U.S. Department of the Interior
National Park Service

Joshua Tree National Park
Resource Stewardship Strategy

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Summary

Joshua Tree National Park preserves and protects the scenic, natural, and cultural resources representative of the Colorado and Mojave Deserts' rich biological and geological diversity, cultural history, wilderness, recreational values, and outstanding opportunities for education and scientific study.

Joshua Tree National Park

In the early 1920s, road development and homesteading laws prompted an influx of cactus collectors and land developers to the desert lands north of Palm Springs, California. Recognizing the need to preserve the desert as a natural area, conservationists led by Minerva Hamilton Hoyt founded the International Deserts Conservation League. The League worked towards the goal of establishing parks to preserve desert landscapes. Minerva prepared a recommendation for setting aside more than a million acres across the Mojave and Colorado Deserts.

In 1936, a part of these million acres became Joshua Tree National Monument, an addition to the National Park Service (NPS) system. This monument protected the unique assembly of natural resources brought together by the junction of two of California's deserts. In 1950, Congress redrew the monument boundaries, reducing it to approximately 560,000 acres. The 1994 California Desert Protection Act reincorporated much of the land withdrawn in 1950 and established Joshua Tree National Park.

Today, Joshua Tree National Park maintains some of the most culturally, geologically, and biologically rich public land in California. The park encompasses approximately 792,000 acres, of which over 595,000 are designated wilderness. The park lies within a 3.5 hour drive of more than 18 million people in the Los Angeles metropolitan area. Close proximity of this large urban population to the park's vast wilderness, viewsheds, and natural resources has caused the park to grow in popularity.

The varied ecosystems and diverse habitats of the park are home to approximately 750 plant species, 52 mammal species, more than 250 species of birds, 25 species of snake, and 18 species of lizards. Humans have also occupied the land we know today as Joshua Tree National Park for at least 8,000 years. The first group known to inhabit the area was the Pinto culture. Today, at least 15 tribes maintain an affiliation with the park. The park preserves a diverse set of prehistoric archeological resources which include seasonal camps, rock-shelters, milling sites, lithic and ceramic scatters, and rock art sites.

In the late 1800s, cattlemen drove their cows into the area for the ample grass available at the time and built water impoundments for them. Miners dug tunnels through the earth looking for gold and made tracks across the desert with their trucks. Homesteaders began filing claims in the 1900s. The park protects 501 known archeological sites, 88 historic structures, 19 cultural landscapes, and houses 123,253 items in its museum collections.

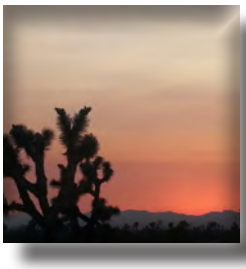
Joshua Tree National Park sits along one of the world's most active earthquake fault zones, the San Andreas Fault, and is located along two geologically-diverse mountain ranges. Geologic processes have played and continue to play a major role in shaping the mountains, valleys, and basins of the park. The natural fluvial processes of the southwestern United States have also served to shape distinct landscapes across the park. The park provides a world-class laboratory for understanding these geological processes. The park's geology, particulalry its mon-

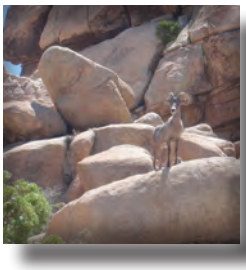
zogranite formations, in turn provides the framework for world-renowned rock climbing opportunities and iconic viewsheds.

Resource Stewardship Strategy

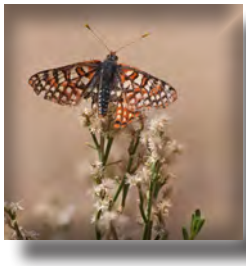
As stewards of Joshua Tree National Park's natural and cultural resources, park managers recognize the importance of developing a comprehensive approach to resource management.

Such an approach must be based on science and scholarship. The underpinnings of this *Resource Stewardship Strategy* (RSS) include the draft *Director's Order 2-1: Resource Stewardship Planning*, the 2004 NPS's *Program Standards: Park Planning*, and NPS's *Management Policies 2006*. Additionally, following a review of the park's enabling legislation and legislative documents, twenty-three *fundamental resources and values* (FRVs) were identified in the park's *Foundation Statement* that will direct management activities at Joshua Tree National Park. The list of FRVs included within the RSS has been revised from the original twenty-three found in the *Foundation Statement* to nineteen FRVs for purposes of clarity and logic within this plan. Joshua Tree National Park developed this *Resource Stewardship Strategy* around the following *fundamental resources and values*:





- Biological diversity and healthy ecosystem function
- Interconnectivity of California desert lands
- Oases and other riparian areas
- Recreational opportunities and values
- Wilderness values and wilderness accessibility
- Ever-expanding knowledge base
- Opportunity to understand, apply, and share knowledge to benefit the park and beyond
- Geological resources and desert landforms
- Hydrological resources
- Night sky
- Clean and breathable air
- Soundscape
- Viewsheds
- Archeology (historic and prehistoric)
- Cultural anthropology
- History



- Historic structures
- Cultural landscapes
- Museum collections of archives, natural history specimens, and archeological artifacts

These 19 *fundamental resources and values* are the systems, structures, processes, experiences, scenery, sounds, and other features key to achieving the park's purpose and maintaining its significance. These resources and values warrant primary consideration during planning and management because they are essential to achieving Joshua Tree National Park's purpose and mission. All divisions will collaborate in a holistic manner to protect these *fundamental resources and values*.

Status of Knowledge

The park has long recognized the importance of making decisions based on science and scholarship. To fully inform the *Resource Stewardship Strategy* planning process, it was essential for park staff to review and understand the depth, breadth and implications of scientific research that has been performed on park resources and related topics to date. This knowledge base, referred to in this document as the status of knowledge, was assessed to identify available and relevant sources of information and acknowledge data gaps that currently exist. Appendix B provides a summary of this status of knowledge for each *fundamental resource and value* and includes a list of bibliographic citations.

Major Threats

Joshua Tree National Park (NP) enlisted regional and Washington specialists support for assessing major threats to park *fundamental resources and values*. Of the many threats identified, air pollution, climate change, and land use intensification (including habitat conversion) were recognized as the most important drivers of change and/or constraints to management. Park resources and resource management in Joshua Tree NP will continue to be strongly affected by conditions and changes that occur outside park boundaries. Section 2.6.3, Status of Knowledge of the Changing Environment, provides a brief synopsis of the known and projected threats from external drivers (related figures to this section appear in Appendix F).

In 2007, Joshua Tree National Park was one of the first parks to participate in the NPS climate change scenario planning process. Appendix C of this RSS summarizes the work done through the 2007 workshop and revisits the latest historic and projected climate change trends for the region to validate the scenarios generated during the 2007 workshop. Climate change may be the single biggest threat to park resources; as a result, Joshua Tree National Park has woven strategies to address climate change throughout the document. Appendix G extracts activities from the comprehensive strategies and divides them into seven tables that represent climate change adaptation strategies, known to the park as the Rs (Reduce, Resilience, Representation, Restoration, Refugia, Reconnaissance, and Relationships). The Rs are discussed in detail in Section 4.2, followed by the potential activities that the park hopes to accomplish, many of which are climate change adaptation strategies. These strategies provide good preparation for future events, and represent low risk with respect to influences from the three plausible climate futures (Appendix C).

Comprehensive Strategies

The *Resource Stewardship Strategy* serves as an analytic tool that distills management objectives from the qualitative statements of a park's priority resources; identifies current threats, opportunities and knowledge gaps; lays out sets of activities designed to meet management objectives; and compiles these activities into comprehensive strategies. Prior to creating comprehensive strategies, parks are encouraged to identify sets of reference conditions and condition targets for each *fundamental resource and value*; comprehensive strategies should be laid out in a manner that inches the park closer to the desired condition target. A considerable amount of work has been done on relatively few resources within the park and a number of knowledge gaps remain; therefore, a number of the comprehensive strategies aim to gather basic information and many of the FRVs do not have well established reference conditions or condition targets.

Implementation of the RSS

Resource Stewardship Strategies are created with a 15-20 year time horizon, yet they are considered "living" documents and should be periodically updated to address emerging threats to park resources. This document provides the basis for assessing and updating comprehensive strategies periodically, based on new information and the results of completed activities. The RSS also provides the park with a strategy for investing both human and fiscal resources in the stewardship of natural and cultural resources and reports progress towards attaining and maintaining desired resource conditions within the park.

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Figures and Tables

Introduction to the Resource Stewardship Strategy

1.1 Structure and Role of the Strategy

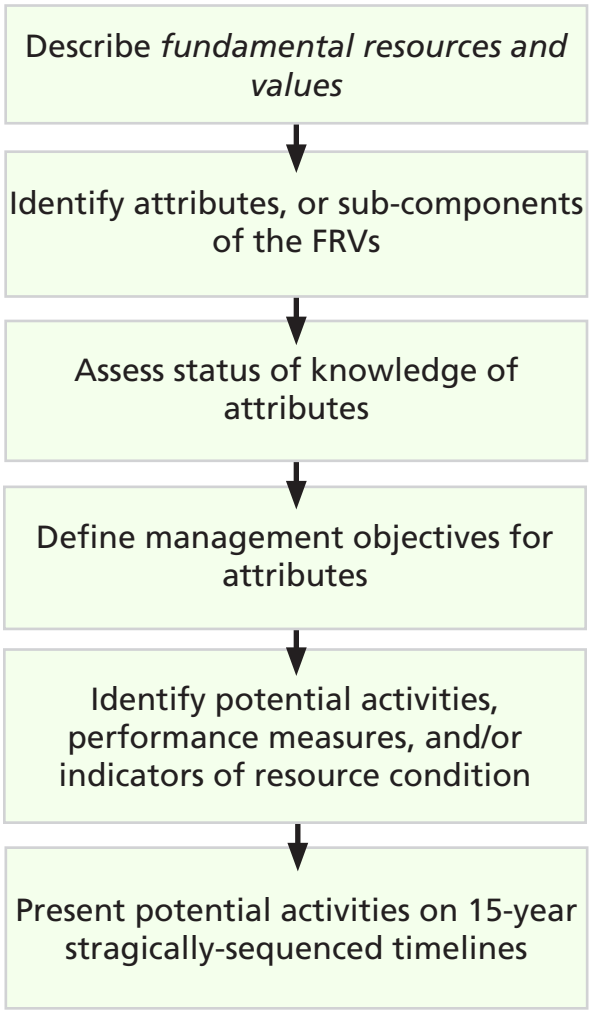
The National Park Service (NPS) protects remarkable natural and cultural resources at Joshua Tree National Park (NP), guided by the best available science and scholarship and in conformance with federal law and agency policy. In order to accomplish this, Joshua Tree NP requires a strategic plan to articulate management objectives, describe current resource condition, identify and prioritize potential management activities, and evaluate program needs. This *Resource Stewardship Strategy* (RSS) fulfills that role, presenting an adaptive framework for protection of the fundamental natural and cultural resources of Joshua Tree NP.

The RSS first describes the park's broad *fundamental resources and values* (Section 2.5) as adapted from the park's *Foundation Statement*. The document then provides an assessment of the current status of knowledge for park resources (Section 2.6.1 and Appendix B). The RSS defines one or more broad management objectives for each *fundamental resource and value* (Section 3.1) based on law, policy, and best available science and scholarship. The RSS identifies one or more potential activities to achieve each objective and performance measures and/or indicators of resource condition to track activities' effectiveness toward meeting objectives (Section 3.2). Finally, the RSS presents the potential activities on 15-year timelines (Section 4.3) to demonstrate a strategic sequencing and provide an assessment of the institutional capacity needed to implement those strategies (see Figure 1).

This document envisions appropriate and feasible actions to undertake in the coming one-and-a-half decades to meet management objectives; however, emerging science and scholarship, as well as changing law and policy will necessitate flexibility and adaptation within that 15-year timeframe.

As an example, park managers are in the early stages of understanding the range of climate futures possible at the park and how best to adapt to these changes. The RSS provides a flexible framework for guiding adaptive management (Section 5.2), and should be updated by NPS managers as needed.

Figure 1. RSS Structure and Development



This RSS does not prescribe any particular set of actions and National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) requirements for environmental impacts analysis and consultation do not apply. Rather, the RSS explores and presents a range of potential activities managers could undertake to meet management objectives. Not all of these activities will be implemented. All management objectives presented in this RSS derive from federal mandates, specific NPS management policies (Table 4), and/or best available science and scholarship. These objectives are wholly consistent with Joshua Tree National Park's 1995 *General Management Plan* (GMP) and 2011 *Foundation Statement*.

Furthermore, many potential activities described in this RSS do not require environmental impact analysis under NEPA. These include routine field observations and data analysis, non-destructive research and documentation, education, law enforcement, and administration. Other potential activities described here would require completion of environmental impacts analysis and a public involvement process before initiation. For activities with potential to affect historic properties the NPS would initiate a review of the undertaking under Section 106 of the NHPA before initiation. NPS staff at the park will follow *Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-Making*.

This document does not address all resource stewardship projects that could be undertaken at Joshua Tree NP, but instead focuses on a reasonable range of activities that could be implemented to promote specified management objectives. Implementation of the RSS will proceed within the capabilities of existing staff capacity and available funding.

The primary audience for this document is NPS staff charged with protecting the natural and cultural resources of Joshua Tree NP. However, the RSS guides management of the park as a whole with respect to resource protection, and therefore this document will also be useful for all NPS staff and partners at Joshua Tree NP. In addition, while the general public is not a primary audience for this document, the RSS is available via the park's website and upon request.

1.2 Development of the Strategy

The interdisciplinary development team for this document (Appendix A) began by considering the park's *fundamental resources and values*, as described in the park's *Foundation Statement* (2011a). NPS staff then assembled a current *status of knowledge* of the park's resources (Section 2.6 and Appendex B). Next, the team used these sources to describe components of the *fundamental resources and values* – or *attributes* – that should be managed or monitored in order to protect the park from degradation with respect to the park's purpose and significance (Sections 2.1 and 2.3). The team identified the laws and policies directing management of these resources in national parks (Section 3.1).

The team then described indicators of condition for a subset of these *attributes* (Section 3.2 and Table 5) and set quantitative measures to track the condition towards which these resources should be managed. These standards will also be used for describing the state of park resources to managers and the general public. Quantitative targets were only set when appropriate; not all resources lend themselves to quantitative indicators and/or targets.

The team then developed one or more broad management objectives for each *attribute*, based on science, scholarship, law, and policy (Table 4). The team described a set of potential activities that could be undertaken to achieve those objectives (Table 5 and Section 4.3). The team organized the potential activities into strategies, which consist of groups of activities that have implementation dependencies. Next, the team established a timeline for each strategy, depicting potential sequencing of all the activities within the strategy (Section 4.3).

In order to incorporate additional, related planning needs in this effort, the team also included wilderness character monitoring planning and climate change planning in the RSS development process. Additional information about these integration efforts can be found in Section 1.3 of this document.

1.3 Relationship of the RSS to Other Plans and Programs

This section describes the relationships between the *Resource Stewardship Strategy* and other planning efforts, reports, and programs.

1.3.1 General Management Plan

NPS *General Management Plans* (GMPs) establish indicators and standards related to visitor capacity of the park; define priorities and management direction for resource protection, research, and monitoring; and address the balance between visitor use and resource protection. Based on these standards, GMPs establish management zones within a park and prescribe desired conditions, a range of visitor experiences, and appropriate management activities for each zone reflecting the suitability of specific areas for specific public and administrative uses.

The *Foundation Statement* defines each park unit's *fundamental resources and values*. The *Foundation Statement* informs GMPs, program management plans such as the RSS, strategic plans, and implementation plans.

The timeline for the next GMP at Joshua Tree National Park has not yet been determined. When an updated GMP is complete for the park, the NPS will revisit and revise the RSS as necessary to ensure consistency with the direction established for resource protection. This *Resource Stewardship Strategy* tiers off the park's 2011 *Foundation Statement* and incorporates objectives embedded within the park's significance statements set out in that document. The RSS also incorporates knowledge of current resources conditions, trends, and threats described in the *Foundation Statement*.

While the *Foundation Statement* identifies significance statements for the park, the RSS provides more detail with respect to management objectives for park resources, consistent with the *Foundation Statement's* significance statements.

Some *fundamental resources and values* occur park-wide and will be managed consistently across the park rather than by management zone. The RSS structure does allow flexibility to define management objectives for both resources located in specific places (*e.g.*, macroinvertebrates in palm oases or historic structures within a cultural landscape) and park-wide resources (*e.g.*, dark night skies).

1.3.2 Other Plans Specific to Joshua Tree NP

In addition to an over-arching GMP, parks incorporate more specific planning objectives and actions under program, strategic, and implementation plans (Table 1). Where appropriate, information from existing plans has been incorporated into the RSS, and all potential activities described in this RSS are consistent with activities proposed in these plans.

Table 1. Joshua Tree National Park Program Planning Documents

Park Plan	Status	Notes
General Management Plan and Related Documents		
General Management Plan	Complete	1995 document
Foundation Statement	Complete	2011 document
Business Plan	Complete	2001 document
General Management Plan Update	TBD	
Program Management Plans		
Resource Management Plan	Complete	1996 document, 1999 update
Long Range Interpretive Plan	Draft	1999 draft
Fire Management Plan	Complete	2005 document, final review 2007, to be updated
Natural Resource Condition Assessment	In Progress	Completion expected 2014
Cultural Resource Condition Assessment	TBD	Tentatively scheduled for 2014/2015
Backcountry and Wilderness Management Plan	Complete	2000 document; amendment to the 1995 GMP
Mojave Desert Network Vital Signs Monitoring Plan	Complete	2008 document
State of the Parks	In Progress	Completion expected 2015
Strategic Plans		
Annual Implementation Plan (Park Strategic Plan 2008-2012)	Complete	2007 document
Implementation Plans		
Revised Recovery Plan for the Mojave Population of the Desert Tortoise	Complete	2011 U.S. Fish and Wildlife Service document
Black Rock Campground Rehabilitation Environmental Assessment	Complete	2012 document
Climate Friendly Action Plan	Complete	2010 document
Climbing Management Plan	Not started	Components included in 2000 Backcountry and Wilderness Management Plan
Oasis of Mara Management Plan	Complete	1995 document, needs update
Pinto Basin Road Environmental Assessment	Complete	2011 document
Keys Ranch Comprehensive Plan	Complete	2005 document
Raven Management Plan	Complete	2008 document
Museum Management Plan	Complete	2005 document
Scope of Collections Statement	Complete	2009 document
Archeological Overview and Assessment	Completed	2013 document
Joshua Tree Museum Collection Emergency Operation Plan	Complete	2006 document
Administrative History	In Progress	Planned completion in 2015

1.3.3 State of the Park Report

Joshua Tree National Park staff will be completing a *State of the Park Report* following publication of the RSS. This document will present a snapshot of the current condition of the park – including metrics reflecting the status of natural and cultural resources, visitor experiences, and facilities. The primary audience for this report will be the general public, but it will also be of use to lawmakers and NPS national, regional, and park staff. Many of the measures of resource condition presented in Table 5 will be incorporated into this *State of the Park Report*.

1.3.4 Natural and Cultural Resources Condition Assessments

Natural Resource Condition Assessments (NRCAs) and Cultural Resource Condition Assessments (CRCAs) evaluate current conditions for a subset of a park's resources. Focal study resources (and associated resource indicators and measures) are selected on a park-by-park basis, or for multiple parks with similar resources.

Each Condition Assessment (CA):

- Describes the park setting, natural and cultural resources, and selected resource management issues or concerns
- Identifies data gaps
- Provides analyses of current conditions (and trends, where possible) for the focal study resources, indicators, and measures
- Provides a holistic interpretation or summary of overall condition findings by park areas and/or by topics of management interest

CAs rely on existing scientific data and information from diverse sources, combined with expert and scholarly interpretations or syntheses of these data as the primary basis for developing condition findings. Successful CAs provide science-based information that is accurate, reliable, and useful to managers and partners. CAs are specifically designed to assist strategic planning and resource condition reporting by local park managers.

Ideally a CA should be complete, or nearly complete, prior to initiation of an RSS. The Joshua Tree NP NRCA is in progress but is not scheduled for completion until the fall of 2014. Work for the park's NRCA is being performed in conjunction with NRCAs for five other NPS units: Death Valley National Park, Lake Mead National Recreation Area, Manzanar National Historic Site, Mojave National Preserve, and Grand Canyon – Parashant National Monument.

The NRCAs for these six parks will focus on these resources and values:

- Land use
- Climate change
- Air quality
- Water availability
- Fire dynamics
- Distribution and dynamics of non-native invasive and native plants
- Desert bighorn sheep
- Desert tortoise
- Bats
- Feral burros
- Mule deer
- Sonoran pronghorn

The CRCA for Joshua Tree NP is tentatively scheduled for 2014 or 2015.

The NRCAs, the CRCAs and the RSS utilize similar tables to present indicators of condition, reference condition, and other information. However, since the CAs will be completed after the RSS, the next RSS update will need to revisit any measures, data, resource conditions, stressors (ben-

eficial and detrimental influences in the RSS), and management recommendations developed in the NRCA that may also be relevant to the RSS

1.3.5 Planning for Climate Change

NPS lands include large, relatively undeveloped areas with a broad representation of natural and cultural resources. Because of this, these lands provide managers, scholars, and researchers with unique opportunities to study and learn about the effects of human-accelerated climate change.

NPS staff at Joshua Tree NP have been at the forefront of planning for climate change within the National Park Service. In 2007, the NPS Climate Change Response Program conducted a climate change scenario planning workshop for Joshua Tree NP, the first of its kind in the NPS. Workshop participants reviewed climate data and models and derived three climate scenarios for the park (summarized in Appendix C). Building upon these plausible scenarios, workshop participants described a set of potential management actions, or "robust strategies" that NPS staff and their partners could implement to mitigate detrimental effects on natural and cultural resources and park facilities. In addition, workshop participants described robust strategies to educate park visitors about the impacts of climate change on the park. Results of that workshop are presented in more detail in Appendix C.

