung-MacCoubrey, Mojave Desert Network Program Manager, Lake Mead National Recreation Area, 601 Nevada Hwy., Boulder City, NV 89005. Alice_Chung-MacCoubrey@nps.gov, 702-293-8911.

The namesake of Josh
Joshua tree (*Yucca br*
significant changes in
change.

Climate change may
springs and seeps, wh
natural water sources

An increase in invasive grasses and annuals could change the desert landscape by establishing a fire cycle to which native plants are not adapted.

Sonoran Desert Network
Information Brief

National Park Service
U.S. Department of the Interior
Intermountain Region
Inventory & Monitoring Program

2010

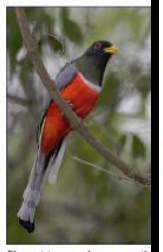
Climate Change in the Sonoran Desert Network
Current Findings and How Future Monitoring

How might climate change affect a place like the Sonoran Desert, whose bi-modal precipitatio
area's amazing species and lifeform diversity? The Sonoran Desert and its "sky islands" are un
the southernmost habitat for temperate species and the northernmost habitat for tropical spec
unique assemblage of flora and fauna that has responded to previous climatic changes. Over th
have established and flourished, and others have been extirpated.

The Sonoran Desert Network (SODN) is one of 32 National Park Service inventory and monit
vital signs monitoring to assess the condition of park ecosystems and develop a stronger scient
ment of natural resources across the National Park System. The SODN is monitoring several vit
of climate change. This brief offers a summary of the network's local-scale findings to date, as
monitoring will detect future change.

Current Findings

Bird Species Found North of its Historical Range
In 2008 and 2009, Sonoran Desert Network landbird monitoring detected elegant trogons (*Trogons elegans*) nesting at both units of Montezuma Castle National Monument. The park is located in north-central Arizona, several hundred miles north of the previously documented distribution for this beautiful and distinctive tropical species, which was previously thought to extend only to the borderlands of southeastern Arizona. It is believed that milder winter and spring seasons linked to climate change may have permitted an extension of this species north, to exploit the riparian environments of the Verde Valley just south of Flagstaff, Arizona.



Elegant trogons have recentl
National Monument, far nort

Vegetation Change at Saguaro National Park Indicates Shift Toward Warm-season Plants
To support the development of a vegetation monitoring protocol, staff at the Sonoran Desert Network and Saguaro National Park located and remeasured permanent vegetation plots established in 1976, in the Cactus Forest area of Saguaro National Park. Designed to document potential grazing effects on native vegetation, this extensive study instead illustrated a major increase in the abundance of shallow-rooted subshrubs, grasses, and other herbs, at the expense of deeper-rooted trees and shrubs. Deeper-rooted species are primarily supported by cool-season precipitation, whereas shallow-rooted species tend to take advantage of the brief, intense pulses of moisture following summer thunderstorms. These shifting vegetation patterns mirror changes in seasonal precipitation measured over the last 30 years, illustrating the close linkages between ecosystems and the bi-modal precipitation regime that defines the Sonoran Desert, and tracking predicted regional effects of global climate change.

A recent study at Saguaro NP
the abundance of shallow-roo
deeper-rooted trees and shru
serve as nurse trees for sagua

Chihuahuan Desert Network
Information Brief

National Park Service
U.S. Department of Interior
Intermountain Region
Inventory & Monitoring Program

Climate Change and the Chihuahuan Desert
The Chihuahuan Desert Network (CHDN) is one of 32 National Park Service inventory and monitoring networks implementing Vital Signs monitoring to assess the condition of park ecosystems and develop a strong scientific basis for stewardship and management of natural resources across the National Park System. The CHDN is currently developing protocols to monitor several Vital Signs that may reflect current and future impacts of climate change. This brief offers a summary of how CHDN monitoring will detect future change.

Seeps and Springs
Water and water-dependent ecosystems are scarce resources in the arid southwest, and are generally regarded as biodiversity hotspots. Seeps and springs are critical surface water sources and are among the most restricted habitats for plant and animal species. Precipitation is critical to the existence of seeps and springs. The size, frequency, and duration of precipitation events are key factors influencing spring-water availability. Climate change is expected to alter surface water quantity, as well as seasonal patterns of flooding and drought, and springs will be a direct indicator of these changes. The CHDN will monitor discharge, water quality, macroinvertebrates, and vegetation at a subset of springs in the network.