To minimize park operations' contribution to human-accelerated climate change, in 2010 NPS staff created a *Climate Friendly Action Plan* for Joshua Tree NP. This plan is a road map for reducing greenhouse gas emissions from park operations to below 2008 levels in the energy, transportation, and waste sectors.

Finally, in order to better understand which resources may be most impacted by changing temperature and hydrologic regimes, NPS staff have created a *Vulnerability Assessment* (Hoines et al., 2014) for natural resources at Joshua Tree NP. This analysis models current and probable future habitat needs and ranges of a large set of plant and animal species. The assessment will facilitate long-term monitoring to better evaluate how flora and fauna are responding to changing climate regimes.

1.3.6 Wilderness Character Preservation and Monitoring

Wilderness character is:

> . . . the combination of biophysical, experiential, and symbolic ideals that distinguishes wilderness from other lands (NPS, 2014).

The five following *qualities* of wilderness character, derived from the Wilderness Act of 1964, apply to all wilderness areas in the United States:

- **Natural quality**: wilderness ecological systems are substantially free from the effects of modern civilization.
- **Solitude or primitive and unconfined recreation quality**: wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.
- **Undeveloped quality**: wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation.
- **Untrammeled quality**: wilderness is essentially unhindered and free from the actions of modern human control or manipulation.
- **Other Features**: tangible features that provide scientific, educational, scenic, or historical value to the wilderness.

NPS policy requires all planning efforts which encompass federally-designated wilderness to call out actions for preservation of wilderness character. Policy also requires these efforts to identify a framework for monitoring the five qualities of wilderness character.

In order to incorporate wilderness character protection into the creation of this RSS, the development team – with support from a representative of the NPS Wilderness Character Integration Team – identified preliminary indicators and measures relevant to wilderness character monitoring. Where directly relevant to natural and cultural resources, these were incorporated into the RSS as *indicators of condition* (Table 5). All wilderness character indicators and measures are presented in a separate table (Appendix D). These indicators may help fill data needs for wilderness character monitoring, even though the associated data may not be spatially-restricted to wilderness lands. This RSS predates a *Wilderness Stewardship Plan* for Joshua Tree National Park Wilderness, therefore any of the preliminary indicators and measures presented in this document will be further refined and vetted through a public participation process during wilderness planning.

Wilderness character monitoring indicators described in this RSS fulfill partial requirements for developing *wilderness building blocks* for the park. *Wilderness building blocks* describe the fundamental information needed to effectively integrate wilderness character into park planning, management, and monitoring. Developing these building blocks is a requirement for all national park units encompassing designated wilderness and are a component of a wilderness stewardship plan. *Wilderness character narratives* are a component of *wilderness building blocks*; the RSS development team wrote these as a component of wilderness character integration into the RSS (Appendix D). These narratives can be shared with park staff and public to provide fundamental information about Joshua Tree National Park Wilderness.

1.3.7 Inventory and Monitoring Program

Understanding the condition of natural resources in national parks is key to fulfilling the NPS mission to manage park resources "unimpaired for the enjoyment of future generations" (NPS, 1916). The NPS has implemented the Inventory and Monitoring program (I&M) to provide rigorous, scientifically-based information on the status and trends of ecosystem metrics.

Under this program, the National Park Service organized park units into 32 networks to link parks with similar geographic and natural resource characteristics. Joshua Tree NP is included in the Mojave Desert Inventory and Monitoring Network (MOJN I&M), which also encompasses Death Valley National Park, Mojave National Preserve, Great Basin National Park, Manzanar National Historic Site, Grand Canyon-Parashant National Monument, and Lake Mead National Recreation Area.

The MOJN I&M program provides guidance, funding, and technical assistance for parks to complete a set of basic natural resource inventories. The program has finalized basic inventories for the following resources at Joshua Tree NP:

- Base cartography data
- Air quality data
- Air quality related values
- Climate inventory
- Water body location and classification
- Species occurrence and distribution
- Vegetation mapping inventory

The program has also completed a comprehensive natural resource bibliography. A geologic resources inventory and a soil resources inventory are in progress. Species lists are complete for birds, mammals, amphibians, reptiles, and fish assemblages. Recertification of the vascular plants species list is scheduled for completion in 2014.

In addition to completing basic inventories, the I&M program tracks trends in a set of "vital signs" or indicators of the overall health of natural resources as selected by network and park staff with input from subject matter experts. These vital signs and their selection are described in the program's *Vital Signs Monitoring Plan* (Chung-MacCoubrey et al., 2008). At present, network staff are developing detailed monitoring protocols for the following "vital sign" resources present at Joshua Tree NP:

- Upland vegetation and soils
- Arid land springs
- Selected large springs
- Riparian vegetation of selected large springs
- Riparian vegetation of arid land springs
- Invasive plant species early detection
- Weather and climate

These programs appear in this RSS as individual potential activities (Table 5) and are generally expected to continue with funding from the MOJN I&M Program.

1.3.8 Regional Cultural Resource Program Support

The chief of resources position at Joshua Tree NP fulfills the role of an integrated natural and cultural resource manager; however, the park has a cultural resource program manager,who reports to the chief of resources. The park's current museum curator manages the curatorial program at the park and serves as curator of record for the Mojave Desert Network. Park staff manages Joshua Tree NP archeology, history, and historic structure needs through positions in the cultural resource program as well.

The NPS Pacific West Region's cultural resource program provides assistance for cultural anthropology, cultural landscapes, historic structures, and landscape architecture. Regional staff are often consulted when projects require expertise; regional staff also comment on park compliance documents.

Joshua Tree National Park Resources and Values

This chapter provides an introduction to Joshua Tree National Park through the lens of natural and cultural resource stewardship. It reiterates the park's purpose, administrative history, significance, and interpretive themes. It also describes the park's *fundamental resources and values*, presents resource inventories, provides a brief assessment of the state of knowledge of park resources, and identifies resource stressors associated with climate change.

2.1 Park Purpose

Joshua Tree National Park preserves and protects the scenic, natural, and cultural resources representative of the Colorado and Mojave deserts' rich biological and geological diversity, cultural history, wilderness, recreational values, and outstanding opportunities for education and scientific study.

2.2 Abbreviated Administrative History

In the early 1920s, road development and homesteading laws prompted an influx of cactus poachers and land developers to the high desert lands north of Palm Springs, California. Recognizing the need to preserve the desert as a natural area, conservationists led by Minerva Hamilton Hoyt founded the International Deserts Conservation League. The League worked towards the goal of establishing parks to preserve desert landscapes. Minerva prepared a recommendation for setting aside more than a million acres across the Mojave and Colorado Deserts.

On August 10, 1936, President Franklin Roosevelt established the 825,000-acre Joshua Tree National Monument under authority of the Antiquities Act of 1906. This act authorized presidents to set aside land by proclamation to preserve areas with significant cultural resources. In 1950 Congress redrew the monument boundaries, reducing it to approximately 560,000 acres. The 1994 California Desert Protection Act reincorporated many of the lands withdrawn in 1950 and established Joshua Tree National Park. Today the park encompasses over 792,000 acres.

2.3 Park Significance

Significance statements express why the park's resources and values were important enough to warrant national park designation from Congress. Statements of the park's significance describe why the park is important within a global, national, regional, and system-wide context and are directly linked to the purpose of the park. A park's significance statements are substantiated by data or consensus and reflect the most current scientific or scholarly inquiry and cultural perceptions.

- Joshua Tree National Park preserves a world-renowned, undisturbed population of Joshua trees (*Yucca brevifolia*), an integral component of the Mojave Desert ecosystem.
- Outstanding examples of Mojave and Colorado Desert landscapes that converge at Joshua Tree National Park create a biologically rich system of plant and animal life characterized by iconic Joshua tree woodlands, native palm oases, and vast expanses of creosote (*Larrea tridentata*) scrub that are uniquely adapted to desert conditions. The park also contributes significantly to the connectivity of open lands and large protected areas across the California desert.
- Joshua Tree National Park provides accessible and diverse opportunities in a remote desert to large and burgeoning urban populations.
- Joshua Tree National Park preserves a rich array of prehistoric, historic, and contemporary resources that demonstrate the integral connection between desert ecosystems, land use, and human cultures.
- Joshua Tree National Park lies along one of the world's most active earthquake faults, the San Andreas Fault. Geologic processes, including tectonic activity, have played and continue to play a major role in shaping the mountains, valleys, and basins of the park.
- Joshua Tree National Park offers unparalleled opportunities for research of arid land ecosystems and processes, adaptations of and to desert life, sustainability, and indications of climate change. The proximity of the park to urban regions of Southern California and Nevada enhances its value for scientific research and education.
- Huge, eroded monzogranite boulder formations are world-renowned natural features that provide unique aesthetic, educational, and recreational opportunities for Joshua Tree National Park visitors.
- Geologic, climatic, and ecological processes create scenic landscapes unique to deserts and fundamental to the character of Joshua Tree National Park.

2.4 Primary Interpretive Themes

Primary interpretive themes connect park resources to relevant ideas, meanings, concepts, contexts, beliefs and values that are based upon park purpose and significance. They provide the foundation on which the park's educational and interpretive program is based. They support the desired interpretive outcome of increasing visitor understanding and appreciation of the significance of the park's resources.

- Joshua Tree National Park encompasses two desert ecosystems within its boundaries; the higher, cooler Mojave Desert in the northwestern portion of the park merges with the Colorado Desert, a region of the lower, warmer Sonoran Desert, creating an unusual ecological transition zone rich in desert biodiversity.
- The Joshua tree, with its iconic shape and adaptations, is a perfect species to help us understand the interdependence of organisms living in the desert; it is an important symbol and indicator species of the Mojave Desert. Other desert plants and animals, such as the desert tortoise (*Gopherus agassizii*), creosote bush (*Larrea tridentata*), and kangaroo rats (*Dipodomys* spp.), demonstrate creative solutions to the problems of desert survival.
- The park area has been occupied since the early Holocene period by Native American groups. Habitation and ceremonial sites, petroglyphs, and bedrock mortars remind us that human cultures can adapt successfully to life in a desert environment.
- Historic properties from the late 1800s through the 1960s offer evidence for the era of prospectors, miners, cattle ranchers, and homesteaders. These popular visitor destinations help depict the challenges of rural life in an arid environment. The industry and resourcefulness of desert homesteaders, such as the William F. Keys family, in this challenging desert environment provide a compelling view of the desert's past.
- Mountain ranges, desert basins, and massive rock outcrops were created by dynamic processes such as plate tectonics, volcanism, earthquakes, and erosion.
- Current human activity creates external and internal forces that influence Joshua Tree NP and present continuing challenges for balancing public use with resource preservation.
- Approximately 595,000 acres of designated wilderness make Joshua Tree National Park Wilderness one of the largest wilderness areas in southern California. The wilderness experience is characterized by both physical and intangible qualities such as solitude, freedom, isolation, refuge, and connection with nature. These qualities provide contrast to an increasingly urbanized regional landscape and emphasize the park's value.
- Joshua Tree's diverse desert landscapes provide internationally significant outdoor recreation opportunities to more than 1.3 million annual visitors
- Extensive granite outcrops, boulder piles, desert mountain ranges and canyons create a world-class destination for rock climbers as well as hundreds of miles of scenic trails for hikers and equestrians.
- The natural setting provides ideal conditions for campers, photographers, star gazers and explorers. The desert offers many lessons for those interested in outdoor learning and nature exploration.
- The park provides opportunities for quiet introspection, reflection, cleansing, nurturing and emotional healing. The ruggedness of the Joshua Tree landscape offers opportunities for physical exertion and the promotion of physical fitness and general well- being.
- The story of the park illustrates the ongoing struggle between forces reflecting different visions for the management of desert landscapes.

2.5 Fundamental Resources and Values

Fundamental resources and values (FRVs) are the systems, structures, processes, experiences, scenery, sounds, and other features key to achieving a park's purpose and maintaining its significance. These resources and values warrant primary consideration during planning and management because they are critical to achieving the park's purpose and maintaining its significance.

Joshua Tree National Park RSS *fundamental resources and values*:

- Biological diversity and healthy ecosystem function
- Interconnectivity of California desert lands
- Oases and other riparian areas
- Recreational opportunities and values
- Wilderness values and wilderness accessibility
- Ever-expanding knowledge base
- Opportunity to understand, apply, and share knowledge to benefit the park and beyond
- Geological resources and desert landforms
- Hydrological resources
- Night sky
- Clean and breathable air
- Soundscape
- Viewsheds
- Archeology (historic and prehistoric)
- Cultural anthropology
- History
- Historic structures
- Cultural landscapes
- Museum collections of archives, natural history specimens, and archeological artifacts

NPS staff and partners identified the park FRVs through a thorough review of the enabling legislation and legislative documents that direct National Park Service management activities at Joshua Tree National Park. The original FRVs that appear in the park's *Foundation Statement* were modified for the purposes of the *Resource Stewardship Strategy* to remove FRVs unrelated to resources management and provide better correspondence with law and policy that directs NPS resource stewardship (Appendix E).

Fundamental Resource/Value:

Biological Diversity and Healthy Ecosystem Function

Although to the casual visitor the desert appears to be an unchanging landscape, a closer look reveals a mosaic of dynamic ecosystems with varied habitats. As Joshua Tree National Park lies at the convergence of two deserts and near coastal ecosystems, a large variety of flora and fauna can be found in the park.

However, extreme winter and summer temperatures coupled with small amounts of rainfall limits the park's year-round inhabitants to those organisms whose life histories have adapted to survive seasonally extreme environments. Joshua Tree NP is home to upwards of 750 hardy native plant species that exhibit various mechanisms and/or life history traits to withstand extreme heat during the summer months. These desert plant species were largely the reason the park was set aside as a national monument in 1936.

The park also provides habitat for over 52 different species of mammals, 250 different species of birds, 75 species of butterflies, 25 species of snakes, and 18 species of lizards. Joshua Tree NP is inhabited by the iconic desert tortoise (*Gopherus agasizii*) and provides roughly 266,000 acres of tortoise habitat for the federally-listed threatened species.

A Mojave woodyaster (Xylorhiza tortifolia var. tortifolia) in bloom.

Fundamental Resource/Value:

Interconnectivity of California Desert Lands

Joshua Tree National Park's nearly 800,000 acres of land were set aside to protect the assembly of natural resources brought together by the junction of three of California's ecosystems – the Colorado Desert, the Mojave Desert, and the juniper/pinyon pine community of the Little San Bernardino Mountains.

The park links these three systems but also serves as a vital piece of the mosaic of protected lands spread across the California deserts, including lands managed by the Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), Department of Defense (DoD) as well as other National Park Service lands. Connectivity between large protected areas is vital for the long-term population viability of certain species, especially those with long-range movement such as bighorn sheep (*Ovis canadensis nelsonii*), mountain lion (*Puma concolor*) and bobcat (*Lynx rufus*). Transportation corridors, urban development and energy installations fragment the connectivity of these lands to varying degrees.

Desert bighorn sheep (Ovis canadensis nelsonii) at Barker Dam.

Fundamental Resource/Value:

Oases and Other Riparian Areas

Five desert fan palm oases and over 100 springs occur within Joshua Tree National Park. The presence of water in a desert landscape allows life to flourish and attracts high levels of wildlife and human use. A well known destination for bighorn sheep, coyote (*Canis latrans mearnsi*), mountain lion and many other species of wildlife, these verdant oases and a handful of springs are the only year-round dependable water sources in the park.

In addition, the oases have tremendous cultural resource significance due to their long history of human use. Some of the park's oases are well protected and unspoiled; others such as Cottonwood Spring and 49 Palms Oasis receive high visitation and associated impacts.

California fan palm (Washingtonia filifera) and Fremont cottonwood (Populus fremontii) at Cottonwood Spring Oasis.

Fundamental Resource/Value:

Recreational Opportunities and Values

In 2011, 1,396,237 people visited the park. Visitation is often concentrated at popular sites such as the Oasis of Mara, the Wonderland of Rocks, and Keys View, although many visitors venture out beyond these areas into the nearly 800,000 acres of expansive desert. Joshua Tree National Park provides accessible and diverse recreational opportunities in a desert environment.

The topographic relief and fluctuations in temperature draw visitors to the park year-round, as each season offers a different experience. Many visitors prefer spring visits for biological events such as bird migration and the wildflower bloom, combined with pleasant temperatures for hiking, sightseeing, and taking in long, dramatic views.

The old mines, mills, ranches, and interpreted prehistoric rock art sites are destinations for visitors drawn to the park's cultural resources.

Boulders and rock outcrops in the park offer some of the best rock climbing in the world. Climbers from novice to expert travel from around the world to test their skills on climbing routes in Joshua Tree NP. Protecting these park resources from overuse and recreational impacts is a management priority.

Hikers near Cottonwood Spring Oasis.

Fundamental Resource/Value:

Wilderness Values and Wilderness Accessibility

Solitude, dark night skies, quiet, and expansive views reward the exploring visitor who wanders beyond the main roads into Joshua Tree Wilderness.

The congressionally designated Joshua Tree Wilderness comprises approximately seventy-five percent of Joshua Tree National Park. Between the original wilderness designation in 1976, the lands added through the California Desert Protection Act of 1994, and through the passage of public law P.L. 111-11 in 2009, an additional 80,000 acres was added. Joshua Tree Wilderness currently totals 595,364 acres, with 70,557 acres of potential wilderness and 402 acres of proposed wilderness. Collectively, 84% of the park is designated, proposed or potential wilderness.

Rock climbers, hikers, and overnight backpackers are regulars here. The park's wilderness provides opportunities for primitive recreation and solitude in wild settings. Wilderness access is limited to hikers as no motorized equipment is permitted.

A view of Joshua Tree Wilderness with the Wonderland of Rocks in the distance.

Fundamental Resource/Value:

Ever-expanding Knowledge Base

Joshua Tree National Park seeks to increase the knowledge base across multiple academic disciplines. The park offers unparalleled opportunities for research of arid land natural and cultural resources. The park is improving inventory and monitoring efforts, data management, research, and communication among the Mojave Desert Network parks. Many researchers work collaboratively with park staff to improve efficiency and effectiveness of projects. This also facilitates an improved transfer of information from researchers to the park.

A view of Saddle Rock from Ryan Mountain.

Fundamental Resource/Value:

Opportunity to Understand, Apply, and Share Knowledge to Benefit the Park and Beyond

The relatively undisturbed lands of the park offer visitors and students opportunities to experience Mojave and Colorado Desert plant communities; visit 19th and early 20th century structures associated with the ranching and mining days; study native fauna, and more. Resource education and outreach through interpretive messages, programs, media, and displays broaden the visitor experience and convey knowledge beyond park boundaries. Joshua Tree National Park serves as a classroom for educators, non-profit organizations, tribes, communities, families, and individuals.

A California barrel cactus (Ferocactus cylindraceus) in bloom.

Fundamental Resource/Value:

Geologic Resources and Desert Landforms

Joshua Tree National Park sits along one of the world's most active earthquake fault zones, the San Andreas Fault, and is located along two geologically-diverse mountain ranges. Geologic processes, including tectonic activity, have played and continue to play a major role in shaping the mountains, valleys, and basins of the park.

The natural fluvial processes of the southwestern United States have also shaped distinct landscapes across the park. The park provides a world-class laboratory for understanding these geological processes and offers a world-renowned rock climbing area. In addition, the park's unusual geology, particularly its monzogranite formations, provides some of the park's most iconic viewsheds.

A view of monzogranite formations in the northwestern portion of the park.

Fundamental Resource/Value:

Hydrological Resources

Joshua Tree National Park lies in a desert region of Southern California with limited water resources. Freshwater sources occur at springs, wells, oases, and seeps. Springs flow from fractures and joints in the bedrock. Desert fan palm oases often occur along fault lines, where uplifted layers of low permeability rock force underground water to the surface.

There are three artificial impoundments in the park: Barker Dam, Cow Camp, and Keys Lake. These artificial impoundments are historic structures associated with early ranching activities. The park also has a limited number of artificial watering devices (guzzlers) in various states of working condition that were built last century with the intention to support wildlife; many of these are located in areas now designated as wilderness. Management of these devices is under review.

The NPS seeks to fill information gaps regarding water quality and quantity in the park, as internal and external land uses may threaten park aquifers.

A Student Conservation Association intern measures depth-to-water at Howard's Well.

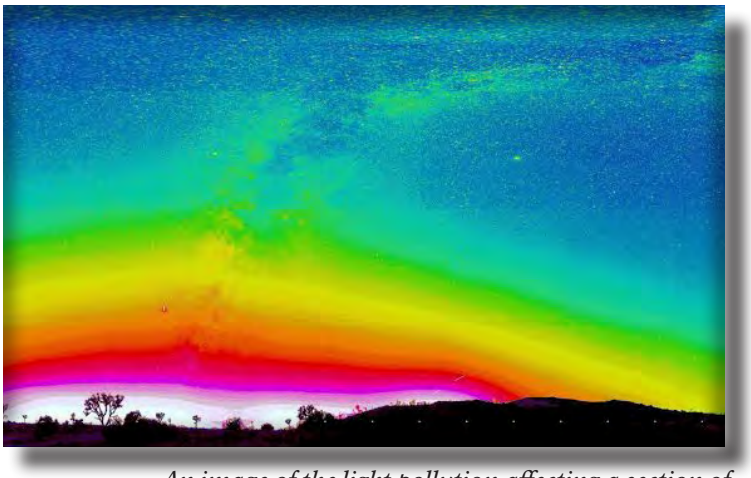
Fundamental Resource/Value:

Night Sky

The park is a dark-sky refuge from nearby urban areas and provides excellent night sky viewing opportunities for visitors. However, certain areas of the park are experiencing increased light pollution from urban development both nearby (the Coachella Valley, San Bernardino/Riverside, the Morongo Basin) and farther afield (Las Vegas and the Greater Los Angeles area).

Currently, the least impacted area of the park for night sky darkness is the eastern half of the park. This area is also the most threatened, due to large-scale renewable energy development. Poorer dark night sky conditions exist in communities near the western end of the park.

The park encourages local governments to implement and enforce lighting ordinances that contribute to the protection of the dark night sky. Park managers continue collaboration and education with surrounding developments and local governments to protect the dark sky within and beyond park boundaries. San Bernardino County has enforced ordinances; 29 Palms and Yucca Valley have ordinances; and ordinances in Coachella Valley are in development.



An image of the light pollution affecting a section of night sky looking south from Keys View. Different colors represent different levels of luminance; pictured here are portions of strong luminance, or skyglow, emanating from the Coachella Valley and Los Angeles.

Fundamental Resource/Value:

Clean and Breathable Air

Although the park is protected as a Class I airshed under the Clean Air Act - the highest protection afforded by this legislation - air quality at Joshua Tree National Park is compromised by population growth and development (power plants, transportation, construction, etc.) of surrounding urban areas. These sources release dust, particulates, and smog that blow into the park and impact visibility. The Los Angeles metropolitan area, with a population of over 18 million, is the major contributor of ozone that reaches the park. This area is also a major contributor to elevated levels of nitrogen oxides, volatile organic compounds and other pollutants. These pollutants adversely impact both human health and sensitive vegetation and wildlife.

The Environmental Protection Agency (EPA) sets stringent levels of protection for air quality, but Joshua Tree NP consistently exceeds the ozone concentration levels. Ongoing research and monitoring programs measure multiple indicators of air quality within the park.

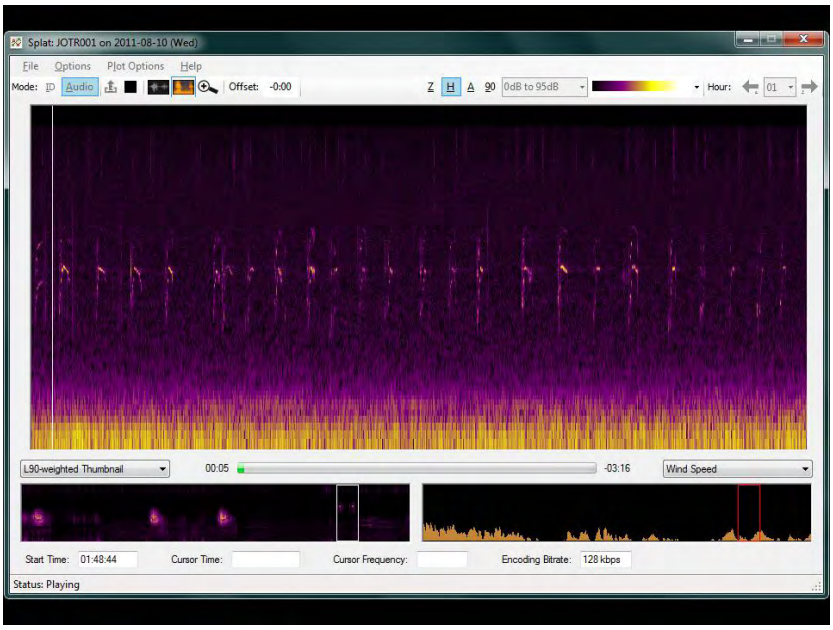
A view from Belle Mountain looking southeast, taken by the park's air-quality monitoring webcam in July 2013.

Fundamental Resource/Value:

Soundscape

The naturally quiet soundscapes found at Joshua Tree National Park are pristine in comparison to soundscapes found in nearby urban areas. The farther the visitor moves away from the main road, the quieter the environment becomes as modern noise fades away.

However, the park's natural soundscapes are impacted by modern developments that are decreasing areas of natural quiet. Military activities, commercial airlines, and excessive mechanical noise produced within and adjacent to the park degrade the natural soundscape. Impact to the acoustic environment may affect multiple components of the ecosystem and the visitor experience.



A screenshot of the Sound Pressure Level Annotation Tool used by NPS staff to analyze soundscapes at Joshua Tree National Park. This image shows a spectrograph of a coyote howl (faint yellow lines, center) against the wind (yellow "fuzz", bottom). This tool can be used to document noise disturbance generated by such activities as commercial overflights and large-scale developments adjacent to the park.

Fundamental Resource/Value:

Viewsheds

Visitors are often lured to the desert by extensive views of panoramic landscapes. On extremely clear days, Signal Mountain in Mexico is visible from the mile-high vantage point of Keys View. Keys View scenic vista also provides panoramic views of the Coachella Valley, Salton Sea, Santa Rosa Mountains, and San Gorgonio Mountain.

The park's dramatic vistas are a primary attraction and are essential to visitors' enjoyment. However, air quality affects visibility, which can seasonally obscure views and viewsheds. In addition, views from the perimeter of the park that look towards adjacent lands are transforming; human habitation and other developments (i.e. large-scale renewable energy installations) are becoming more conspicuous across the landscape.

A view of the Little San Bernardino Mountains near the West Side Loop Trail in Joshua Tree Wilderness.

Fundamental Resource/Value:

Archeology (historic and prehistoric)

Joshua Tree National Park contains a diverse set of archeological resources, including prehistoric, ethnographic and historic-era sites. Prehistoric archeological resources include seasonal camps, rock-shelters, milling sites, lithic and ceramic scatters, and rock art sites. A few prehistoric archeological sites are associated with the Pinto Culture, one of the earliest prehistoric cultures found in the California desert (8,000 to 10,000 years old). Three main archeologically significant time periods are represented within the park: Lake Mohave-Pinto, Saratoga Springs, and Protohistoric. Four ethnographic Native cultures are associated with the land area in and around Joshua Tree NP: the Cahuilla, Serrano, Chemehuevi, and Mohave Indians.

Historic archeology sites include roads, trails, artifact scatters, dams, homesteads, temporary camps, mines, and mills. Joshua Tree NP has five historic sites that are actively interpreted by the park and represent important ranching, mining, milling, and homesteading sites of late 1800s through early 1900s California: Lost Horse Mine and Mill, Ryan Ranch, Keys Ranch, Wall Street Mill, and Barker Dam. Other historic sites are located throughout the park, and are typically associated with ranching, mining, and homesteading.

A Pinto point from the Joshua Tree National Park Museum Collection.

Fundamental Resource/Value:

Cultural Anthropology

Cultural anthropology identifies and describes the origins, history, and development of human culture, especially its social forms and institutions. There are several sites and resources at Joshua Tree National Park that remain traditionally significant to Native American tribes associated with the park. These associations are links to living traditions and cultures. For example, some of the park's oases were cultivated; leaves of palm trees were used for baskets and canes were used to make arrows.

Conducting oral histories and collaborative projects with the park's associated tribal groups documents cultural and historical memory, fill gaps in the historical record, and incorporates the perspectives of diverse people into park management and interpretation. Interviews have been conducted with local homesteaders and their descendants as well as with tribal elders to document significant Native American cultural perspectives.

A collection of Cahuilla baskets from the Joshua Tree National Park Museum Collection.

Fundamental Resource/Value:

History

A rich history preserved through time demonstrates the integral connection between deserts, changing land use, and human cultures. Historic uses of what would later become park lands included cattle ranching, homesteading, prospecting, mining and processing of gold ore and construction of roads and trails. Historic inhabitants dug wells, constructed windmills, constructed dams, and built cabins and outbuildings. Many mine shafts, adits, camps, roads, trails, cairns, and mills remain on the landscape.

When the land became a National Monument in 1936, the National Park Service began to develop park infrastructure. Mission 66 construction (1945-1972) was the largest single organized effort to develop park units, adding a great deal of infrastructure to the park, including campgrounds, various roads and trails, entrance signs and two visitor centers.

While two of General Patton's World War II training camps are just outside of the park, there are many visible remains of training in the park, such as tank tracks, exploded ordinance, target ranges, and ammunition cans.

Remains of the Colorado River Aqueduct construction include a large concrete water catchment pond, small camps and dumps, and large earth debris piles.

The Oasis of Mara, circa 1889.

Fundamental Resource/Value:

Historic Structures

The NPS manages 140 structures at Joshua Tree National Park that are listed on the national *List of Classified Structures* (LCS). These historical features have been evaluated and determined to contain historical and architectural significance. Most park structures on the LCS have also been either listed or determined eligible for listing on the National Register of Historic Places.

The following examples represent structures common to Joshua Tree NP: habitation, storage sheds, walls, fences, wells, dams, roads, trails, cairns, tanks, stamp mills, and arrastras. Many mining and ranching structures associated with Joshua Tree NP remain on the landscape. In addition to the sites listed in the Archeology section, other sites include Moorten's Mill, Eagle Cliff, Henson's Well and Mill and Hexahedron Mine.

The black smith shop and other historic structures at Desert Queen Ranch.

Fundamental Resource/Value:

Cultural Landscapes

A cultural landscape is:

> "a geographic area, including both natural and cultural resources and the wildlife and/or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values." (NPS, 1998a)

Cultural landscapes also examine circulation networks, including roads and trails, which tie areas together.

Joshua Tree NP contains at least four cultural landscapes: Keys Ranch Historic District, Hexie Mountains Mining Historic District, Northern Piñon Mining District and Lost Horse Mining Historic District. The NPS is currently researching the National Register eligible Southern Piñon Mountain Historic Mining District; the district will likely be updated to a National Register eligible landscape in 2014.

Historic artifacts and structures in the Keys Ranch Historic District.

Fundamental Resource/Value:

Museum Collections of Archives, Natural History Specimens, and Archeological Artifacts

The museum and archival collection at Joshua Tree National Park provides on-site examples or documentation of park resources.

The museum collection houses scientific specimens and associated records (reports, images, correspondence, and other information) as well as artifacts and records related to historic, archeological and traditional sites. The collection as a whole serves as documentation for resource inventories, environmental monitoring and impact studies, interpretation, and research, and is mostly accessed by employees and researchers. The collections illustrate the story of the park, its environment, and the people who have inhabited its lands.

Specimens from the Joshua Tree National Park Museum collection. Clockwise, from top-left: Short-tailed black swallowtail (Papilio indra), American painted lady (Vanessa virginiensis), California sister (Adelpha californica), and sleepy orange (Vanessa cardui).

2.6 Status of Knowledge of Park Resources

In order to identify management objectives and describe potential activities for promoting those objectives, NPS managers sought to better understand the state of the park's resources and the status of the knowledge of those resources. As part of this process, the team identified inventories that have been completed to date for the park.

2.6.1 Status of Knowledge Summary

The table below summarizes the status of knowledge for each *fundamental resource and value*. Where appropriate, FRVs have been subdivided into *attributes* to better illuminate strengths and gaps in knowledge of particular park resources. This table was completed by NPS subject matter experts based on professional judgment.

The experts evaluated the degree of knowledge or adequacy for the following categories:

- **Research:** the degree to which park managers and their partners have conducted research to evaluate or better understand resources.
- **Inventory:** the degree to which park managers and their partners have documented where, what kind, and how many of this resource exists within park boundaries.
- **Monitoring:** the degree to which park managers and their partners have initiated and are conducting qualitative or quantitative monitoring to better understand the condition of the resource now and into the future.
- **Documentation:** the degree to which park managers and their partners have completed records pertaining to cultural resources and collected data relevant to National Register of Historic Places eligibility.

For evaluating the status of research, inventory, monitoring, and documentation, park managers reported whether current knowledge or level of adequacy is high (•••), moderate (•), or low ( ). Documentation is only applicable to cultural resources. Other instances where a category is not applicable for the resource attribute are denoted with n/a. These ratings are relative to each other within and between resource attribute and categories.

Park managers also compiled a narrative and short bibliography (Appendix B) to provide more information about the status of knowledge for each FRV.

Table 2. Status of Knowledge of Park Resources and Values (Summary)

Fundamental Resources and Values	Research	Inventory	Monitoring	Documentation
Fundamental Resource: **Biological diversity and healthy ecosystem function**				
Joshua trees and Mojave desert flora	•	•	•	
Juniper woodlands		•		
Transition zone communities				
Colorado desert flora				
Native plants	•	•••		
Fire regimes	•	•••	•	
Desert tortoise	•	•••	•	
Desert bighorn sheep	•	•		
Golden eagles and raptors		•		
California treefrog	•	•••	•	
Bat species		•		
Wildlife assemblages				
Fundamental Resource: **Interconnectivity of California desert lands**				
Migration corridors beyond Joshua Tree NP	•	•		
Migration corridors within Joshua Tree NP	•	•		
Fundamental Resource: **Oases and other riparian areas**				
Human connections with riparian areas				
Spring, oasis, and riparian habitat	•	•		
Species dependent on riparian habitat				
Fundamental Resource: **Recreational opportunities and values**				
Visitor use				
Hiking, climbing, bouldering, slack lining and related activities				
Vehicle use on unpaved roads				
Camping				

Fundamental Resources and Values	Research	Inventory	Monitoring	Documentation
Fundamental Resource: **Wilderness values and wilderness accessibility**				
Wilderness character	•	•		
Fundamental Resource: **Ever-expanding knowledge base**				
Research	•	•		
Fundamental Resource: **Opportunity to understand, apply, and share knowledge to benefit the park and beyond**				
Data quality and quantity				
Fundamental Resource: **Geological resources and desert landforms**				
Geologic resources		•		
Desert landforms		•		
Fundamental Resource: **Hydrological resources**				
Surface water	•	•	•	
Groundwater				
Fundamental Resource: **Night sky**				
Light pollution impacts originating from outside park boundaries		•		
Night sky within park boundaries		•		
Fundamental Resource: **Clean and breathable air**				
Air quality	•	•	•••	
Fundamental Resource: **Soundscape**				
Natural quiet beyond park boundaries			•	
Natural quiet within park boundaries			•	
Fundamental Resource: **Viewsheds**				
Views beyond park boundaries				
Views within park boundaries				

Fundamental Resources and Values	Research	Inventory	Monitoring	Documentation
Fundamental Resource: **Archeology (historic and prehistoric)**			•	
Fundamental Resource: **Cultural anthropology**		n/a	n/a	
Fundamental Resource: **History**			n/a	•
Fundamental Resource: **Historic structures**	•	•		•
Fundamental Resource: **Cultural landscapes**	•	•	•	•
Fundamental Resource: **Museum collections**				
Museum collection information availability		•	•	•
Finding aids, catalogs, and online resources				
Collection facility, storage, and exhibit materials				
Museum objects and specimens, archives, and library materials				

2.6.2 Natural and Cultural Resource Inventories and Studies

While considering the status of knowledge of park resources, the RSS team also conducted an assessment of completed and in-progress resource inventories and studies. These are presented in Table 3 below.

The table reports coverage/comprehensiveness, status, and data quality. Column headings in the table represent:

- **Inventory or Document -** this table is not organized by *fundamental resources and values* or by *attribute*, as are other tables in this document. Natural resources are organized by physical and biological resource types. Cultural resources are grouped according to discipline.
- **Coverage/Comprehensiveness -** depending on the resource type, this percentage varies slightly -
  - Air quality, weather and climate, and water quality monitoring programs – proportion of planned programs that are operational.
  - Soils, geology, digital elevation, fuel model classification – completeness of the inventory.
  - Biological inventories – completeness of the park's species list, with the exception of inventories for threatened and endangered species.
  - Threatened and endangered species – completeness of inventories of suitable habitat and other important baseline information needed for management of these species in the park.
  - Cultural resource documents – how much of the document has been completed.
  - Archeological surveys – acres of the park that have been surveyed.
  - Nominations for the National Register of Historic Places – completeness of the nomination.
- **Status:**
  - Needed – no current resource inventory or document exists for this resource.
  - Draft – inventory data or document is in draft form and is close to complete.
  - In progress – inventory is ongoing, currently underway, or inventory has been started and has at least minimal effort ongoing annually.
  - Incomplete – inventory was initiated and terminated, limited by funding, or completed to the level specified in a research project but not applicable to report on as a park wide inventory. This could also indicate research that has been conducted and is useful but out of date.

- Complete – inventory or document is complete and park staff are satisfied with the level of current information and consider the information useful for management.

- **Data quality:**

  - 1 – data are reliable, relevant, useful to management, conducted by a researcher or a professional, and represent a high quality data set.

  - 2 – data provide relevant information that is useful to park management, but some gaps exist.

  - 3 – data exist but datasets may be older, no recent inventories have been conducted, data exist from visitor or staff sightings only, or data are not as reliable as 1 and 2 to park managers.

  - 4 – data do not exist or inventory is currently being developed, data are not reliable or useful to park managers, data may have large information gaps, questionable methods.

Table 3. Inventories and Documentation for Natural and Cultural Resources

Inventory or Documentation	Coverage and Status		Data Quality	Notes
Physical resources				
Digital elevation model	100%	Complete	1	
Fuel model classification	0%	Needed	2	Two potential fuel models exist for the Mojave Desert. Each of the models can provide useful information but they require regular updates to reflect current conditions and seasonal dynamics.
Geology and Paleontology	98%	In Progress	1	Conducted by the USGS (Geology) and San Bernardino County Musem (Paleontology).
Natural resources bibliography	90%	In Progress	2	NRBib for Joshua Tree NP has been reviewed; a few citations are still missing.
Soils	95%	In Progress	2	Field work completed; report still needed.
Dark night sky	60%	In Progress	1	Two more sampling locations needed.
Soundscape	2%	In Progress	1	Currently only on eastern area of park; interior of the park needs to be inventoried.
Water quality	5%	Needed	2	
Water resources	100%	Complete	2	Water body location and classification inventories are complete.
Weather and climate	25%	In Progress	1	Another station needed. MOJN I&M climate inventories are complete.
Air quality	80%	In Progress	1	Four air quality/weather and climate stations are operational in the park year-round as of 2014, but a total of five stations would provide comprehensive, park-wide monitoring.
Springs and oases	100%	Complete	1	
Visual resources	0%	Needed		
Biological resources				
Federal/state rare, threatened or endangered plant species	90%	In Progress	1	A project to map populations, identify genetic markers, and establish baseline seed germination and ecology for both federally listed plants in the park is underway. Ongoing ad hoc mapping of state listed species and monitoring of populations continues as time and funding permits.
California native plant society-listed species	75%	In Progress	2	Locality of 30 species is known.
Federal/state rare, threatened or endangered animal species (desert tortoise)	90%	In Progress/ Ongoing	1	Line distance transects in addition to historic datasets provide robust understanding of desert tortoise populations and trends.

Inventory or Documentation	Coverage and Status		Data Quality	Notes
Species of special concern (bighorn sheep, burrowing owl, California treefrog)	70%	In Progress/ Ongoing	2	Multiple surveys and numerous research projects have been completed on bighorn sheep. California treefrogs are located in fewer locations than has been documented historically and a reintroduction program is underway. Habitat modeling is planned for the park's species of special concern once datasets for these species are robust enough for analysis.
Lichens	95%	In Progress/ Ongoing	1	An annotated checklist is in final draft.
Mosses and bryophytes	100%	Complete	1	An annotated checklist is in final draft.
Vascular plants	95%	In Progress/ Ongoing	1	An annotated checklist will be published in 2013/2014. Continuation of vascular plant inventories needed.
Vegetation map	99%	Complete	1	Completed in 2013.
Butterflies	90%	In Progress	2	Joshua Tree NP has hosted an annual springtime butterfly count beginning in 1995.
Other arthropods, including riparian aquatic invertebrates	Unknown (estimate <25%)	In Progress	3	Data is limited in nature and collection has been undertaken on an ad hoc basis through external researchers. The most recent invertebrate inventories have been undertaken by a cooperative study between Copper Mountain College and the Smithsonian as well as short-term citizen-science based bio-blitz style surveys that focus on riparian areas. More thorough park inventories of various families are needed for a complete invertebrate species list.
Land birds	100%	Complete	2	New species added to the list with every revision. However, the majority of additions are rare vagrants to the area.
Mammals	100%	Complete	1	
Raptors	100%	Complete	1	
Riparian aquatic vertebrates species (frogs, toads, fish)	100%	Complete	1	
Reptiles	100%	Complete	1	
Bats	80%	In Progress/ Ongoing	1	Majority of work with bats has been related to NPS mine management.

Inventory or Documentation	Coverage and Status		Data Quality	Notes
Archeological resources				
Survey and documentation	<4% of lands inventoried; 75% of reports completed	Ongoing/ Needed	3	Most of the large surveys are outdated and/ or inadequate. There is a backlog of survey reports that need to be completed and/ or edited, archived, and distributed.
Archeological site documentation	3%	Ongoing	2	All sites located during surveys have been recorded (800). There are many reliable data points in the park's Geographic Information System (GIS) database for cultural resources found by park staff or partners that are not recorded. An estimate of sites in the park, based on a random inventory of vegetation zones, is 24,000.
Archeological sites management information system database entry	100%	Ongoing	1	All 800 recorded sites are entered into the ASMIS database with required fields completed.
Archeological overview and assessment	100%	Complete	1	2013 document.
Cultural resource base maps	80%	In Progress	2	
History				
Administrative history		In Progress		Due to be completed fall 2015.
Historic resource study	100%	1983, 2009	2	Greene (1983) provides information for monument lands; this information is out of date but work was done to high standards. Hardesty (2006) provides information for new park lands; this work could be more thorough.
Cultural landscapes				
Keys Ranch Historic District cultural landscape inventory	100%	Complete	1	Determined Eligible to the National Register.
Hexie Mountain Mining Historic district cultural landscape inventory	100%	Complete	1	Determined Eligible to the National Register.
Northern Piñon Mining District cultural landscape inventory	100%	Complete	1	Determined Eligible to the National Register.
Lost Horse Mining Historic District cultural landscape inventory	100%	Complete	1	Determined Eligible to the National Register.