Smith Springs at Guadalupe Mountains NP is one of many springs in the CHDN that serve as an important source of water for plants and animals. D. Bieri photo.

Groundwater
In the Chihuahuan Desert, groundwater is the source of most surface water bodies. Availability of groundwater also has critical consequences for plants, animals, and nutrient, water, and energy flows. In many parts of the American Southwest, long-term drought and human development have already led to significant declines in groundwater levels at local and regional scales. Impacts to groundwater resources associated with reduced infiltration and storage, often related to soil loss and changes in surface characteristics, can be directly addressed by management actions aimed at soil conservation and recharge enhancement. The possibility of a reduction in precipitation recharge related to climate change, however, would be far more problematic and have the potential for broad-scale impacts to surface-water systems. The CHDN will monitor groundwater quantity in wells throughout the network.

Lower: Climate change may have direct and indirect effects on streamflow and water quality in the Rio Grande, which also has the exotic plant *Arundo*, growing along its banks. R. Skiles photo.

Rivers
Chihuahuan Desert Network parks contain 247 miles of the Rio Grande, as well as the confluence of the Devils, the Pecos, and the Rio Grande in Amistad National Recreation Area. The condition of these rivers within CHDN parks is greatly influenced by drivers and stressors occurring across the landscape in areas located well beyond park boundaries. Climate change may have direct and indirect effects on streamflow and water quality. As temperature and precipitation patterns affect the abundance, type, and distribution of vegetation cover in watersheds, changes in flood magnitude and duration, sediment loads, and water chemistry will likely occur. CHDN monitoring of water quality, channel morphology, macroinvertebrates, and stream discharge will allow park managers to address proximate issues occurring within park boundaries and will also provide an index of overall watershed condition.

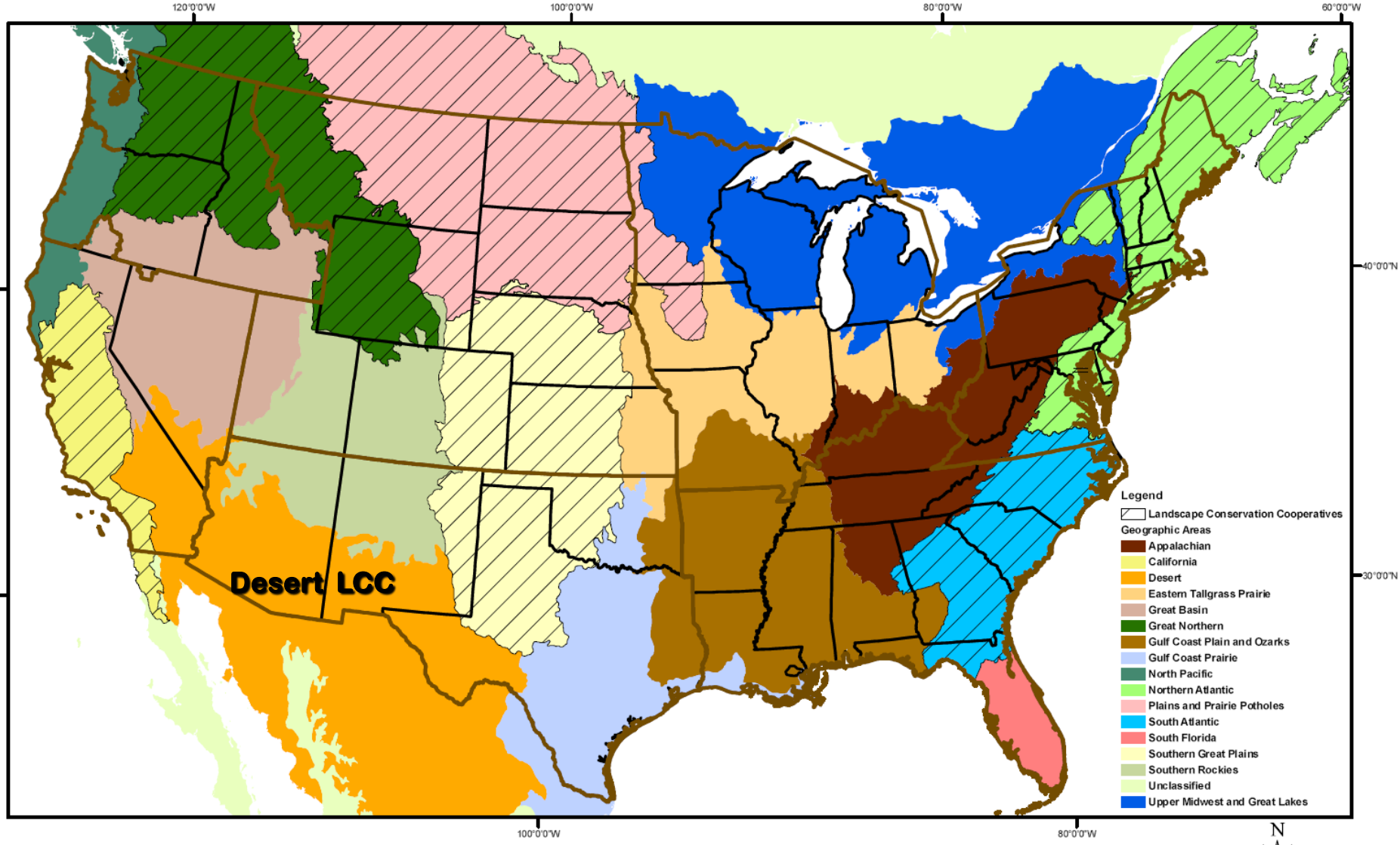
http://science.nature.nps.gov/im/climate/index.cfm