Inventory or Documentation	Coverage and Status		Data Quality	Notes
Southern Piñon Mining Distrct cultural landscape	60%	In Progress		To be completed end of 2014.
Cultural landscape reports	0%	Needed		The potential cultural landscapes noted in Hardesty's report need to be assessed.
Historic structures				
Historic structures report	0%	Needed		Report needed for Keys Ranch.
List of Classified Structures	100%	Complete		Everything that is determined to be eligible in the park has been added to the LCS database. More structures may be added as Cultural Landscape Inventories are completed.
Historic American Buildings Survey (HABS)/Historic American Engineering Reports (HAER)	100%	Complete		Reports completed for Lost Horse Gold Mill, Desert Queen Ranch, Wall Street Gold Mill
Museum collections				
Catalog of archeological and museum objects (ICMS)	85%	In progress/ ongoing	2	Conversion of paper records into electronic cataloging database.
Collection condition survey	100%	Complete	1	Cyclic in nature.
Museum management plan	100%	Complete	2	2005 document. Needs update.
Collection management report	100%	Complete	2	Annual report.
Scope of collections statement	100%	Complete	1	2009 document.
Housekeeping plan	100%	Complete	1	Needs update.
Integrated pest management plan	100%	Complete	1	Needs update.
Emergency response plan	100%	Complete	1	
Fire plan	100%	Complete	1	
Cultural anthropology				
Traditional use study for rock art	20%	Incomplete	2	Existing study (Deur, 2006) focused exclusively on rock art.
Traditional use study for everything other than rock art	0%	Needed	2	Archival materials and releases do not exist.
Ethnographic overview	100%	Complete	2	
Ethnobotany study	75%	Incomplete	4	Needs photographs, final edit, and printing/publishing.

Inventory or Documentation	Coverage and Status		Data Quality	Notes
Traditional cultural property study for Oasis of Mara	20%	Incomplete	4	Interviews with tribes are in various stages of completion.
Traditional cultural property study for Queen Mountain	20%	Incomplete	4	Interviews are with tribes and in various stages of completion.
Determinations of eligibility for the National Register of Historic Places				
Barker Dam (CA-RIV-9427)	100%	Complete	1	Listed in 1975 as a structure. Included in the eligible Keys Ranch Historic District Cultural Landscape.
Cow Camp	100%	Complete	1	Listed as a district in 1975. Included in the eligible Keys Ranch Historic District Cultural Landscape.
Desert Queen Mine	100%	Complete	1	Listed in 1976 as a district. Included in the eligible Northern Pinon Mining District Cultural Landscape.
Keys Desert Queen Ranch (CA-SBR-762/h)	100%	Complete	1	Listed as a district in 1975. Included in the eligible Keys Ranch Historic Cultural Landscape.
Ryan Ranch and Lost Horse Well (CA-RIV-4942/h)	100%	Complete	1	Listed as a district in 1975. Included in the eligible Lost Horse Mining Historic District Cultural Landscape.
Wall Street Mill (CA-12131/h)	100%	Complete	1	Listed as a building in 1975. Included in the eligible Northern Pinon Mining District Landscape.
Eagle Cliff Mine (CA-RIV-7308h)	100%	Complete	1	Determination of Eligibility (DOE) 1993. Also part of Northern Pinon Mining District Landscape.
New Eldorado Mine and Mill (CA-RIV- 9345h)	100%	Complete	1	DOE 1993. Part of Hexie Mountain Mining Historic District Cultural Landscape.
Pinto Wye Arrastra (CA-RIV-4663h)	100%	Complete	1	DOE 1993.
Lost Horse Mine and Mill (CA-RIV-4901h)	100%	Complete	1	DOE. Part of Lost Horse Mining Historic District Cultural Landscape.
Twentynine Palms Oasis (CA-SBR-2052/h)	25%	Complete	3	DOE. 1971 nomination is badly in need of an update. Location is mis-mapped.
Cottonwood Spring Oasis (CA-RIV-2049/h)	80%	Complete	3	DOE. 1971 nomination is badly in need of an update.
CA-RIV-92	100%	Complete	1	DOE. Includes archeological testing.
CA-RIV-346	100%	Complete	1	DOE. Includes archeological testing.
Cap Rock (CA-RIV-1959)	100%	Complete	1	DOE. Includes archeological testing.
Red Lady (CA-RIV-902)	100%	Complete	1	DOE. Includes archeological testing.

2.6.3 Status of Knowledge of the Changing Environment

Resources and resource management in Joshua Tree NP will continue to be strongly affected by conditions and changes that occur outside park boundaries. Of the many changes, park staff and partners have identified air pollution, climate change, and land use intensification (including habitat conversion) as important drivers of change and/or constraints to management responses.

Air quality is a valued park resource (see Appendix B, Section B.11) considered to be in poor condition (Table 5) due to exceedances of standards for ozone, particulates, and nitrogen. Ozone levels have exceeded the national standard every year at some location in the park (U.S. Environmental Protection Agency, 2013). Nitrogen deposition is of particular concern because of its interactions with other ecosystem processes (Rao and Allen, 2010; Rao, Allen, & Meixner, 2010). Human-enhanced nitrogen deposition has been found to contribute to invasions of nonnative annual grasses at Joshua Tree NP. Modeling indicates that this deposition has reached levels in some areas of the park that may increase fire risk by stimulating the growth of invasive grasses that can form a continuous fuel layer capable of carrying fire (Rao et al., 2010). Tonnesen, Wang, Omary, & Chien (2007) documented the gradient of anthropogenic nitrogen in southern California, including the Joshua Tree area. To date, all large fires in the park have occurred in areas of the park estimated to receive at least four kilograms of nitrogen per hectare per year. Figure F.4 in Appendix F illustrates the complicated history of fire and nitrogen deposition at Joshua Tree NP. Many shrub species in the park are not fire adapted and their relative cover and density are dramatically reduced by fire. These systems were shown to recover along a successional trajectory, yet even 65 years after wildfire, vegetation diversity and composition was not comparable to unburned levels of adjacent stands (Vamstad & Rotenberry, 2010). Preliminary, unpublished data from the park show repeat burning is converting shrublands into an exotic grass-dominated system.

Joshua Tree NP has already experienced a significant increase in temperatures and projections from global circulation models are consistent in forecasting further temperature increases for the foreseeable future (Gonzalez, 2012; Kunkel et al., 2013). During the past century average temperatures have increased by about 1° C (Appendix C) and the 21st century projected rate of increase is about 4° C per century for moderate-emission scenarios. Kunkel et al. (2013) estimate about half this increase – about 2° C – will occur by mid-century. These projected changes will eventually affect virtually every natural resource in the park, including the iconic Joshua tree (Cole et al., 2011 and Barrows & Murphy-Mariscal, 2012) and other species found throughout the park (Barrows, 2009).

Maintenance of biodiversity in the park depends on connectivity between habitats both within and outside park boundaries (Hansen et al., 2011). Developments along high-speed transport corridors to the northwest and southwest of Joshua Tree NP pose barriers to species movements, inhibiting access to habitat outside of the park (Figure F.1, Appendix F). Furthermore, since the 1970s, housing densities in these areas have increased from generally rural to exurban. Demographic projections forecast that by 2050 these areas will be heavily suburban. This land use intensification will precipitate habitat loss, fragmentation and loss of connectivity, increased colonization and spread of invasive species, and increased disturbance to ecosystems and species (Monahan, Gross, Svancara, & Philippi, 2012). The first climate change response identified by Barrows (2009) is to maintain connectivity to regions outside the park – a goal that will be increasingly challenged by land uses outside park boundaries.

Management Objectives and Activities

This chapter lays out management objectives for Joshua Tree National Park's *fundamental resources and values* identified in Chapter 2. Management of natural and cultural resources of a unit of the National Park System is guided by a wealth of mandates from national law, Presidential Executive Orders, and departmental and agency policies. In addition to specific mandates from law and policy, NPS management policy guidance calls for management of natural and cultural resources in accordance with best available science and scholarship.

The RSS team considered potential activities that the NPS and its partners could undertake to promote those objectives. Concurrently, the team determined performance measures that could be used to evaluate the success of activities and/or indicators of condition that could be measured to evaluate the status of resources relative to the objective. These are presented in Table 5.

3.1 Management Objectives Based on Law and Policy

The following table presents management objectives, organized first by *fundamental resource and value* and then by *attributes* within those broad categories. The table also identifies the law and policy that underpins each management objective.

Many laws and policies provide overarching mandates to natural and cultural resources management, and are therefore not repeated again in the table below. These include:

- The National Environmental Policy Act of 1970, as amended
- National Historic Preservation Act of 1966, as amended
- NPS Director's Order 28: Cultural Resource Management Guidelines
- NPS Director's Order 77: Natural Resources Inventory and Monitoring
- NPS Reference Manual 77, Natural Resource Management Guidelines
- Secretary of the Interior Order 3289, Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources

Table 4. Management Objectives Based on Law and Policy

FRVs and Attributes	Objectives	Relevant Law and Policy
Biological diversity and healthy ecosystem function		
Joshua trees and Mojave Desert flora (and associated fauna)	Understand and minimize threats to Joshua trees within park	• **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
	Improved knowledge of trends in Joshua tree distribution and resilience to environmental change	
Juniper woodland, Mojave mid-elevation mixed desert scrub, and California mesic north-slope chaparral biotic communities	Improved knowledge of trends in distribution of this community and resilience to environmental change	• **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
	Improved knowledge of plant/animal/microorganism interactions in west-park higher elevation habitat, and potential novel plant/animal associations emerging there	
Colorado Desert and transition zone communities	Increased knowledge of community structure, distribution and trends of Colorado Desert flora	• **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
Native plants	All known populations of rare, threatened and endangered plants stable or increasing; high quality habitat; human impacts on rare plant populations minimized	• **Federal Noxious Weed Act of 1974** • **National Invasive Species Act of 1996** • **Executive Order 13112,** Invasive Species • **NPS Management Policies 2006,** Section 4.4, Biological Resources Management • **NPS Management Policies 2006,** Section 4.4, Biological Resources Management
	Native plant communities resilient; non-native plant richness and abundance declining	
	Improved knowledge and documentation of plant communities and species	
	Improved knowledge of ecosystem adaptation in the park	
	Improved knowledge of phosphorous deposition from fire retardant use and effects on plant communities	

FRVs and Attributes	Objectives	Relevant Law and Policy
Fire Regimes	Minimal impacts to native flora and fauna from perturbed fire regime	• **NPS Director's Order 18,** Wildland Fire Management • **Reference Manual 18, Wildland Fire Management** • **NPS Management Policies 2006,** Section 4.5, Fire Management • **NPS Management Policies 2006,** Section 4.4.2.3, Management of Natural Landscapes • **NPS Management Policies 2006,** Section 4.4, Biological Resources Management
Desert tortoise	Improved knowledge of abundance and distribution of desert tortoise in the park Minimization of impacts to tortoises from human activities	• **Federal Endangered Species Act of 1973** and amendments • **Desert Tortoise Recovery Plans of 1994 and 2011** • **NPS Management Policies 2006,** Section 4.4.2.3, Management of Threatened or Endangered Plants and Animals • **NPS Management Policies 2006,** Section 4.1.4, General Management Concepts, Partnerships • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
Desert bighorn sheep	Improved understanding of range and metapopulation structure of desert bighorn sheep Minimal disturbance to bighorn sheep from park visitors at selected locations	• **NPS Management Policies 2006,** Section 4.4, Biological Resources Management • **NPS Management Policies 2006,** Section 4.1.4, General Management Concepts, Partnerships • **NPS Management Policies 2006,** Section 4.2, Studies and Collections • **NPS Management Policies 2006,** Section 1.6, Cooperation Beyond Park Boundaries

FRVs and Attributes	Objectives	Relevant Law and Policy
Golden eagles and raptors	Minimal disturbances to eagle and raptor nesting from recreation activities	• **Bald and Golden Eagle Protection Act 1940** • **Migratory Bird Treaty Act 1918** • **NPS Management Policies 2006,** Section 4.4, Biological Resources Management • **NPS Management Policies 2006,** Section 4.1.4, General Management Concepts, Partnerships • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
	Improved understanding of impacts of development near park boundaries on raptors and eagles	
California treefrog	Maintenance, where possible, of California treefrog in historically-occupied habitat, with demonstrated success	• **NPS Management Policies 2006,** Section 4.4.1.1, Plant and Animal Population Management Principles • **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
Bat species	High quality natural and artificial habitat for bats	• **NPS Management Policies 2006,** Section 4.4.1.1, Plant and Animal Population Management Principles • **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
Wildlife assemblages	Improved understanding of trends in bird species richness in park	• **NPS Management Policies 2006,** Section 4.4, Biological Resources Management • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
	Improved understanding of reptile and amphibian species richness in park	
	Increased knowledge on native and non-native invertebrate species diversity and interactions	

FRVs and Attributes	Objectives	Relevant Law and Policy
Interconnectivity of California desert lands		
Migration corridors that extend beyond Joshua Tree National Park	Improved connectivity for vertebrate species via migration corridors extending out from park boundaries	• NPS Management Policies 2006, Section 3.2, Land Protection Methods • NPS Management Policies 2006, Section 3.3, Land Protection Plans
	Protected habitat with minimal impacts to park biota from activities originating outside park boundaries	
Migration corridors within Joshua Tree National Park	Improved understanding of migration corridors within park boundaries and regionally	• **NPS Management Policies 2006,** Section 4.3.6, Special Designations, Biosphere Reserves • **NPS Management Policies 2006,** Section 3.4, Cooperative Conservation • **NPS Management Policies 2006, S**ection 1.6, Cooperation Beyond Park Boundaries • **NPS Management Policies 2006,** Section 4.1.4, General Management Concepts, Partnerships
Oases and other riparian areas		
Human connections with springs, oases, and riparian areas	Improved understanding of human connections and traditional associations with spring, oasis, and riparian areas and transportation routes between these water sources	• **NPS Management Policies 2006,** Section 5.3.5.2.6, Land Use and Ethnographic Value

FRVs and Attributes	Objectives	Relevant Law and Policy
Spring, oasis, and riparian habitat	Aquatic plant and animal habitat is maintained or improved to support all native life and natural processes	• **Federal Clean Water Act of 1972 and amendments** • **Federal Endangered Species Act of 1973 and amendments** • **NPS Management Policies 2006,** Section 4.6, Water Resource Management • **NPS Management Policies 2006,** Section 4.4, Biological Resources Management • **NPS Director's Order 77-1,** Wetland Protection • **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals
	Improve management of selected oases	
Species dependent on riparian habitat	Increased knowledge of species dependent on aquatic and riparian habitat	• **NPS Management Policies 2006,** Section 4.4.2, Management of Native Plants and Animals • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
Recreational opportunities and values		
Visitor use	Increased understanding of the impacts of recreational activities to natural and cultural resources	• **NPS Management Policies 2006,** Section 8.2, Visitor Use
Hiking, climbing, bouldering, slack lining and related activities	Appropriate recreational opportunities consistent with the park's purpose and values, without unacceptable impacts	• **NPS Management Policies 2006,** Section 8.2, Visitor Use
Vehicle use on unpaved roads		• **NPS Management Policies 2006,** Section 8.2, Visitor Use
Camping		• **NPS Management Policies 2006,** Section 8.2, Visitor Use

FRVs and Attributes	Objectives	Relevant Law and Policy
Wilderness values and wilderness accessibility		
Wilderness character	Joshua Tree National Park Wilderness – including physical resources, intangible values, and wilderness character qualities – protected, preserved, and access maintained	• **Wilderness Act of 1964 as amended** • **Wilderness Designations for Joshua Tree National Park (1976- PL 94-567, 1994 PL 103-433, and 2009 PL 111-11)** • **Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character (2008)** • **NPS Wilderness Stewardship Plan Handbook (2014)** • **NPS Director's Order 41,** Wilderness Preservation and Management • **NPS Management Policies 2006,** Section 6, Wilderness Preservation and Management • **NPS Management Policies 2006,** Section 6.4.3.1, Recreational Use Evaluation • **Keeping it Wild in the National Park Service,** a user guide to integrating wilderness character into park planning, management and monitoring

FRVs and Attributes	Objectives	Relevant Law and Policy
Ever-expanding knowlege base		
Research	Research activities in the park further park management goals and scientific understanding	• **NPS Director's Order 11B,** Ensuring quality of information disseminated by the National Park Service • **NPS Management Policies 2006,** Section 5.1, Research • **NPS Management Policies 2006,** Section 4.2, Studies and Collections • **NPS Management Policies 2006,** Section 4.3.6, Special Designations, Biosphere Reserves • NPS Management Policies 2006, Section 4.7.2, Weather and Climate • NPS Management Policies 2006, Section 4.1.2, Natural Resource Information
	Improved understanding of changing climate and its impact on park natural and cultural resources and development of adaptive management strategies	
	Appropriate data storage and access	
Opportunity to understand, apply, and share knowledge to benefit the park and beyond		
Data quality and quantity	Improved quality and quantity of information provided by the NPS to the public and partners about park natural and cultural resources	• **NPS Management Policies 2006,** Section 5.1, Research • **NPS Management Policies 2006,** Section 4.2, Studies and Collections

FRVs and Attributes	Objectives	Relevant Law and Policy
Geological resources and desert landforms		
Geological resources	Joshua Tree NP boulders and rock formations are protected from human caused alteration while natural processes are allowed to occur	• **NPS Management Policies 2006,** Section 4.8.2, Management of Geologic Features • **NPS Management Policies 2006,** Section 4.2, Studies and Collections • **Omnibus Public Land Management Act (OPLMA) of 2009, Public Law 111-011, Title VI, Subtitle D on Paleontological Resources Preservation** • **NPS Management Policies 2006,** Section 4.8.2.1, Management: Paleontological resources and their contexts
	Improved understanding of tectonic processes of the park in order to integrate knowledge into operations, planning, and interpretation for park visitors	
	Paleontological resources protected, preserved and managed for resource education, science, and interpretation	
	Improved understanding of paleontological deposits in the context of climate change	
Desert landforms	Improved understanding of processes that create desert landforms	• **NPS Management Policies 2006,** Section 4.8.2, Management of Geologic Features • **NPS Management Policies 2006,** Section 4.2, Studies and Collections
Hydrological resources		
Surface water	Impoundments managed for wildlife use, wildlife viewing, cultural resources management and safety and so as to minimize negative impacts to other park values and resources	• Federal Clean Water Act of 1972 and amendments • NPS Management Policies 2006, Section 4.6.1, Protection of Surface Waters and Groundwater • NPS Management Policies 2006, Section 4.6.6, Watershed and Stream Processes • NPS Management Policies 2006, Section 9.1.5.1, Water Supply Systems
	Improved understanding of trends in quantity and quality of surface water	
	Improved understanding of locations and trends in springs, including interannual variability	

FRVs and Attributes	Objectives	Relevant Law and Policy
Groundwater	Increased knowledge of local and regional groundwater hydrology	• **Federal Clean Water Act of 1972 and amendments** • **NPS Management Policies 2006,** Section 4.2, Studies and Collections • **NPS Management Policies 2006,** Section 4.6.1, Protection of Surface Waters and Groundwaters • **NPS Management Policies 2006,** Section 9.1.5.1, Water Supply Systems • **NPS Management Policies 2006, S**ection 7.1, Interpretive and Education Programs
	Human use of groundwater resources in the park minimized	
	Resource education promoting better understanding of water for human consumption	
Night sky		
Light pollution impacts originating from outside park boundaries	Decreased light pollution emanating from sources outside of park boundaries, as feasible	• **NPS Management Policies 2006**, Section 4.10, Lightscape Management • **NPS Management Policies 2006,** Section 4.1.4, General Management Concepts, Partnership • **NPS Management Policies 2006,** Section 1.6, Cooperative Conservation Beyond Park Boundaries
Night sky within park boundaries	Natural darkness maintained and light pollution minimized within park boundaries	• **NPS Management Policies 2006,** Section 4.10, Lightscape Management
Clean and breathable air		
Air quality	Air quality protected in the park and neighboring lands; trends in air quality condition understood	• **Federal Clean Air Act of 1970 as amended** • **NPS Management Policies 2006,** Section 4.7, Air Resource Management • **NPS Management Policies 2006**, Section 3.4, Cooperative Conservation
	Park staff collaborate with surrounding communities and agencies to minimize air pollution	

FRVs and Attributes	Objectives	Relevant Law and Policy
Soundscape		
Natural quiet beyond park boundaries	Soundscapes relatively unimpacted by anthropogenic sources from beyond park boundaries	• **NPS Director's Order 47,** Sound Preservation and Noise Management • **NPS Management Policies 2006,** Section 4.9, Soundscape Management • **NPS Management Policies 2006,** Section 5.3.1.7, Cultural Soundscape Management • **NPS Management Policies 2006**, Section 3.4, Cooperative Conservation
Natural quiet within park boundaries	Soundscapes relatively unimpacted by anthropogenic sources from within park boundaries	• **NPS Director's Order 47,** Sound Preservation and Noise Management • **NPS Management Policies 2006,** Section 4.9, Soundscape Management • **NPS Management Policies 2006,** Section 5.3.1.7, Cultural Soundscape Management • **NPS Management Policies 2006**, Section 3.4, Cooperative Conservation
Viewsheds		
Views beyond park boundaries	Scenic views and integral vistas preserved for vistas extending beyond the park boundaries	• **NPS Management Policies 2006,** Natural Resource Management, Section 4.7, Air Quality • **NPS Management Policies 2006,** Section 4.1.4, General Management Concepts, partnership • **NPS Management Policies 2006**, Section 3.4, Cooperative Conservation
Views within park boundaries	Scenic views and integral vistas within boundaries of Joshua Tree NP preserved	• **NPS Management Policies 2006,** Natural Resource Management, Section 4.7, Air Quality