U.S. Fish and Wildlife Service

Geographic Areas with Regional and State Boundaries

Conterminous United States

Proposed Landscape Conservation Cooperatives - FY 2010



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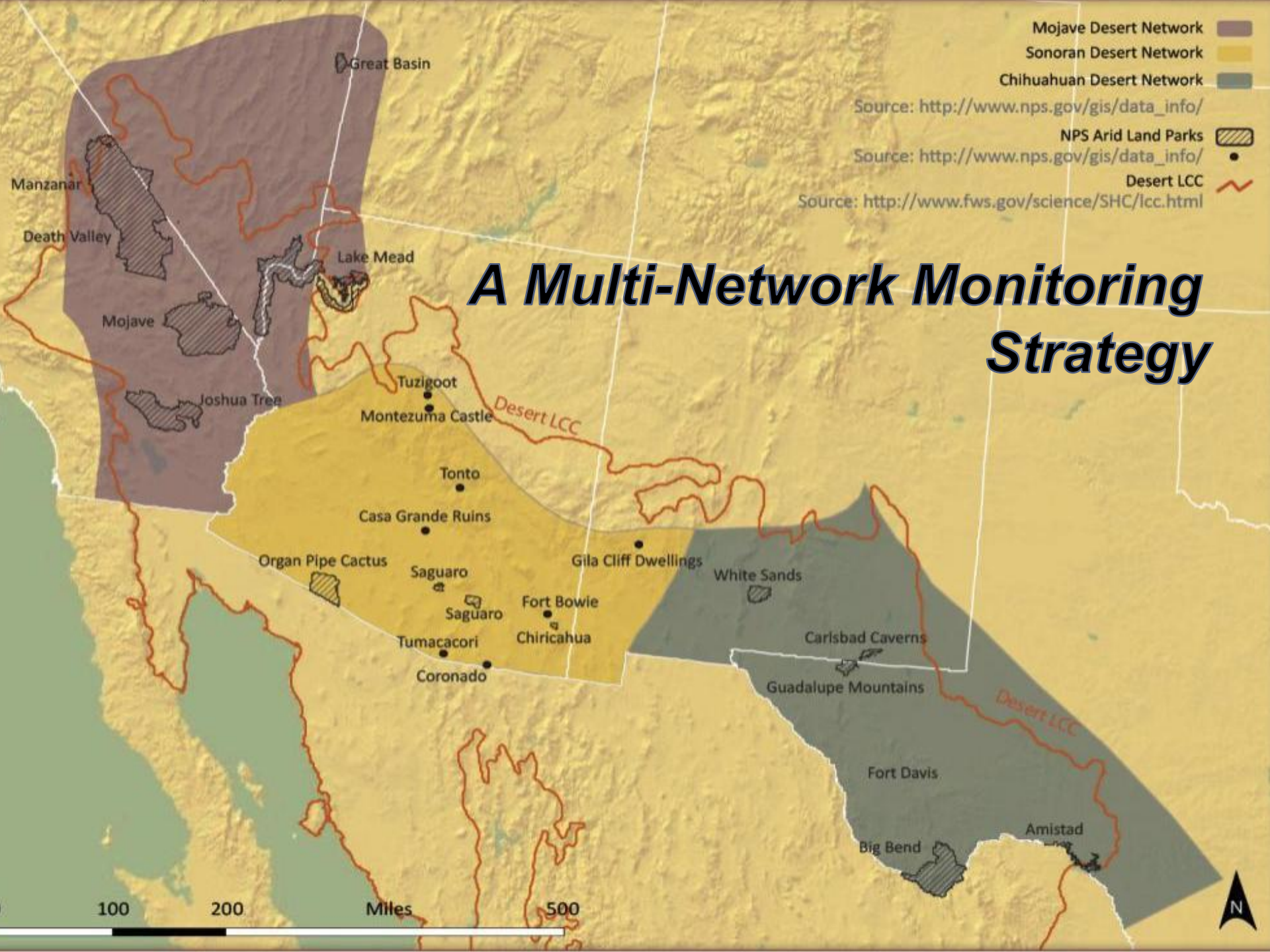
Monitoring Ecological Response to Climate Change in the Desert Landscape Conservation Cooperative