FRVs and Attributes	Objectives	Relevant Law and Policy
Archeology (historic and preshistoric)		
Archeology	Increased knowledge of the human past at Joshua Tree NP through adequate research, field work, recording and evaluation to the National Register	• **Archaeological Resources Protection Act of 1979** • **Secretary of the Interior Standards for Archeology and Historic Preservation** • **NPS Management Policies 2006**, Section 5.1, Research • **NPS Management Policies 2006,** Section 5.3.5.1, Archeological Resources • **Programmatic Agreement among the National Park Service, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation (2008)**
	Prehistoric and historic archeological sites professionally inventoried and recorded and evaluated for the National Register	
	Prehistoric and historic archeological sites preserved, protected and monitored for future research (and possibly limited interpretation of these sites)	
Cultural anthropology		
Cultural Anthropology	Improved understanding and relationship with traditionally associated peoples in the region and respect their traditional practices	• **American Indian Religious Freedom Act of 1978** • **NPS Management Policies 2006,** Section 1.11, Relationship with American Indian Tribes
History		
History	Comprehensive knowledge of the history of the region and the park	• **NPS Management Policies 2006,** Section 5.1, Cultural Resources Research • **NPS Management Policies 2006,** Section 4.1.4, Partnerships • **NPS Management Policies 2006,** Section 5.2.2, Agreements
	NPS relations with historians, historical organizations, academic, other governmental agencies, and descendants of homesteaders maintained	

FRVs and Attributes	Objectives	Relevant Law and Policy
Historic structures		
Historic Structures	Protect historic structures and their character defining elements that may contribute to the listing or eligibility for listing on the National Register of Historic Places or provide for public enjoyment	• **Historic Sites Act of 1935** • **National Historic Preservation Act of 1966** • **Secretary of the Interior's Standards for Guidelines for Archeology and Historic Preservation** • **Secretary of the Interior's Standards for the Treatment of Historic Properties** • **NPS Management Policies 2006,** Section 5.3.5.4, Historic and Prehistoric Structures • **NPS Management Policies 2006,** Section 5.1.3.2.1, National Register Nomination • **Programmatic Agreement among the National Park Service, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation (2008)**

FRVs and Attributes	Objectives	Relevant Law and Policy
Cultural landscapes		
Cultural Landscapes	Improved understanding of the historic integrity, significance, landscape characteristics, and features associated with ranching, homesteading and mining	• **Secretary of the Interior Standards for the treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes** • **NPS Management Policies 2006,** Section 5.3.5.2, Cultural Landscapes • **NPS Management Policies 2006,** Section 4.4.2.4, Management of Natural Landscapes • **Advisory Council on Historic Preservation's implementing regulations regarding the Protection of Historic Properties**
	Integrity of character and interrelationships between the structures and their historic setting maintained	
Museum collections of archives, natural history specimens and archeological artifacts		
Museum collection information availability	Museum collection maintained and readily accessible and researchable while maintaining NPS standards for preservation and use	• **Management of Museum Properties Act of 1955** • **Archaeological Resources Protection Act of 1979** • **Native American Graves Protection and Repatriation Act** • **NPS Director's Order 24, Museum Collections Management** • **NPS Management Policies 2006,** Section 5.3.5.5, Museum Collections • **NPS Management Policies 2006,** Section 4.1.2, Natural Resource Information
Finding aids, catalogs and online resources	Park collection searchable via finding aids and significant collection materials digitized for access	• **Management of Museum Properties Act of 1955** • **NPS Director's Order 24,** Museum Collections Management • **NPS Management Policies 2006,** Section 5.3, Museum Collections
Collection facility, storage and exhibit materials	Museum collection storage and exhibit facilities maintained to full National Park Service standards	• **NPS Museum Handbook (2010)**

3.2 Measures of Resource Condition and Potential Activities

The following table was developed as one of the primary components of the RSS to illustrate a strategic process to improve the condition, management, or understanding of park resources:

- Moving from broad *fundamental resource and values* and *management objectives* toward establishment of condition or performance measures;
- Identifying potential activities to meet *management objectives*;
- Setting preferred condition or performance targets; and
- Providing a reporting field (Table 5: Target Met column).

The structure of the table facilitates resource managers' ability to extract and/or update pertinent condition and management information regarding a specific resource.

To evaluate the current status of resources relative to management objectives and evaluate progress toward meeting objectives, the RSS team linked selected *attributes* to measurable indicators of resource condition, or condition indicators, when appropriate. Indicators of condition allow park managers to directly report on resource condition now and in the future. Indicators were selected by park cultural and natural resource specialists and subject matter experts, through expertise and by current research and indices.

Measures, condition/trend information and condition targets are displayed within the same row as their respective condition indicators and are only reported on when information is available. Condition indicator rows are highlighted in Table 5 with a blue background. Activities that are related to condition indicators are displayed underneath that condition indicator row; groups of activities related to particular condition indicators are delineated from non-related activities by solid, bold black lines drawn across the table.

Managers currently only report on resource condition, measures, condition/trend, and rationale, or those resources that have accurate and up-to-date baseline data and/or are resources that are already being monitored. For many resources, this information does not exist, and the RSS team could not establish condition indicators. Establishing indicators of condition also requires effort and funding for tracking metrics reflecting condition. For many specific activities, setting quantitative or semi-quantitative indicators of condition was not realistic (*e.g.*, one time performance based activities such as "establish a monitoring program"). For these, the RSS team also described a performance measure – that is a measure to identify the success of management efforts. Many performance measures, once accomplished, may provide sufficient information or data to establish an appropriate condition measure for that resource.

The RSS team identified potential activities that the NPS and its partners could undertake to promote the management objectives. Each potential activity is labeled with a unique code.

The RSS team identified eight types of potential activities:

- **Research:** NPS conducts a one-time effort to gather information to assess the need for monitoring, management, and resource education and to design such efforts as needed.

- **Inventory:** NPS conducts a one-time effort to determine the extent, type, abundance, and location of the resource.
- **Documentation:** NPS completes records pertaining to cultural resources and collects data relevant to their eligibility for the National Register of Historic Places.
- **Monitoring:** NPS monitors resource condition. The NPS may have limited or no ability to affect change in the resource, but needs to track trends in order to manage other park resources. Alternatively, no management is needed at present because current status is acceptable, but ambient monitoring will provide early warning of unacceptable change in order to trigger appropriate management.
- **Direct management:** NPS manages resource directly to achieve or trend towards desired status. NPS monitors results of management. Many resource management activities require initial project specific assessments, inventories, and/or environmental compliance.
- **Administrative management:** NPS promotes objective through collaboration, planning, and policy response. NPS monitors results of management.
- **Resource education:** NPS promotes the objective through targeted communication with visitors, NPS staff, and partners. This may include enforcement of park resource-protection regulations or development of resource education materials.
- **Collaboration:** NPS works with other federal agencies, local agencies, stakeholders, educators, Tribes, associated groups, researchers, and/or institutions to promote resource management goals.

Often research, inventory, documentation, and monitoring activities must be completed before appropriate direct management, administrative management, resource education, or collaboration can be described in detail. However, in many cases the NPS must take action based on best available science and scholarship, law or policy, without waiting for more detailed information.

The RSS team established performance targets for all performance measures. However, the team only established condition targets for the subset of condition indicators where sufficient information was available. In addition, for some resources, managing towards a target may not be relevant with changing conditions or climate; in those cases, a condition target was not set. The "target met" column provides a place for evaluation of whether or not a condition or performance target has yet been attained.

As a final step, all potential activities were ranked by subject matter experts and the RSS team as high, medium, or low; this is the final column in the table and follows the "target met" column.

Many of these activities are actions that park staff have already described and requested funding for, others are ongoing actions, and others have not yet been implemented in any form. For many of the resource objectives, the park requires an initial inventory or study in order to refine management objectives. Similarly, for management objectives for which level of achievement is unknown, the team may have proposed further monitoring or study. For other objectives, where resource knowledge is adequate to begin direct action, the team proposed very specific resource management activities.

The RSS team established performance targets for all performance measures but established condition targets for a subset of

the condition indicators. In many cases, not enough information was available to establish condition targets, and in some cases, managing towards a target value may not be appropriate in light of evolving conditions and interrelationships associated with rapid climate change.

Table 5. Potential Activities and Condition Indicators

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Biological diversity and healthy ecosystem function									
Joshua trees and Mojave Desert Flora (and associated fauna)	Improved knowledge of trends in Joshua tree distribution and resilience to environmental change	**Condition Indicator:** Joshua trees	**Condition Measure:** Density of Joshua tree individuals at multiple life stages (e.g., adult, seedling, subadult) and spatial extent (acreage) of each life stage	2013: Current condition unknown, likely deteriorating, high confidence			**Condition Target:** n/a - no direct management actions will be taken, only monitoring as of 2013		
		Performance Measure: Implementation of Joshua tree monitoring program		n/a	**BIO1**	**Monitoring:** Monitor Joshua tree abundance, reproductive success, associated temperature regimes, fire extent, and invasive species in Joshua tree woodlands	**Performance Target:** Repeat monitoring once every five years	2013: Development of monitoring program in-progress	H
		Performance Measure: Initiation/facilitation/completion of research projects on Joshua tree genetics		n/a	**BIO2**	**Research:** Investigate Joshua tree genetics and demographic trends and gain better understanding of the diversity of Joshua tree genetics across the species' range	**Performance Target:** Research complete and management implications for Joshua tree populations understood	2013: Not started	L
		Performance Measure: Initiation/facilitation/completion of research projects on Joshua tree reproduction		n/a	**BIO3**	**Research:** Investigate and communicate relationship between Joshua tree reproduction, pollinators, and other connected species	**Performance Target:** Research complete and management implications for Joshua tree populations understood	2013: Not started	M
	Understand and minimize threats to Joshua trees within park	**Condition Indicator:** Non-native annual grasses in Joshua tree woodlands	**Condition Measure:** Total area of Joshua tree woodlands infested with non-native annual grasses	2013: Unknown, but condition likely stable or deteriorating (i.e. levels of infestation in Joshua Tree woodlands stable or increasing)			**Condition Target:** <5% total cover of non-native grasses per acre in Joshua tree woodlands by 2030 Total decrease in fuel loads as contributed by non-native grasses	2013: No, ongoing invasives work needed	
		Performance Measure: # hours dedicated to control non-native grasses in Joshua tree woodland; # acres treated		n/a	**BIO4**	**Direct management:** Control non-native annual grasses associated with Joshua tree stands in order to minimize threats from fire	**Performance Target:** Ongoing control program in place; equvilant of 1 FTE (EPMT, staff, intern, and volunteer) dedicated to control non-native grasses	2013: Partial, ongoing	H
		Performance Measure: # fire breaks established and maintained around core Joshua tree stands		n/a	**BIO5**	**Direct management:** Establish and maintain fire breaks to protect Joshua tree stands (e.g., remove non-native grasses to create breaks)	**Performance Target:** X # fire breaks established and maintained covering X acreage	2013: Not started	M
		Condition Indicator: N-Deposition in Joshua tree Woodlands	**Condition Measure**: No standard set; possible metric could be annual difference between naturally occuring deposition vs. anthropogenically generated deposition	2013: Unknown			**Condition Target:** n/a - while no direct management actions can be taken, installing and maintaining comprehensive N deposition monitoring stations would be an action the park can/should take.		
		Performance Measure: Facilitation/continuation of research on N deposition		n/a	**BIO6**	**Research:** Investigate sources and timing of N deposition and other airborne pollutants and impacts on native flora, including Joshua trees	**Performance Target:** Research complete; appropriate management actions taken, thresholds for unacceptable damage better understood	2013: Partial; some external research has been completed	H
		Performance Measure: Initiation/facilitation/completion of research on Joshua trees post fire		n/a	**BIO7**	**Research:** Investigate techniques to restore Joshua tree stands post-fire	**Performance Target:** Research completed and available for application in Joshua tree restoration post-fire	2013: Not started	L

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Juniper woodlands/ Mojave Mid Elevation Mixed Desert Scrub, and/or California Mesic North Slope Chaparrel biotic communities	Improved knowledge of trends in distribution of Juniper woodlands/ Mojave Mid Elevation Mixed Desert Scrub, and/or California Mesic North Slope Chaparral and resilience of these communities to environmental change	**Condition Indicator:** Representative tree species assemblage of Juniper woodlands/ Mojave Mid Elevation Mixed Desert Scrub, and/or California Mesic North Slope Chaparral	**Condition Measure:** Tree species richness, population abundance and reproductive success.	2013: Unknown			**Condition Target:** As of 2013: n/a - no direct management actions taken, but long-term goal of persistent tree species assemblages in this community		
		Performance Measure: Design and implementation of monitoring program for high elevation woodland		n/a	**BIO8**	**Monitoring:** Track trends in abundance and reproductive success of pinyon/manzanita/oak communities, and associated temperature regimes, fire extent, invasive species	**Performance Target:** Monitoring designed and implemented in 18 locations by 2014 and trends understood in abundance and cover and community composition within selected stands for these species	**2014:** Monitoring at nine vegetation macroplots commenced; plans for 18 more macroplots in place for 2015/2016.	H
		Performance Measure: Initiation/facilitation/completion of research on vegetation and response to N deposition		n/a	**BIO9**	**Research:** Investigate direct and secondary vegetation responses to N deposition and other airborne pollutants (e.g., responses of non-native plants, pinyon pine, manzanita, and oaks)	**Performance Target:** Research completed and knowledge used to understand thresholds for unacceptable damage	2013: Partial; some external research has been completed	M
	Improved knowledge of plant/animal/microorganism interactions in west-park higher elevation habitat communities (i.e. Juniper woodlands/ Mojave Mid Elevation Mixed Desert Scrub, and/or California Mesic North Slope Chaparral), and potential novel plant/animal associations emerging there	**Condition Indicator:** Microfauna in west-park	**Condition Measure:** Presence / Absence or species richness	2013: Unknown			**Condition Target:** n/a - no direct management action taken as of 2013		
		Performance Measure: Initiation/facilitation/completion of microfauna inventory		n/a	**BIO10**	**Inventory:** Inventory microfauna associated with higher elevation plant communities, i.e. Juniper woodlands/ Mojave Mid Elevation Mixed Desert Scrub, and/or California Mesic North Slope Chaparral	**Performance Target:** Inventory completed in collaboration with external partners by 20XX	2013: Not started	M
		Condition Indicator: Microbial community composition in west-park	**Condition Measure:** TBD	2013: TBD			**Condition Target:** n/a - no direct management action can be taken		
		Performance Measure: Design and implementation of microbial community monitoring program		n/a	**BIO11**	**Monitoring:** Investigate potential shifts from a fungal to bacterial driven microbial community in Juniper woodlands/ Mojave Mid Elevation Mixed Desert Scrub, and/or California Mesic North Slope Chaparral, and track trends in plant and animal associations	**Performance Target:** Monitoring program designed and implemented and management implications understood	2013: Not started	M
Transition zone communities	Increased knowledge of community structure, distribution and trends of Colorado Desert flora	**Condition Indicator:** Composition of transition zone communities	**Condition Measure:** Presence and abundance of representative transition zone species	2013: Unknown			**Condition Target:** n/a - no direct management action taken as of 2013		
		Performance Measure: Design of native plant communities monitoring program		n/a	**BIO12**	**Monitoring:** Track trends in the distribution and species composition of plants/animals/mircobial communities in the Mojave/Colorado Deserts transition zone	**Performance Target:** Monitoring designed and implemented in 18 locations by 2014 and trends understood in abundance and cover and community composition within selected stands for these species	**2014:** Monitoring at nine vegetation macroplots commenced	H
Colorado Desert Flora (and associated fauna)	Increased knowledge of community structure, distribution and trends of Colorado Desert flora	**Condition Indicator:** Ocotillo *(Fouqiueria splendens)*	**Condition Measure:** Density and spatial extent of Ocotillo	2013: Unknown; possibly susceptible to drought (but low confidence)			**Condition Target**: n/a - no direct management action taken as of 2013		
		Performance Measure: Design of Ocotillo monitoring program		n/a	**BIO13**	**Monitoring:** Track trends in Ocotillo abundance (as representative of a larger plant community) and migration	**Performance Target:** Monitoring designed and implemented in 18 locations by 2014 and trends understood in abundance and cover and community composition within selected stands for these species	2014: Monitoring at nine vegetation macroplots commenced; plans for 18 more macroplots in place for 2015/2016.	H

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Number and extent of high-priority non-native Colorado Desert plant species	**Condition Measure:** Species richness, areal extent of highly-infested area	2013: Unknown			**Condition Target:** As of 2013: Multiple priority targets for the Colorado desert. Zero tolerance for species anticipated to invade the park in the future, such as buffle grass (*Cenchrus ciliaris*). Hold the line strategy for plants we already have, such as Sahara Mustard (*Brassica tournefortii)* . Limit the spread of species like Sahara Mustard within the park and push it back where we can	2013: Partial, ongoing invasives work needed	
		Performance Measure: # hours dedicated to control non-natives in Colorado desert; # acres treated		n/a	**BIO14**	**Direct management:** Control high-priority non-native Colorado Desert plant species	**Performance Target:** Ongoing control program in place; equivalent of 0.5 FTE (EPMT, staff, intern, and volunteer) dedicated to control non-native species in the Colorado desert portions of JOTR	2013: Yes, ongoing.	M
Native plants	All known populations of rare, threatened and endangered plants stable or increasing; high quality habitat; human impacts on rare plant populations minimized	**Condition Indicator:** Populations of federally listed plant species	**Condition Measure:** Distribution/Abundance	2013: Species present			**Condition Target:** No direct management actions as of 2013, but longterm goal of stable or increasing populations of two federally-listed rare plant species		
		Performance Measure: Initiation/facilitation/continuation of research on federally listed plant species		n/a	**BIO15**	**Research:** Improve knowledge of two federally-listed plant species, including mapping populations, identifying genetic markers, establishing baseline seed germination and ecology studies	**Performance Target:** Research investigating population, life history and ecological characteristics completed; monitoring program designed and implemented	2013: Partial, In-progress	H
		Performance Measure: Completion of management plan		n/a	**BIO16**	**Administrative management:** Complete management plans for federally listed plant species (including addressing how to minimize human impacts, e.g., N deposition)	**Performance Target:** Management plans completed and implemented between 2014 and 2019	**2014:** Management plans are in review and should be published at the end of 2014	H
		Condition Indicator: State-listed plant species	**Condition Measure:** Distribution/Abundance	2013: Populations are stable; medium confidence.			**Condition Target:** No direct managememt actions as of 2013, but longterm goal of stable or increasing populations of 44 state-listed plant species		
		Performance Measure: Design of monitoring program		n/a	**BIO17**	**Monitoring:** Document continued presence of 44 state-listed plant species (continue mapping and inventory)	**Performance Target:** Repeat monitoring to document continued presence should take place once every five years	2013: Partial, some inventories completed	H
	Native plant communities resilient; non-native plant richness and abundance declining	**Condition Indicator:** Noxious weeds (novel and legacy)	**Condition Measure:** # of occurrences, areal extent	2013: Unknown, possibly deteriorating (i.e. increasing levels of invasive plants in park) or stable			**Condition Target:** No new occurrences; zero tolerance for species anticipated to invade the park in the future.	2013: Partial, ongoing invasives work needed	
		Performance Measure: Early detection ongoing, # hours spent continuing active early detection program		n/a	**BIO18**	**Monitoring:** Continue active early detection program to inventory and control noxious novel weeds and track changes in behavior of existing invasive plant populations (in conjunction with MOJN work)	**Performance Target:** Early detection program and non-native plant control ongoing; 1 FTE (EPMT, staff, intern, and volunteer) working on invasives program for early detection and rapid response	2013: Partial, ongoing	H
		Performance Measure: Initiation and completion of invasive species management plan		n/a	**BIO19**	**Administrative management:** Complete invasive species management plan	**Performance Target:** Plan is completed by 2017	2013: Not started	H
		Performance Measure: Continuation of collaboration to prevent noxious plant introductions		n/a	**BIO20**	**Collaboration:** Continue to work with weed management area and local conservation organizations to minimize introductions of noxious plant species	**Performance Target:** Ongoing collaboration with demonstrated results	2013: Yes, ongoing	M
		Performance Measure: Establishment and implementation of road shoulder Best Management Practices (BMPs)		n/a	**BIO21**	**Administrative management:** Establish Best Management Practices (BMPs) for road shoulder management to minimize impacts from invasive species	**Performance Target:** BMPs completed and implemented by 20XX	2013: Not started	L
		Performance Measure: Quality and number of education materials developed; regular update of these materials		n/a	**BIO22**	**Resource education:** Develop and distribute educational materials for recognizing and reporting observations of noxious plants; update as needed (in conjunction with MOJN work)	**Performance Target**: X # high-quality education materials completed for the following topics: _____, _____, _____, by 20XX	2013: Not started	L