April 6-7, 2010
Tucson, AZ


Mojave Desert Network
Sonoran Desert Network
Chihuahuan Desert Network
Source: http://www.nps.gov/gis/data_info/
NPS Arid Land Parks
Source: http://www.nps.gov/gis/data_info/
Desert LCC
Source: http://www.fws.gov/science/SHC/lcc.html
A Multi-Network Monitoring Strategy
Great Basin
Manzanar
Death Valley
Lake Mead
Mojave
Joshua Tree
Tuzigoot
Montezuma Castle
Desert LCC
Tonto
Casa Grande Ruins
Organ Pipe Cactus
Saguaro
Gila Cliff Dwellings
White Sands
Saguaro
Fort Bowie
Chiricahua
Tumacacori
Coronado
Carlsbad Caverns
Guadalupe Mountains
Desert LCC
Fort Davis
Amistad
Big Bend
100
200
Miles
500
N

Arid Lands Workshop
74 Participants

National Park Service
US Fish and Wildlife Service
US Geological Survey
Bureau of Land Management
Department of Defense
Arizona Game and Fish
University of Arizona
Sonoran Desert Monitoring Partnership
Sonoran Institute

High Elevation Workshop
73 Participants

National Park Service
US Fish and Wildlife Service
US Geological Survey
Bureau of Land Management
Montana State University
National Ecological Observatory Network
Sonoran Institute

Workshop Objectives

- Share knowledge of climate change related impacts to arid and high elevation resources and ecosystems
- Identify opportunities for enhancing and leveraging climate change monitoring efforts and resources, including coordination with partner agencies (USFWS)
- Prioritize resource management issues and indicators of ecological response to climate change
- Draft long-term climate change monitoring strategies and work plans for NPS units within networks of the Landscape Conservation Cooperatives

Workshop Agenda

- **Day 1:** Climate Change Presentations & Information
  - Climate change patterns– past, projected and ecological impacts
  - Ongoing and new efforts related to monitoring ecological response to climate change
  - Review LCC framework for coordinating monitoring efforts

- **Day 2:** Prioritizing Management Issues & Indicators
  - Planning principles for multi-network strategies
  - Conceptual models and projected impacts to systems
  - Convene breakout groups for prioritizing issues and indicators

- **Day Three:** NPS Planning Session
  - Finalize priorities for monitoring climate change impacts
  - Identify projects to be funded in FY10-11

Primary Workshop Products

- Summaries of current understanding of climate change impacts to key resources and ecosystems
- Updated conceptual models for climate change impacts to key ecosystems
- Draft NPS priorities for long-term monitoring of ecological response to climate change in arid-land and high-elevation parks