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
	Improved knowledge and documentation of plant communities and species	**Condition Indicator:** Botanical knowledge of Joshua Tree National Park	**Condition Measure:** Completeness of maps, inventories and integration of legacy data	2013: Increasing, high confidence, Good			**Condition Target:** Web-based flora, vegetation map and other documents 100% complete	2013: Partial	
		Performance Measure: Verification of legacy data and completion of data entry into the park database		n/a	**BIO23**	**Administrative management:** Complete verification of legacy (pre-2011) datasets of non-native plant occurrences	**Performance Target:** 100% legacy data entered by 20XX	2013: Not started	L
		Performance Measure: Accuracy and completeness of vascular plant list		n/a	**BIO24**	**Administrative management:** Maintain annotated vascular plant checklist	**Performance Target:** Highly-accurate vascular plant list completed by 2013 and updated every 2 years for publication in park visitor centers and web site	2013: Annotated vascular plant checklist completed; needs regular updating	M
	Improved knowledge of ecosystem adaptation in the park	**Performance Measure:** # volunteer hours dedicated to phenology program per year; # sites surveyd		n/a	**BIO25**	**Monitoring:** Track trends in phenology of key plant and pollinator species (in conjunction with University of California, Santa Barbara (UCSB) and the National Phenology Network through the NPS California Phenology Project)	**Performance Target:** Phenological monitoring ongoing with atleast 300 volunteer hours and 75 % of sites monitoried twice a week from the beginning of January until the end of July	2013: Yes, Ongoing	H
		Condition Indicator: Native nuisance species	**Condition Measure:** Abundance and distribution	2013: Unknown			**Condition Target:** Reduction of negative effects of nuisance species to an acceptable level TBD.	2013: Unknown	
		Performance Measure: Design native nuisance species monitoring program		n/a	**BIO26**	**Monitoring:** Track trends in abundance of native nuisance species (including locally subsidized species), and presence of species regionally native but new to Joshua Tree NP	**Performance Target:** Nuisance species monitoring program designed and implemented in X locations by 20XX	2013: Not started	L
Fire regimes	Improved knowledge of phosphorous deposition from fire retardant use and effects on plant communities	**Condition Indicator:** Fire retardant use	**Condition Measure:** Frequency, location and effects	2013: Need improved tracking of frequency and location of use			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Design fire retardant use monitoring program		n/a	**BIO27**	**Monitoring:** Document frequency and location of fire retardant use in park	**Performance Target:** 100% of fire retardant uses in the park documented	2013: Not started	L
		Performance Measure: Initiation/facilitation/completion of research on fire retardant effects on plant communities		n/a	**BIO28**	**Research:** Investigate effects of fire retardant on plant communities (including riparian and wetland communities)	**Performance Target:** Research complete, effects understood and information used in fire management program	2013: Not started	L
Minimize impacts to native flora and fauna from perturbed fire regime		**Condition Indicator**: Frequency and areal extent of wildfires	**Condition Measure:** Number of fires per year; areal extent of fires	2013: Fire frequency stable, size increasing; high confidence			**Condition Target:** Fire extent decreasing	2013: TBD	
		Performance Measure: Continuation of spatial/frequency fire monitoring		n/a	**BIO29**	**Monitoring:** Continue to track trends in frequency and areal extent of fires	**Performance Target:** Fire trends documented and reviewed every 2 years and updated in the fire Mangemant Plan	2013: Yes, ongoing	M
		Condition Indicator: Non-native plants	**Condition Measure:** Measures of control of non-native plants	2013: Unknown			**Condition Target:** Hold populations at or below current levels, and minimize/eliminate the expansion of new populations once they enter the park.	2013: Partial; ongoing invasives work needed	
		Performance measure: Reduced average fire size/decade when compared to long-term average.		n/a	**BIO30**	**Direct management:** Continue to minimize areal extent and frequency of fires through control of non-native plants (particularly in areas where these non-native species carry fire unnaturally - Joshua tree stands, blackbrush)	**Performance Target:** Fire suppression program in place; average fire size/decade less than 2500 acres	2013: Yes, ongoing	H

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Fire Impacts	**Condition Measure:** Trends in recovery in years after burn	2013: Unknown			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Initiations/facilitation/completion of research on native plant / animal response to fire		n/a	**BIO31**	**Research:** Investigate response of native plant and animal species to fire	**Performance Target:** Research complete and management implications understood	2013: Not started	M
		Performance Measure: Initiation/facilitation/completion of research on non-native plant response to fire		n/a	**BIO32**	**Research:** Investigate response of invasive species to fire and mechanisms to minimize invasions following fire	**Performance Target:** Research complete and management implications understood	2013: Not started	M
		Performance measure: Integration of science into fire management planning		n/a	**BIO33**	**Resource education:** Work with fire management personnel to utilize science in fire management planning.	**Performance Target:** Science incorporated into fire management plan by 20XX	2013: Not started	M
		Performance measure: Continuation of READ program		n/a	**BIO34**	**Resource education:** Continue READ program to improve fire management outcomes for natural resources	**Performance Target:** READ program utilized in fire management on an ongoing basis	2013: Yes, ongoing	M
Desert tortoise	Improved knowledge of abundance and distribution of desert tortoise in the park	**Condition Indicator:** Desert tortoises	**Condition Measure:** Density tortoises per square km	2013: Medium density, Stable, high confidence			**Condition Target:** Stable or increasing populations	2013: TBD	
		Performance Measure: Continuation of desert tortoise monitoring program		n/a	**BIO35**	**Monitoring:** Continue to assist USFWS with range-wide monitoring of desert tortoise	**Performance Target:** Monitoring program ongoing in colloboration with USFWS	2013: Yes, ongoing	M
		Performance Measure: Continued collaboration with USFWS Desert Tortoise Recovery effort		n/a	**BIO36**	**Collaboration:** Work with USFWS Desert Tortoise Recovery Implementation Team to promote goals of the plan	**Performance Target:** Ongoing collaboration with USFWS	2013: Yes, ongoing	L
		Performance Measure: Design of monitoring program for non-native plants in tortoise habitat		n/a	**BIO37**	**Monitoring:** Document trends in non-native plant infestations in tortoise habitat	**Performance Target:** Monitoring program designed and implemented	2013: Not started	L
		Performance Measure: Initiate research and response to prime causes or tortoise mortality		n/a	**BIO38**	**Research:** Investigate prime causes of mortality and stress in desert tortoise populations	**Performance Target:** Research complete and management implications understood	2013: Not started	L
	Minimization of impacts to tortoises from human activities	**Condition Indicator:** Tortoise mortalities on roadways	**Condition Measure:** Number of mortalities	2013: Minimal, stable, medium confidence			**Condition Target:** Stable or declining mortalities	2013: TBD	
		Performance Measure: Continuation of tortoise protection and mitigation activities		n/a	**BIO39**	**Administrative management:** Continue to study and mitigate impacts to tortoises from roads and other visitor activities; implement seasonal closures of visitor use areas as warranted	**Performance Target:** Tortoise closures and mitigations ongoing	2013: Yes, ongoing	L
		Performance Measure: Completion of research on road/tortoise interaction study		n/a	**BIO40**	**Research:** Finalize road/tortoise interaction study	**Performance Target:** Research complete and management implications understood	2013: Completion expected FY 2014	M
		Condition Indicator: Ravens/raven nests	**Condition Measure:** Number of raven nests above natural levels.	2013: Unknown			**Condition Target:** Raven numbers to natural levels. Decrease human subsidies for ravens to the greatest extent possible. Although ravens are natural components of the desert ecosystem, human activities have promoted increasing raven numbers. Aiming for natural numbers of ravens would encourage natural levels of tortoise predation from ravens	2013: No	
		Performance Measure: Design and implementation of raven nest monitoring program.		n/a	**BIO41**	**Monitoring:** Track trends and distributions of raven nests in the park	**Performance Target:** Formal monitoring program designed and implemented.	2013: Informal monitoring in place; no formal monitoring program established and implemented	M

FRV/Attribute	Objective	Condition Indicator	Measures	Condition/Trend	Activity Code	Potential Activity	Condition Target	Target met?	Validated Ranking
		Performance Measure		**N/A**			**Performance Target**		
		Performance Measure: # resource education materials continue resource education messages		n/a	**BIO42**	**Resource education:** Continue to provide public education to minimize subsidy of wildlife populations with human food; ensure that education materials are updated when necessary	**Performance Target:** X # Materials and messages up to date and distributed	2013: Partially completed	L
		Performance measure: Spearhead interagency communication on tortoise conservation		n/a	**BIO43**	**Resource education:** Restart interagency regional effort to communicate about tortoise conservation	**Performance Target:** Interagency communication reestablished	2013: Not started	L
Desert bighorn sheep		**Condition Indicator:** Self-sustaining populations of Desert Bighorn Sheep (resistant to extirpation)	**Condition Measure:** Population metric - TBD Number of incidents of human caused mortality (road kill, accidental poisoning, poaching, etc.) within the park	2013: Present; trend unknown			**Condition Target:** Population numbers are such that they are resistant to extirpation	2013: Parkwide numbers are not well-known; some information relating to Queen Mtn herd.	
	Improved understanding of range and metapopulation dynamics of desert bighorn sheep	**Performance Measure:** Design of bighorn sheep monitoring program		n/a	**BIO44**	**Monitoring:** Track trends in range and abundance of three desert bighorn sheep metapopulations (direct observation via on-foot surveys, pellet monitoring)	**Performance Target:** Design and implement formal bighorn sheep monitoring program by 20XX	Partial, Informal monitoring; no formal monitoring program established and implemented	M
		Performance Measure: Evaluation of water sources for desert bighorn sheep		n/a	**BIO45**	**Inventory:** Evaluate exisiting water sources for desert bighorn sheep	**Performance Target:** Formal evaluation completed	2013: Not started; I&M Large Springs Protocol implementation will provide useful information	H
		Performance Measure: Documentation of causes of bighorn sheep mortality		n/a	**BIO46**	**Monitoring:** Continue to assess causes of reported bighorn sheep mortality	**Performance Target:** Causes of mortality documented and management actions taken to mitigate causes	2013: Yes, ongoing	L
	Minimize disturbance to bighorn sheep from park visitors at selected locations	**Performance Measure:** Maintainenance of closures and implement additional closures as needed		n/a	**BIO47**	**Direct management:** Maintain closures to human visitation at Cow Camp and Keys Ranch. Implement measures to protect sheep populations from visitor impacts at 49 Palms Oasis, Barker Dam, and other water sources	**Performance Target:** Bighorn closures and mitigations ongoing	2013: Yes, ongoing	H
		Performance Measure: # of high-quality interp/resource education materials produced regarding visitor behavior for sheep viewing		n/a	**BIO48**	**Resource education:** At visitor centers and areas where visitors are likely to interact with sheep, provide interpretive materials regarding appropriate distances and behaviors to view sheep	**Performance Target:** X # of high-quality interpretive materials produced and updated every X years	2013: Partial, ongoing	M
Golden eagles and raptors	Minimize disturbances to eagle and raptor nesting from recreation activities	**Condition Indicator:** Raptor species nest successfully in the park, including near energy developments	**Condition Measure:** Abundance and diversity of pairs observed	2013: Unknown			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Maintainenenace of closures and implement additional closures as needed		n/a	**BIO49**	**Direct management:** Maintain climbing and hiking route closures during raptor nesting season; track compliance with closures and nesting presence and nest success	**Performance Target:** Raptor and Golden Eagle closures as needed during nesting season and mitigations ongoing	2013: Yes, ongoing	H
	Better understand impacts of development near park boundaries (specifically energy developments) on raptors and eagles	**Performance Measure:** Design of monitoring program to track raptor mortality near energy developments		n/a	**BIO50**	**Monitoring:** Track mortality and abundance in eagles and raptors near energy development projects	**Performance Target:** Formal monitoring program designed and implemented in collaboration with USFWS	2013: Underway; in collaboration with the USFWS. Ten mile radius around energy developments is being surveyed.	M
		Performance Measure: Collaboration with partners and agencies for protection of eagles and raptors		n/a	**BIO51**	**Collaboration:** Work with park partners, including USFWS, to track and minimize impacts to eagles and raptors (e.g. collaborating with BLM & USFWS on research about large scale renewable resource development effects on raptors)	**Performance Target:** Collaboration ongoing	2013: Yes, ongoing	H
California treefrog	Maintain, where possible, California treefrog in historically-occupied habitat, with demonstrated reintroduction success	**Performance Measure:** Initiation/facilitation/completion of research on tree frog habitat characterization		n/a	**BIO52**	**Research:** Characterize treefrog habitat (hydrology, water quality, surface area, rainfall, sedimentation, soil characteristics in surrounding uplands, frog abundance, reproduction)	**Performance Target:** Research complete and management implications understood	2013: Partial	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Populations of tree frogs	**Condition Measure:** # of frogs / amount of surface water in spring	2013: TBD			**Condition Target:** Self-sustaining populations of frogs at selected sites	2013: Unknown	
		Performance Measure: Development of reintroduction plan and reintroduction efforts in-progress		n/a	**BIO53**	**Admin Management:** Develop a California treefrog reintroduction plan. This includes studying and understanding the reasons for extirpation in previously inhabited California treefrog habitats of the park.	**Performance Target:** Reintroduction plan complete by 2016 with reintroduction underway	2013: Not started	H
		Condition Indicator: California treefrog habitat at extirpated sites and at currently inhabited sites	**Condition Measure:** Quality and water availability	2013: TBD			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Reintroduction of California treefrogs at artificial habitat sites		n/a	**BIO54**	**Direct management:** Evaluate creating California tree frog habitat to replace historical habitat that no longer has adequate surface water for frog persistence.	**Performance Target:** Manipulated habitat for California treefrog created according to re-introduction plan	2013: Not started	L
		Performance Measure: Initiation/facilitation/completion of research on California tree frog genetics		n/a	**BIO55**	**Research:** Investigate California treefrog genetics, determine if bottleneck resulted in loss of heterogeneity- genetic loss/ reintroduction strategies and regional conservation efforts	**Performance Target:** Complete research and management implications understood	2013: Yes, information is available	M
Bat species	Maintain high quality natural and artificial habitats for bats	**Condition Indicator:** Bat Habitat	**Condition Measure:** Total area/sites suitable for bat habitat	2013: Unknown; bat habitat should be modeled			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Regular evaluation and maintenance of mine openings and colsures as needed		n/a	**BIO56**	**Direct management:** Evaluate mine openings for bat habitat and visitor safety; gate mine openings where necessary; maintain existing gates	**Performance Target:** Complete mine evaluations as mines are closed for safety and resource protection purposes.	2013: Yes, Ongoing	H
		Performance Measure: Regular evaluation of need for signage; install signage when necessary		n/a	**BIO57**	**Resource education:** Install signage about white-nose syndrome at mine openings where necessary to protect bat populations	**Performance Target:** Complete X # of mine evaluations every X years.	2013: Not started	L
		Performance Measure: Evaluation of recreational impacts to bats		n/a	**BIO58**	**Research:** Evaluate impacts to bats from recreational activities (e.g., cavers), including evaluation of climbing routes near roosts	**Performance Target:** Impacts to bats from recreational activities evaluated every X years	2013: Not started	L
		Performance Measure: Quality of BMPs			**BIO59**	**Administrative Management:** Establish best practices for work conducted in or around mines, rock shelters	**Performance Target:** Effective BMPs developed and applied to operations by 20XX	2013: Not started	L
		Condition Indicator: Bat species richness	**Condition Measure:** Number of bat species documented in park	2013: TBD			**Condition Target:** n/a - no direct management actions can be taken as of 2013		
		Performance Measure: Design of bat monitoring program		n/a	**BIO60**	**Monitoring:** Track trends in bat species richness at open water habitat and palm oases	**Performance Target:** Regular bat monitoring program established	2013: Not started	H
Wildlife assemblages	Improved understanding of trends in bird species richness in park	**Performance Measure:** Facilitation of annual bird count events		n/a	**BIO61**	**Monitoring:** Continue to facilitate Great Backyard and Christmas bird counts	**Performance Target:**Great Backyard and Christmas Bird Counts take place annualy at park	2013: Yes, ongoing	L
		Condition Indicator: Bird species richness	**Condition Measure:** Number of bird species documented in park	2013: Stable; well-documented			**Condition Target:** n/a - no direct management actions can be taken as of 2013		
		Performance Measure: Design of bird abundance monitoring program		n/a	**BIO62**	Monitoring: Track trends in bird abundance for species of concern (Threatened and Endangered, other species of concern)	**Performance Target:** Bird abundance monitoring ongoing	2013: Not started	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
	Improved understanding and persistence of reptile and amphibian species richness in park	**Condition Indicator:** Reptile and Amphibian Species Richness	**Condition Measure:** # of species, abundance/distribution, location	2013: Unknown			**Coindition Target:** n/a - no direct management actions will be taken as of 2013, but longterm goal is that species located historically within the park remain present		
		Performance Measure: Design of reptile and amphibian monitoring program		n/a	**BIO63**	**Monitoring:** Track trends in reptile and amphibian distributions, ranges, and abundances across the transition zone (community trends and response to climate change monitoring).	**Performance Target:** Monitoring program designed and implemented when funding becomes available	2013: No, funding not currently available	H
	Increased knowledge on native and non-native invertebrate species diversity and interactions	**Performance Measure:** Facilitation of annual butterfly counts		n/a	**BIO64**	**Monitoring:** Continue annual butterfly counts (focus on trends in certain species and look for opportunities to partner based on specific questions)	**Performance Target:** Butterfly counts ongoing	2013: Yes, ongoing	L
		Performance Measure: Design and implentation of inventory invertebrate guilds		n/a	**BIO65**	**Inventory:** Document species richness and distribution of invertebrate guilds	**Performance Target:** Inventory complete	2013: Partial documentation; more work needed	M
		Performance Measure: Design and implementation of invasive invertebrate early detection monitoring program		n/a	**BIO67**	**Monitoring:** Create and implement early detection monitoring program for invasive invertebrate species	**Performance Target:** Monitoring program designed and implemented in X locations by 20XX	2013: Not started	L
		Performance Measure: Initiation/facilitation/completion of research on interactions between invertebrates and other species		n/a	**BIO68**	**Research:** Understand interactions between invertebrates and other species of concern	**Performance Target:** Research complete and management implications understood	2013: Not started	M
Interconnectivity of California desert lands									
Migration corridors that extend beyond Joshua Tree National Park	Improve connectivity for vertebrate species by maintaining migration corridors extending out from park boundaries	**Performance Measure:** Collaboration with neighbors to enhance landscape connectivity		n/a	**INC1**	**Collaboration:** With neighboring governments and agencies, improve migration across roads and highways, reduce fragmentation, and enhance connections between protected areas	**Performance Target:** Collaboration ongoing	2013: Yes, ongoing	M
		Performance Measure: Development and distribution of interpretive materials about regional wildlife migration corridors		n/a	**INC2**	**Resource education:** Improve visitor awareness of importance of wildlife migration corridors	**Performance Target:** X # of interpretive materials produced every X years	2013: Partial, ongoing	L
	Protect habitat and minimize impacts from activities originating outside park boundaries	**Condition Indicator:** OHV incursions	**Condition Measure:** # and location of incursions	2013: Unknown; no baseline available			**Condition Target:** Incursions decreasing	2013: Unknown	
		Performance Measure: Completion of map of roads and trails to detect OHV incursions		n/a	**INC3**	**Inventory:** Map illegal roads and trails within park boundaries and evaluate OHV incursions into the park; update map as needed	**Performance Target:** Map completed by 2016 and management implications understood	2013: Underway	H
		Condition Indicator: Current status and projected land use adjacent to park boundary	**Condition Measure:** Change in compatible and incompatible land use adjacent to park boundary based on NPScape; BLM programmatic EIS for solar development connectivity corridors, if applicable. BLM Regional Ecological Assessment	2013: TBD, increase in type and intensity of development (thus, deteriorating condition); high level of certainty			**Condition Target:** Impacts from developments near park boundaries mitigated/minimized	2013: Unknown	
		Performance measure: Collaboration with neighbors for protection from development		n/a	**INC4**	**Collaboration:** With neighboring governments and agencies, work to minimize impacts to biota from developments near park boundaries	**Performance Target:** Collaboration ongoing	2013: Yes, ongoing	H
Migration corridors within Joshua Tree National Park	Improve understanding of migration corridors within park boundaries and regionally	**Performance Measure:** Mapping of wildlife migration corridors		n/a	**INC5**	**Research:** Investigate and map migration corridors, including habitat for genetic linkages, for mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), desert bighorn sheep (*Ovis canadensis*), tortoise (*Gopherus agasizii*), chuckwalla (*Sauromalus ater*)	**Performance Target:** Migration corridors for larger fauna known	2013: Partial	H
		Condition Indicator: Road kill within the park	**Condition Measure:** Location and frequency	2013: Unknown			**Condition Target:** Minimal roadkill within park	2013: Unknown	
		Performance Measure: Continued monitoring road kill locations/frequency		n/a	**INC6**	**Monitoring:** Track frequency and locations of road kill within park boundaries to inform management	**Performance Target:** Road kill monitoring designed and implemented by 20XX	2013: Yes (informal monitoring in place, formal monitoring being developed by external partners)	L
		Performance Measure: Evaluation of need for improved signage at road/migration intersections		n/a	**INC7**	**Administrative Management:** Evaluate need for improved signage and speed limits reduction at road/migration corridor intersections; install signage and increase visitor awareness as needed	**Performance Target:** Evaluation complete for improved signage by 20XX	2013: Not started	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Oases and other riparian areas									
Human connections with spring, oasis, and riparian areas	Better understanding of human connections and traditional associations with spring, oasis, and riparian areas and transportation routes between these water sources	**Performance Measure:** Completion of environmental history		n/a	**OAS1**	**Research:** Complete environmental history regarding human connections with waters in the park (including guzzlers, mills, wells, water development, impoundments, tanks)	**Performance Target:** Environmental history completed by 20XX	2013: Not started	M
		Performance Measure: Enhancement interpretive materials and make available		n/a	**OAS2**	**Resource education:** Improved comprehensive interpretation regarding connections between humans and riparian habitat in the park	**Performance Target:** X # of interpretive materials updated/redone to enhance education message	2013: Not started	L
Spring, oasis, and riparian habitat	Improve management of selected oases	**Performance Measure:** Update site plan and continue implementation		n/a	**OAS3**	**Administrative management:** Update 1980s site management plan for Oasis of Mara	**Performance Target:** Site plan updated for Oasis of Mara by 20XX	2013: Not started	M
		Performance Measure: Initiation/facilitation/completion of comprehensive site plan for oasis, spring, and riparian areas		n/a	**OAS4**	**Administrative management:** Complete comprehensive spring, oasis, and riparian area management plan	**Performance Target:** Complete management plan by 2020	2013: Not started	H
		Performance Measure: Development of interpretive materials developed and make available		n/a	**OAS5**	**Resource education:** Improved comprehensive interpretation of park oases; including the story of oasis vegetation distribution changes over time and importance of riparian biodiversity (i.e., install wayside exhibits)	**Performance Target:** X # of interpretive materials updated/redone to enhance education message	2013: Not started	L
	Aquatic plant and animal habitat is maintained or improved to support all native life and natural processes	**Condition Indicator:** California Fan Palm	**Condition Measure:** Abundance, distribution, demographics	2013: Unknown			**Condition Target:** Palm oasises mapped and recorded number of palms.	2013: No	
		Performance Measure: Design of palm recruitment monitoring program		n/a	**OAS6**	**Monitoring:** Track trends in oasis palm (*Washingtonia filifera*) recruitment, palm demographics, and other high-priority oasis plant species	**Performance Target:** Palm recruitment monitoring designed and implemented between 2017 and 2023	2013: Not started	H
		Condition Indicator: Bird species richness in palm oases	**Condition Measure:** # species (new and overall), reproductivity metric	2013: Unknown			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Design of bird species richness and density monitoring program		n/a	**OAS7**	**Monitoring:** Track trends in bird occupation and reproduction in palm oases (potentially tracking new occurrences, compared with historical observations)	**Performance Target:** Palm Oases bird monitoring designed and implemented by 20XX	2013: Not started	M
		Condition Indicator: Urban-edge species	Condition Measure: Number and abundance new species	2013: Unknown			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Design of monitoring program to track trends in disturbance-tolerant and urban-edge species		n/a	**OAS8**	**Monitoring:** Track trends in disturbance-tolerant and urban-edge species as indication of degradation of palm oases (e.g., rat, raccoon, feral cat, opossum)	**Performance Target:** Monitoring program designed and implemented by 20XX	2013: Not started	L
		Condition Indicator: High-priority invasive plant species in riparian habitat	**Condition Measure:** Number of species	2013: Stable			**Condition Target:** Hold populations at or below current levels, and minimize/eliminate the expansion of new populations once they enter the park.	2013: Partial, ongoing invasives work needed	
		Performance Measure: # periodic surveys for high-priority invasive plant species in riparian habitat		n/a	**OAS9**	**Direct management:** Continue monitor and control of invasive plant species in riparian habitat (e.g., Tamarisk (*Tamarix* spp.), fountain grass (*Pennisetum setaceum*), pepperweed (*Lepidium latifolium*)	**Performance Target:** 1 FTE per year	2013: Partial, ongoing	H
		Condition Indicator: Non-native fauna	**Condition Measure:** # of species, abundance/distribution, location	2013: Unknown			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Design of non-native fauna early-detection program and evaluate their effect on native fauna.		n/a	**OAS10**	**Monitoring:** Design an early detection program for native and non-native invasive fauna in riparian habitats (e.g., bullfrog (*Rana catesbiana*), Africanized honey bees (*Apis* spp.) Eurasian collared dove (*Streptopelia decaocto*))	**Performance Target :** Early detection monitoring program in place by 20XX	2013: Not started	M
		Performance Measure: # evaluations conducted seasonally, closures implemented as needed		n/a	**OAS11**	**Direct management:** Evaluate impacts from social trailing/human trampling in riparian habitat on a seasonal basis; implement seasonal exclusions as needed	**Performance Target:** Reduced number of social trails through understory vegetation and and an increase in sensitive species such as the stream orchid.	2013: Yes, informal monitoring program in place, no formal monitoring established	H