Common Vital Signs

MOJN (14)	CHDN (21)	SODN (18)
	Aquatic Invertebrates	Aquatic Invertebrates
Biological Soil Crusts	Biological Soil Crusts	Biological Soil Crusts
Groundwater Dynamics & Chemistry	Groundwater Quantity	Groundwater Dynamics
Riparian Bird Communities	Bird Communities	Bird Community Dynamics
Invasive/Exotic Plants	Invasive/Non-native Plants	Exotic Plants - Status and Trends
Landscape Dynamics	Land Cover and Land Use	
	River Channel Characteristics	Channel Morphology
Soil Disturbance	Bare Ground	Soil Compaction
Soil Erosion & Deposition	Soil Erosion (Wind and Water)	Soil Cover & Aggregate Stability
Soil Hydrologic Function	Soil Hydrologic Function	
Surface Water Chemistry	Surface Water Quality	Water Quality
Surface Water Dynamics	Surface Water Dynamics	Surface Water Dynamics
Vegetation Change	Vegetation Composition	Vegetation Composition and Structure

Workshop Outcome: Priorities

- **Spring Distribution and Water Availability**

Objective: Determine sensitivity of springs to climate change and monitor patterns of water availability (timing, amount) across the landscape

- **Leading Indicators of Climate Change**

Objective: Enhance existing protocols to collect additional information to identify species most sensitive to climate change

- **Climate Protocol Development**

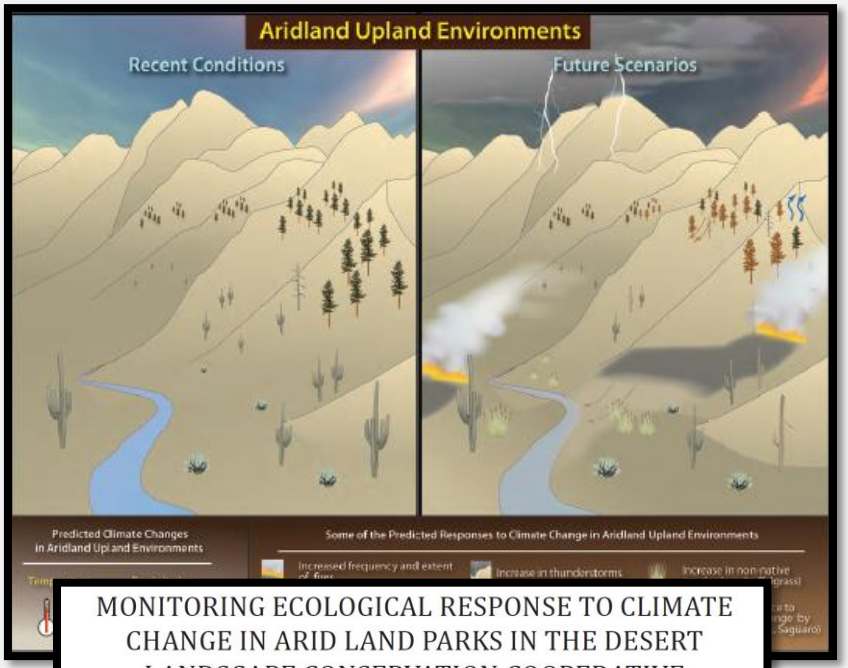
Objective: Consistent protocol for reporting data based on park needs and at the LCC scale

- **Phenology and Snowpack**

Objective: Evaluate MODIS and similar technologies for broad-scale monitoring of phenology, snowpack, and productivity

- **Communication**

Objective: Enhance Learning Center of the American Southwest (LCAS) to report climate change information across the LCC



MONITORING ECOLOGICAL RESPONSE TO CLIMATE CHANGE IN ARID LAND PARKS IN THE DESERT LANDSCAPE CONSERVATION COOPERATIVE

An Inventory and Monitoring workshop to explore ecological response to climate change, develop criteria and preliminary priorities for monitoring, and explore opportunities to expand monitoring partnerships.

Hilton East, Tucson, Arizona
April 6-7, 2010

National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Enhanced Monitoring to Better Address Rapid Climate Change in Southwest Desert Parks

A Multi-Network Strategy

Natural Resource Report NPS/IMR/NRR—2010/XXX