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Surface water at oases	**Condition Measure:** Areal extent of surface water at oases; other metrics (TBD) tracking natural seasonal variation in surface water and associated aquatic conditions	2013: n/a - dependent on rainfall			**Condition Target:** n/a - no direct management actions will be taken as of 2013		
		Performance Measure: Design of surface water monitoring program for oasis to increase understanding of surface water dynamics		n/a	**OAS12**	**Monitoring:** Track trends in surface water area extent in selected oases (potentially 49 Palms Oasis, Smithwater Canyon, Johnson Spring)	**Performance Target:** Monitoring program designed and implemented as of 2013	2013: Yes, I&M Selected Large Springs protocol monitoring of areal extent of open water at 49 Palms is underway in 2013	H
		Performance Measure: Design of photo-monitoring program for riparian habitat change detection		n/a	**OAS13**	**Monitoring:** Track gross-scale changes in spring, oasis, and riparian habitat qualities (e.g., via photomonitoring)	**Performance Target:** Photomonitoring designed and implemented between 2017 and 2023 at X sites	2013: Not started	H
Species dependent on riparian habitat	Increased knowledge of species dependent on aquatic and riparian habitat	**Performance Measure:** Initiation/faciliation/completion of hybridization study between native and non-native palm species		n/a	**OAS14**	**Research:** Investigate potential hybridization between native and non-native palm species	**Performance Target:** Research on hybridization complete and management implications understood	2013: Not started	L
		Performance Measure: Design and implementation of ephemeral waters inventory post-monsoonal events		na	**OAS15**	**Inventory:** Survey ephemeral waters for occupancy following monsoonal events (e.g., amphibians, dragonfly, damselfly, fairy shrimp)	**Performance Target:** Post-monsoonal event ephemeral water inventory occurs after x% of rain events at x locations	2013: Not started	L
		Performance Measure: Design and implement inventory of night-active riparian animals		n/a	**OAS16**	**Inventory:** Survey for night-active animals in riparian habitat (e.g., owl, bat, gecko, snake) including yellow bats (*Lasiurus xanthinus*)	**Performance Target:** Night-active animal inventory designed and implemented in X number of locations by 20XX	2013: Not started	M
		Performance Measure: Design and implement inventory of riparian-dependent invertebrates		n/a	**OAS17**	**Inventory:** Survey for riparian-dependent invertebrates	**Performance Target:** Riparian-dependent invertebrates surveys in X number of locations complete by 20XX	2013: Not started	M
Recreational opportunities and values									
Visitor use	Increased understanding of the impacts of recreational activities to natural and cultural resources	**Performance Measure:** Initiation/continuation of research on impacts to natural and cultural resources from recreation		n/a	**REC1**	**Research:** Research impacts of recreation on archeological resources, vegetation, soil, wildlife (e.g., climbing, bouldering, horseback riding, off-road vehicles, backcountry camping)	**Performance Target:** Suite of studies completed and management implications understood between 2014 and 2016	2013: Partial, ongoing	H
		Performance Measure: #/quality of educational messages to increase awareness on resource management topics		n/a	**REC2**	**Education:** Develop education/outreach messages to increase resource protection and awareness to ensure a balance -reduce speeds for wildlife protection on roadways -no dogs on park trails, -maintaining safe distances from wildlife -no fires or fire rings -climbing ethics (e.g., social trails, rock art) -equestrian practices	**Performance Target:** Complete six educational messages by 20XX	2013: Not started	M
		Performance Measure: Utilization of GIS and field crews to determine distribution of invasive species adjacent to hiking and horse trails		n/a	**REC3**	**Research:** Investigate relationship between invasive species distribution and proximity to equestrian use trails and hiking trails	**Performance Target:** Distribution determined for X feet of trails by 20XX	2013: Not started	M
		Performance Measure: Initiation of social science study to understand visitor perceptions on resource impacts and effectiveness of resource conservation messaging, specifically desert tortoise conservation		n/a	**REC4**	**Research:** Collaborate with interpretation to increase understanding of visitor perceptions of resource impacts and effectiveness of conservation messaging, specifically desert tortoise conservation	**Performance Target:** Complete study by 20XX and management implications understood	2013: Not started	L
Hiking, climbing, bouldering, slack lining, scrambling, and related activities	Provide appropriate recreational opportunities that are consistent with the park's purpose and values, without causing unacceptable impacts	**Performance Measure:** Collaboration with appropriate divisions and outside groups for resource protection from recreation		n/a	**REC5**	**Resource education:** Collaborate with interpretation, law enforcement, and outside groups to increase protection measures in recreational areas (e.g., signs, effective closures, education messages, ranger routes)	**Performance Target:** Collaboration ongoing and increase in resource protection	2013: Yes, ongoing	M
		Performance Measure: Initiation/facilitation/completion of visitor and ecological carrying capacity study		n/a	**REC6**	**Research:** Investigate visitor and ecological carrying capacity studies to understand how the number of visitors affects visitor experience and resources	**Performance Target:** Study completed between 2017 and 2020 and management implications understood	2013: Not started	H
		Performance Measure: Strengthen relationships with media and authors to promote resource protection		n/a	**REC7**	**Collaboration:** Conduct outreach to media and authors to promote park climbing ethics, policies, and practices within Joshua Tree NP (e.g., access to climbing areas, closures)	**Performance Target:** Ongoing collaboration	Partial, ongoing	M
		Performance Measure: Scoping for a climbing management plan		n/a	**REC8**	**Administrative Management:** Develop Climbing Management Plan, including determining level of climbing in the park	**Performance Target:** Complete initial scoping by 2020	2013: Not started	H

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Social trails	**Condition Measure:** Number of restored social trails; acreage of restored area	2013: Significant concern, stable, high confidence			**Condition Target:** Restored areas maintain/develop native floral/faunal assemblages that are self sustaining and reduce the need for additional restoration in disturbed sites	2013: TBD	
		Performance Measure: Maintain ongoing restoration efforts in areas that receive high resource damage		n/a	**REC9**	**Direct management:** Restore areas that have received resource damage due to high use, specifically social trails, in non-wilderness and implement measures to prevent reoccurring damage	**Performance Target:** Restoration efforts ongoing; 20 acres restored per year	2013: Yes, ongoing	H
		Performance Measure: Collection of data and mapping of locations of social trails		n/a	**REC10**	**Inventory:** Continue ongoing data collection and mapping on social trails	**Performance Target:** Ongoing inventory; X linear feet of trails mapped every X years	2013: Yes, ongoing	M
Vehicle use on unpaved roads	Provide appropriate recreational opportunities that are consistent with the park's purpose and values, without causing unacceptable impacts	**Performance Measure:** Monitoring use of unpaved roads and detect new areas of illegal use		n/a	**REC11**	**Monitoring:** Monitor use of current unpaved roads and creation of new unpaved ones	**Performance Target:** Ongoing monitoring; X number of sites monitored every X years	2013: Yes, ongoing	L
		Condition Indicator: Resource damage	**Condition Measure:** Number of sites restored	2013: Unknown; some preliminary data gathered			**Condition Target:** Restored areas maintain/develop native floral/faunal assemblages that are self sustaining and reduce the need for additional restoraiton in disturbed sites.	2013: TBD	
		Performance Measure: Restoration efforts ongoing; X # acres illegal off road use restored		n/a	**REC12**	**Direct management:** Restore areas of illegal off road use or closed roads	**Condition Target:** Restoration efforts ongoing; 40 acres restored on an annual basis	2013: Partial	H
Camping, unauthorized camping, commercial	Provide appropriate recreational opportunities that are consistent with the park's purpose and values, without causing unacceptable impacts	**Performance Measure:** # of sites that continue to be monitored on an annual basis		n/a	**REC13**	**Monitoring:** Continue commercial use recreation monitoring to identify areas of resource concern (e.g., backcountry camping groups, climbing groups)	**Performance Target:** Ongoing monitoring at X # sites	2013: Yes, ongoing	L
Wilderness values and wilderness accessibility									
Wilderness character	Joshua Tree wilderness – including physical resources, intangible values, and wilderness character qualities – protected, preserved and access maintained	**Performance Measure:** Collaboration with appropriate divisions and outside groups for resource protection from recreation		n/a	**WILD1**	**Collaboration:** With adjacent communities, developers, and agencies work to maintain wilderness character qualities at Joshua Tree	**Performance Target:** Collaboration ongoing and increase in resource protection	2013: Yes, ongoing	M
		Performance Measure: Initiation/facilitation/completion of study to increase knowledge of the location of backcountry registration boards, number of wilderness users and location of use		n/a	**WILD2**	**Research:** Research: In conjunction with REC6, investigate visitor and ecological carrying capacity (type and number of users, location of use, effectiveness of information delivery methods) to understand how the number of people affects wilderness experiences, resources, and wilderness character (e.g., hikers, climbers, commercial groups)	**Performance Target:** Study completed by 20XX	2013: Not started	M
		Performance Measure: Scoping for a wilderness stewardship plan		n/a	**WILD3**	**Administrative Management**: Complete a wilderness stewardship plan	**Performance Target:** Plan completed and implemented by 20XX	2013: Not started	H
		Performance Measure: Establish a monitoring program for wilderness character		n/a	**WILD4**	**Administrative Management:** Define indicators and measures of wilderness character in Joshua Tree Wilderness; implement monitoring program and establish baseline	**Performance Target:** Baseline monitoring completed by 20XX	2013: Not started	M
		Condition Indicator: Restored social trails	**Condition Measure:** Number of restored social trails restored in wilderness	2013: Unknown, but likely social trail proliferation in wilderness is low due to the fact most park visitors use the front country.			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Active program to evaluate and restore areas with resource damage from visitor use		n/a	**WILD5**	**Direct management:** Restore wilderness areas with resource damage due to high use; implement measures to prevent reoccurring damage (e.g., close social trails)	**Performance Target:** Ongoing monitoring and restoration	2013: Partial, ongoing	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Ever-expanding knowledge base									
	Research activities in the park further park management goals and scientific understanding	**Performance Measure:** TBD		n/a	**EXP1**	**Administrative management:** Restructure the research reporting process and improve data management	**Performance Target:** 2013- 2016	2013: Yes, ongoing; databases and reporting process being continuously improved	H
		Performance Measure: Research partnerships with demonstrated research gains		Unknown	**EXP2**	**Collaboration:** Maintain and enhance relationships with researchers, universities, and agencies and link research needs to management concerns; consider conducting periodic outreach to research institutions. In conjunction with this activity, the park could include a list of all research in progress and links to research papers or reports that have been generated by that research on the park's website, as well as providing access to researchers as part of a citizen science effort.	**Performance Target:** Maintain "X" number of relationships with demonstrated research gains (published papers, NPS reports, poster presentations, research applied to management)	2013: Yes, ongoing	M
		Performance Measure: Design and host conservation research symposium		n/a	**EXP3**	**Administrative management:** Establish a science symposium hosted at the park with a management based conservation focus	**Performance Target:** Host inaugural symposium in 20XX	2013: Not started	L
		Condition Indicator: RPRS - delivery of reports to NPS	**Condition Measure:** % of active permits that meet reporting requirements 1 year out from issue of permit	2013: deteriorating, caution, high confidence			**Condition Target:** 100% of active permits meet yearly reporting requirements	2013: No	
		Performance Measure: Establishment of an improved program for transfer of information from researchers to the park and beyond		n/a	**EXP4**	**Administrative management**: Develop a plan for successful transfer of information from researchers to the park network wide, with potential shared database (e.g., renew permits that meet reporting requirements and data delivery)	**Performance Target:** Program established and implemented between 2013-2019 with demonstrated success	2013: Partial, ongoing	H
		Performance Measure: Completion of review of park management and research priorities and make contact with researchers		n/a	**EXP5**	**Administrative management:** Periodically review park management and research priorities and status of knowledge with partners and research community	**Performance Target:** Review of priorities completed every X years and links established with researchers	2013: Not started	M
		Performance Measure: Completion of review of social science materials and update research needs based on relevancy to natural and cultural resources		n/a	**EXP6**	**Administrative management:** Complete review of social science research relevant to management of natural and cultural resources at JOTR, include research needs in annual research needs assessment	**Performance Target:** Review completed every X years and management implications understood	2013: Not started	L
	Improved understanding of changing climate and its impact on park natural and cultural resources and incorporation of adaptive management strategies	**Performance Measure:** Continue to monitor climate change plots		n/a	**EXP7**	**Monitoring:** Monitor the effects of climate change through pitfall traps and vegetation macroplots; expand if necessary. Also monitor climate change variables including precipitation, temperature and extreme weather events. *Project Title: "Managing biodiversity along transition zones in the face of climate change."*	**Performance Target:** Ongoing monitoring at 18 plots	2014: Monitoring at nine vegetation macroplots and multiple pitfall trap sites commenced.	H
		Performance Measure: Completion of vulnerability assessment and development of adaptation plan		n/a	**EXP8**	**Administrative management:** Complete vulnerability assessment	**Performance Target:** Vulnerability assessment complete by 2014.	**2014:** Completed and published as NRTR (See Chapter 6 for citation)	H
	Data stored appropriately and available for use	**Performance Measure:** Establishment and implementation of tissue sample preservation protocol		n/a	**EXP9**	**Administrative management:** Establish protocol for preserving tissue samples from park biota from park research and monitoring efforts (agreement with Smithsonian institution)	**Performance Target:** Protocol established and implemented by 20XX	2013: Not started	L
		Performance Measure: Completion of GIS update to national data transfer standards		n/a	**EXP10**	**Direct Management:** Continue to integrate and update GIS technology to national data transfer standards	**Performance Target:** GIS technology updated to national data transfer standards by 20XX	2013: Partial, ongoing	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Opportunity to understand, apply, and share knowledge to benefit the park and beyond									
	Improve and enhance quality and quantity of information provided by the NPS to the public and partners about park natural and cultural resources	**Performance Measure:** Completion of website and interpretive materials update, pertaining to cultural and natural resources		n/a	**SHARE1**	**Resource education:** With interpretation division, review and maintain interpretive materials (including on-line information) with up to date information about natural and cultural resources; ensure that the webpage includes resource inventories, updated publications, and contacts (provide input to Joshua Tree NP web-management strategy)	**Performance Target:** 100% of website and materials pertaining to natural and cultural resources updated with current information by 2022	2013: Not started	H
		Performance Measure: Rotate exhibit in visitor center with resource based exhibits		n/a	**SHARE2**	**Administrative management:** Annually update rotating visitor center exhibit for natural and cultural resource information; work with interpretation staff to keep other exhibits updated	**Performance Target:** Exhibit annually rotated	2013: Not started	M
		Performance Measure: # and quality of natural and cultural resource briefs		n/a	**SHARE3**	**Administrative management:** Develop and make available subject-specific high-quality resource briefs	**Performance Target:** X # of natural and cultural resource briefs updated	2013: Not started	M
		Performance Measure: # and quality of educational materials on climate change developed		n/a	**SHARE4**	**Resource education**: Develop and provide interpretive materials regarding changes in climate and Joshua Tree distribution, and cascading ecological effects	**Performance Target:** X # of climate change materials developed and up to date	2013: Partial, ongoing	M
		Performance Measure: Collaboration with MOJN Network and professional partners that work directly with staff		n/a	**SHARE5**	**Collaboration:** Continue to integrate MOJN I&M program with park programs and external partners (interpretation, research partnerships, education partnerships, cultural and natural resources programs)	**Performance Target:** Collaboration ongoing	2013: Yes, ongoing	H
		Performance Measure: Improvement of park library and finding aids		n/a	**SHARE6**	**Direct Management:** Continue to maintain park library and improve finding aids	**Performance Target:** Finding aids improved in library by 20XX	2013: Not started	L
		Performance Measure: # and quality of bi-annual biodiversity hunts		n/a	**SHARE7**	**Resource education:** Continue bi-annual biodiversity hunts in springs, oases, and riparian habitat	**Performance Target:** Biodiversity hunts happen twice per year in sensitive riparian habitat	2013: Yes, 1-2 annual Biodiversity Hunts took place in 2011, 2012 and 2013	L
		Performance Measure: # of groups worked with, # materials developed annually		n/a	**SHARE8**	**Resource education:** Provide interpretive materials within and beyond park boundaries to promote environmentally appropriate landscaping in order to reduce invasive weed spread into Joshua Tree wilderness (e.g., local nurseries, contractors, governments, commercial retail, and residents)	**Performance Target:** Work with "X" number of groups annually, # of materials developed	2013: Not started	L
Geological resources and desert landforms									
Desert landforms	Understand processes that create desert landforms	**Performance Measure:** Design and implementation of monitoring program to track alluvial fans		n/a	**GEO1**	**Monitoring:** Monitor alluvial fans for stripping of soil at locations in park that exhibit contrasting precipitation patterns as pertains to climate change	**Performance Target:** Alluvial fan monitoring designed and implemented (ongoing)	2013: Not started	L
Geological resources	Joshua Tree boulders and rock formations are protected from human caused alteration while allowing natural processes to occur	**Condition Indicator:** Vandalism/Bolting on rocks	**Condition Measure:** Repeated photo-points	2013: Deteriorating, medium confidence			**Condition Target:** No observations of vandalism/new bolting on rocks	2013: Unknown	
		Performance Measure: Creation of education and enforcement program to limit use of bolting and vandalism		n/a	**GEO2**	**Resource education:** Prevent vandalism and manage use of bolting on rocks, boulders, and landforms through enforcement and outreach.	**Performance Target:** Decrease in bolting and vandalism from education and enforcement	2013: Partial, ongoing	H
		Performance Measure: Documentation of trends in vandalism		n/a	**GEO3**	**Research:** Track trends in vandalism	**Performance Target:** Understand trends in vandalism and management implications	2013: Not started	M
	Paleontological resources protected, preserved and managed for resource education, science, and interpretation	**Performance Measure:** Completion of neogene deposits inventory		n/a	**GEO4**	**Inventory:** Work with research partners to complete systematic assessments of entire park for neogene deposits	**Performance Target:** In collaborations with research partners, inventory completed by 20XX	2013: Not started	L
		Performance Measure: Continuation of cyclic prospecting for paleontological resources		n/a	**GEO5**	**Direct management:** Work with research partners to protect paleontological resources through cyclic prospecting; correlate cyclic prospecting with rain events (bi-annual basis)	**Performance Target:** Cyclic prospecting ongoing	2013: Yes, ongoing	H
		Performance Measure: Continued processing of paleontological objects with appropriate documentation and curation		n/a	**GEO6**	**Inventory:** Work with research partners to fully process paleontological objects (GPS, record lithology, prepared at museum and curated)	**Performance Target:** In collaboration with research partners, X #/% of objects processed and curated to professional standards	2013: Partial, ongoing	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
	Improved understanding of paleontological deposits in the context of climate change	**Performance Measure:** Collaboration on chronology of Pleistocene deposits		n/a	**GEO7**	**Inventory:** Work with research partners to develop detailed chronology of Pleistocene and/or Neogene deposits that contain paleontologic resources	**Performance Target:** In collaboration with research partners, chronology of Pleistocene and/or Neogene deposits that contain paleontologic resources completed by 20XX	2013: Not started	M
		Performance Measure: Initiation/ facilitation of research on response of paleontological species to climate fluctuations		n/a	**GEO8**	**Research:** Work with researchers to understand how paleontological-species responded to fluctuations in climate	**Performance Target:** Research completed	2013: Not started	L
		Performance Measure: Initiation/facilitation of research projects to bolster geological knowledge base in regards to paleontological resources		n/a	**GEO9**	**Research:** Increase geological knowledge base to bolster knowledge about paleontological resources	**Performance Target:** Research topics identified and research underway	2013: Not started	M
	Increased knowledge of the geology and tectonic processes of the park in order to integrate knowledge into operations, planning and interpretation for park visitors	**Performance Measure:** Initiation/facilitation of research projects to bolster geological knowledge base in regards to historic and prehistoric quarries		n/a	**GEO10**	**Research:** Increase geological knowledge base to bolster knowledge about location of different quarries (historic and prehistoric)	**Performance Target:** X number of research projects initiated to bolster knowledge about quarries by 20XX	2013: Not started	M
		Performance Measure: Development of list of geologic research topics and link researchers to individual studies, e.g. San Andreas Fault finite strain partitioning		n/a	**GEO11**	**Research:** Work with research partners to initiate more scientific studies about geologic processes within the park	**Performance Target:** List of geological research topics developed by 2019	2013: Partial, ongoing development of research list	H
		Performance Measure: #/quality of interpretive materials developed and made available		n/a	**GEO12**	**Resource education:** Provide interpretive materials about Joshua Tree NP's importance as a critical nexus of geological processes (e.g., plate boundaries); update as necessary	**Performance Target:** X# of Interpretive materials developed by 20XX	2013: Partial, ongoing	L
		Performance Measure: Expansion of spatial coverage by increasing the number of new plate boundary observatory stations		n/a	**GEO13**	**Monitoring:** Increase number of tectonic plate boundary observatory stations	**Performance Target:** Facilitate X # of PBO stations by 2027	2013: Not started	H
Hydrological resources									
Surface water	Impoundments managed for wildlife use, wildlife viewing, cultural resources management and safety and so as to minimize negative impacts to other park values and resources.	**Performance Measure:** Development of guidelines for impoundment management		n/a	**HYD1**	**Administrative management:** Develop guidelines for impoundment management	**Performance Target:** Impoundment management plan completed and implemented by 20XX	2013: Not started	M
		Condition Indicator: Water quality and water quantity	**Condition Measure:** Level I and Level II testing including field measurements for quality; areal extent monitoring to assess quantity. **Condition Measure:** Trends in frequency and character of extreme events (e.g. flash floods) including effect on stream/wash geomorphology	2013: TBD			**Condition Target:** n/a - no direct management actions will be taken as of 2013		
	Improved understanding of trends in quantity and quality of surface water; chemical (water quality) integrity of park surface water improved or maintained to support all native life, and hydrologic (water quantity) integrity of park surface waters is improved or maintained to support natural geomorphic process of fluvial systems and support native life	**Performance Measure:** Work with I&M to facilitate monitoring program		n/a	**HYD2**	**Monitoring:** Track trends in water quality and quantity at a random sample of springs through the Mojave Desert Network Inventory and Monitoring Program	**Performance Target:** Ongoing monitoring program	2013: No, monitoring protocol in development	H
	Improved understanding of locations and trends in springs, including interannual variability	**Performance Measure:** Initiation and replication of spring inventories		n/a	**HYD3**	**Monitoring:** Repeat inventories of locations and hydrology characteristics of springs (Citizen Science: "Wet Hands" survey)	**Performance Target:** Inventories performed at as many locations as possible and repeated annually at those locations by 2019	2013: Not started	H
		Performance Measure: Initiation of study		n/a	**HYD4**	**Research:** Comparison of present day locations and conditions of springs with historical surveys	**Performance Target:** Study completed by 20XX	2013: Not started	H
		Performance Measure: Utilize benthic macroinvertebrate data to analyze trends in water quality		n/a	**HYD5**	**Monitoring:** Investigation of trends in water quality based on benthic macroinvertebrate survey	**Performance Target:** Monitoring program designed and implemented	2013: Not started	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Groundwater	Improved knowledge of local and regional groundwater hydrology; chemical (water quality) integrity of park aquifers is improved and/or maintained to support all native life, and hydrologic (water quantity) integrity of park aquifers is improved/maintained to support natural processes and native life.	**Performance Measure:** Initiation and completion of groundwater outflow study in Pinto Basin into Chuckwalla Basin		n/a	**HYD6**	**Research:** Characterize groundwater outflow from the Pinto Basin into the Chuckwalla Basin in order to better understand impacts of water withdrawal by neighbors	**Performance Target:** Study completed by 2020 and management implications understood	2013: Not started	H
		Performance Measure: Initiation and completion of Cottonwood aquifer study		n/a	**HYD7**	**Research:** Characterize Cottonwood aquifer (water balance, faulting system, withdrawal rate, life of well, ecological impacts of human water use)	**Performance Target:** Study completed by 2019 and management implications understood	2013: Not started	H
	Minimize human use of groundwater resources in the park	**Performance Measure:** Development of best management practices for water conservation in the park		n/a	**HYD8**	**Direct management:** Analyze water use in the park and implement best available conservation strategies	**Performance Target:** Best management practices designed and implemented by 2020	2013: Not started	M
	Resource education promoting better understanding of water for human consumption	**Performance Measure:** Completion of study of Pinto Wells water source		n/a	**HYD9**	**Resource education:** Investigate the potential use of water from Pinto Wells to promote understanding of groundwater resources	**Performance Target:** Investigation complete and decision made by 2020	2013: Not started	L
Night sky									
Light pollution impacts originating from outside park boundaries	Decrease light pollution emanating from sources outside of park boundaries, as feasible	**Condition Indicator:** Anthropogenic light pollution/sky glow in surrounding communities	**Condition Measure:** Light dome above azimuth; brightest object in sky, darkest spot in sky; brightest star; total darkness, glare analysis measurements **Condition Measure:** Number of communities with dark sky ordinances in place and enforced	2013: Improving conditions, high confidence			**Condition Target:** Improving darkness	2013: Improving, ongoing	
		Performance Measure: Reach surrounding communities and civic groups for benefit of dark sky visibility		n/a	**NIGHT1**	**Collaboration:** Work with surrounding communities and agencies to restore dark night skies through mitigation of impacts of light pollution on park	**Performance Target:** Ongoing: increased number of communities with ordinances in place as a result of effective outreach	2013: Yes, ongoing	H
		Performance Measure: Inventory light pollution in surrounding communities to establish baselines		n/a	**NIGHT2**	**Inventory:** Quantify light pollution produced by surrounding communities and agencies (Yucca Valley, 29 Palms, San Bernadino, MGACC); establish baseline for light pollution	**Performance Target:** Baseline determined by 2019	2013: Not started	H
		Performance Measure: Provide resource education program on night sky		n/a	**NIGHT3**	**Resource education:** Continue to provide resource education about night sky darkness	**Performance Target:** Two resource education programs completed annually on dark night sky	2013: Yes, ongoing	L
Night sky within park boundaries	Maintain natural darkness and minimize light pollution within park boundaries	**Performance Measure:** Monitor night sky darkness in the park		n/a	**NIGHT4**	**Monitoring:** Continue to monitor night sky darkness in the park	**Performance Target:** Monitoring ongoing at 6 locations in the park by 2019	2013: Partial, ongoing	H
		Performance Measure: Initiation/facilitation/completion of research projects on perturbations in nocturnal behaviors of organisms at the park		n/a	**NIGHT5**	**Research:** Investigate perturbations in nocturnal behaviors of organisms at the park as a result of light pollution	**Performance Target:** Study completed by 20XX and management implications understood	2013: Not started	M
		Condition Indicator: Park light sources that meet shielding standards	**Condition Measure:** Percentage	2013: TBD			**Condition Target:** 100% of light sources meet shielding standards	2013: No	
		Performance Measure: Active program for removal/replacement of outdated light-sources		n/a	**NIGHT6**	**Direct management:** Reduce light pollution produced from park sources	**Performance Target:** See condition target above	2013: Not started	L

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Clean and breathable air									
Air Quality	Air quality protected in the park and neighboring lands; trends in air quality condition understood	**Condition Indicator:** Ozone	**Condition Measure:** Number of exceedances of standards for Ozone	2013: Poor, but slowly improving, high confidence			**Condition Target:** Attainment of federal and state standards for ozone		
		Condition Indicator: Particulates (PM10, PM2.5)	**Condition Measure:** Number of exceedances of standards for particulate\s	2013: Poor, but slowly improving, high confidence			**Condition Target:** Attainment of federal and state standards for particulate pollution		
		Condition Indicator: Wet-Nitrogen deposition	**Condition Measure:** Number of exceedances of standards for nitrogen deposition	2013: Poor, but slowly improving, high confidence			**Condition Target:** Attainment of federal and state standards for nitrogen pollution		
		Condition Indicator: Ammonia	**Condition Measure:** Number of exceedances of standards for ammonia deposition	2013: Poor, but slowly improving, high confidence			**Condition Target:** Attainment of federal and state standards for ammonia pollution		
		Performance Measure: Continuation of air quality monitoring program		n/a	**AIR1**	**Monitoring:** Inventory, monitor, and document the condition of air quality related values for Joshua Tree	**Performance Target:** Monitoring ongoing at 3 air stations	2013: Yes, ongoing	H
		Performance Measure: Spatial coverage of air quality monitoring expanded by X # of stations		2013: 3 stations	**AIR2**	**Monitoring:** Expand air quality monitoring throughout the park by adding more stations	**Performance Target:** Coverage expanded to include 2 additional stations, operational between 2016-2018	2013: Not started	H
		Performance Measure: Gain acceptance from EPA/CARB for X # air stations on eastern boundary as data collection sites		n/a	**AIR3**	**Administrative management:** Pursue determination/ gain acceptance from the Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) of 2 air stations on eastern boundary of park as data collection stations (three years of continuous data and funding)	**Performance Target:** Determination accepted from EPA/CARB for 2 stations on eastern boundary (ongoing)	2013: Partial	H
	Work with surrounding communities and agencies to minimize air pollution	**Performance Measure:** # air pollution focused interpretive materials developed and made available		n/a	**AIR4**	**Resource education:** Provide interpretive information about negative effects of air pollution at Joshua Tree National Park	**Performance Target:** X # of interpretive materials developed and available to visitors	2013: Yes, ongoing	L
		Performance Measure: Provide X # of resource education programs on air quality		At least two per year	**AIR5**	**Resource education:** Continue to provide resource education about impacts of air pollution on park boundaries	**Performance Target:** Two programs completed annually on air quality	2013: Yes, ongoing	L
		Performance Measure: Collaboration with air quality management districts		n/a	**AIR6**	**Collaborate:** Work with air quality management districts, CARB and EPA to strengthen air quality protections	**Performance Target:** Collaboration ongoing	2013: Yes, ongoing	H
		Performance Measure: Identification of specific topics and initiation of research on air quality effects to resources		n/a	**AIR7**	**Research:** Investigate impacts of air quality on natural and cultural resources	**Performance Target:** Research topics identified and research underway	2013: Not started	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Soundscape									
Natural quiet beyond park boundaries	Soundscapes relatively unimpacted by anthropogenic sources from beyond park boundaries	**Condition Indicator:** Intrusions on the natural soundscape	**Condition Measure:** Decibels	2013: Unknown			**Condition Target:** 35 db in wilderness areas	2013: Unknown	
		Performance Measure: Collaboration with municipalities to improve soundscape		n/a	**SOUND1**	**Collaboration:** With municipalities and/developments, work to maintain or improve natural quiet	**Performance Target:** Outreach established and progress towards improving natural quiet underway (ongoing)	2013: Not started	H
		Performance Measure: Collaboration with military/commercial entities to improve soundscape		n/a	**SOUND2**	**Collaboration:** With military/commercial entities, work to maintain or improve natural quiet (including non-tour overflight concerns)	**Performance Target:** Ongoing collaboration	2013: Not started	M
		Performance Measure: Initiation/completion of air-tour management plan		n/a	**SOUND3**	**Administrative management:** Complete air-tour management plan	**Performance Target:** Plan completed and implemented by 20XX	2013: Not started	M
		Performance Measure: Provision of resource education (# presentations, meeting attendance) to airplane owners and operators		n/a	**SOUND4**	**Resource education:** Provide resource education to airplane owners and operators about impacts to natural quiet, with an emphasis on preservation of wilderness character	**Performance Target:** Outreach established and progress towards improving natural quiet underway	2013: Not started	L
		Performance Measure: Completion of sound pollution inventory to establish baselines		n/a	**SOUND5**	**Inventory and Monitoring:** Collect baseline data to quantify levels of noise pollution produced outside of the park	**Performance Target:** Baseline sound levels established at 5 locations outside or near the park boundary by 2016 ; monitoring ongoing after baseline is established	2013: Not started	H
Natural quiet within park boundaries	Soundscapes relatively unimpacted by anthropogenic sources from within park boundaries	**Performance Measure:** Inventory levels of sound pollution to establish baselines		n/a	**SOUND6**	**Inventory:** Collect baseline data to quantify levels of noise pollution produced within park	**Performance Target:** Baseline sound levels established inside the park between 2016-2018	2013: No, in progress	H
		Performance Measure: #/quality of interpretive materials and make available		n/a	**SOUND7**	**Resource education:** Provide interpretive information regarding the value of natural quiet in the park and impacts from anthropogenic noise	**Performance Target:** X # of educational materials developed and current	2013: Not started	L
		Performance Measure: Initiate research on effects of noise pollution to ecological communities		n/a	**SOUND8**	**Research:** Investigate impacts of noise pollution on ecological communities within the park	**Performance Target:** Research topics established and research underway	2013: Not started	M
Viewsheds									
		Condition Indicator: Viewshed change	**Condition Measure:** Repeated photo-point observations at key points within in the Park	2013: Medium, declining in some areas, high confidence			**Condition Target:** Improved viewsheds based on visual resource inventory and mitigations	2013: TBD	
Views within park boundaries	Scenic views and integral vistas within boundaries of Joshua Tree National Park preserved	**Performance Measure:** Completion of visual resources inventory and threshold established		n/a	**VIEW1**	**Research:** Complete visual resource inventory	**Performance Target:** Inventory completed at sensitive viewshed areas of the park by between 2016-2018 and thresholds established	2013: Not started	H
		Performance Measure: Completion and implementation of Visual Resource Management Plan		n/a	**VIEW2**	**Administrative management:** Develop and implement a Visual Resource Management plan; towards the beginning of this process, produce list of key wilderness/natural vistas	**Performance Target:** Visual Resource Management Plan completed and implemented between 2017-2019	2013: Not started	H
		Performance Measure: Design and implementation of best management practices to reduce visibility effects from fire suppression techniques		n/a	**VIEW3**	**Direct management:** Continue best management practices to reduce visibility effects from fire suppression techniques (e.g., fire retardant, hand lines, roads, staging areas)	**Performance Target:** Best management practices established and visibility effects from fire-suppression reduced by 20XX	2013: Partial	L
		Performance Measure: Initiation and completion of desert fire-recovery research; make information available to Interpretive Division		n/a	**VIEW4**	**Research:** Investigate how deserts recover from fires to incorporate into interpretation of fire scars and other visual effects of fires	**Performance Target:** Desert fire-recovery research projects completed and utilized in interpretive materials by 20XX	2013: Not started	L

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Potential visual intrusions on ridgelines	Condition Measure: NEPA documents (NPS or external) that indicate the visual impacts to be greater than negligible	2013: TBD			**Condition Target:** Clear Ridgelines	2013: TBD	
		Performance Measure: Design and implementation of BMP's for maintenance of clear ridgelines		n/a	**VIEW5**	**Administrative management:** Design best management practices to maintain clear ridgelines through minimization of new construction (e.g., cell phone towers)	**Performance Target:** X # of BMP's designed by 20XX	2013: Unknown	M
		Performance Measure: Design and implementation of BMPs for fugitive dust reduction		n/a	**VIEW6**	**Direct management:** Design and implement best management practices to minimize fugitive dust from park activities	**Performance Target:** X # of BMPs designed by 20XX	2013: Unknown	L
		Performance Measure: Expansion of visibility monitoring program to include new stations		n/a	**VIEW7**	**Monitoring:** Expand coverage of visibility monitoring stations and continue monitoring (including web camera and photo-points)	**Performance Target:** Two more photo-sites added between 2017-2019; monitoring ongoing	2013: Not started	H
		Performance Measure: Design and implementation of BMP to preserve viewsheds		n/a	**VIEW8**	**Administrative Management:** Design and implement best management practices to preserve viewsheds in regards to new park infrastructure	**Performance Target:** BMP implemented	2013: Not started	L
Views beyond park boundaries	Scenic views and integral vistas preserved for vistas extending beyond the park boundaries	**Performance Measure:** Collaboration with appropriate groups to preserve viewsheds		n/a	**VIEW9**	**Collaboration:** With municipalities, developers and agencies, maintain natural viewsheds as much as possible	**Performance Target:** Communication maintained among groups whose activities have potential to impact viewsheds (ongoing)	2013: Yes, ongoing	H
Archeology (historic and prehistoric)									
Archeology	Increased knowledge of the human past at Joshua Tree NP through adequate research, field work, recordingand evaluation to the National Register	**Performance Measure:** Completeness of documentation for National Register Evaluations and DOEs		n/a	**ARCH1**	**Documentation:** Continue Determinations of Eligibility to the National Register of Historic Places and possibly listings focused on culturally significant areas (e.g., Pinto Basin, Hayfield rock art district)	**Performance Target:** 100% complete in 2025	2013: Not started, no funding requested	M
		Performance Measure: Completeness of pending documentation for Determination of Eligibility		n/a	**ARCH2**	**Documentation:** Complete Determination of Eligibility for management (e.g., Indian Cove, Barker Dam, Hidden Valley Campground, Oasis of Mara, mines and mills)	**Performance Target:** 0.25 evaluations/DOE documentations complete per year	2013: Ongoing; HVCG & BD almost completed	H
		Performance Measure: Completeness of pending documentation for Determination of Eligibility		n/a	**ARCH3**	**Documentation:** Complete pending Determinations of Eligibility (e.g., Carys' Castle, Anaconda mine, added lands from Hardesty report, WACC report)	**Performance Target:** 100% complete	2013: Ongoing; 0 completed; Paymaster to be submitted in FY13	L
		Performance Measure: Updated National Register Determination of Eligibility documentation for Cottonwood Springs		n/a	**ARCH4**	**Documentation:** Data recovery and update of National Register Determination of Eligibility for Cottonwood Spring Oasis	**Performance Target:** 100% complete by 2018	2013: No; not funded in FY16, was #1 request	H
Pre-historic and historic archeological sites professionally inventoried and recorded		**Performance Measure:** Initiation/completion of springs and water sources inventory for archeological resources		n/a	**ARCH5**	**Inventory:** Inventory springs and other water sources for archeological resources	**Performance Target:** Inventory 100% complete	2013: No, not submitted for funding yet	H
		Performance Measure: Initiation/completion of dry lake beds/terraces inventory for archeological resources		n/a	**ARCH6**	**Inventory:** Inventory dry lake beds and terraces for archeological resources	**Performance Target:** Inventory 100% complete	2013: No; requested starting in FY19	M
		Performance Measure: Identification of high priority inventory areas through predictive modeling		n/a	**ARCH7**	**Research:** Use predictive modeling to identify high priority inventory areas based on existing data (e.g., vegetation map, geoarcheology, Archeological Overview and Assessment)	**Performance Target:** High priority inventory areas identified by 2033	2013: No funding requested	L
		Performance Measure: Relocation and recording of site information from historic collection sites		n/a	**ARCH8**	**Documentation:** Relocate historic archeological collection sites to appropriately record site information (e.g., Campbells, Johnstons)	**Performance Target:** Documentation complete on Cambells and Johnstons sites by 2033	2013: No, no funding requested	L
		Performance Measure: Recording known unrecorded archeological sites		n/a	**ARCH9**	**Documentation:** Collect baseline documentation on known but unrecorded archeological sites	**Performance Target:** 100% unrecorded known sites are visited and documented by 2028	2013: No, but GIS information avail. on known unrecorded sites, funding requested starting in FY17	H
		Performance Measure: Initiation/completion of park developed area inventories for archeological resources		n/a	**ARCH10**	**Inventory:** Inventory in park developed area cultural resources	**Performance Target:** 100% of developed areas APEs inventories	2013: Partial, no longer eligible for FLREA	H

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Performance Measure: Initiation/completion of survey of fire prone areas for archeological resources		n/a	**ARCH11**	**Inventory:** Conduct archeological surveys in areas subject to increased wildland fires (e.g. pinyon/juniper areas)	**Performance Target:** 25% sample of fire prone areas surveyed for archeological resources	2013: No; funded starting in FY16	H
		Performance Measure: Initiation/completion of multi-year archeological survey		n/a	**ARCH12**	**Inventory:** Conduct multi-year archeological sample survey (9 yr. project, utilize vegetation map and incorporate added lands)	**Performance Target:** Sample survey underway	2013: Some monument lands were sampled in 1991; funds requested for FY19	M
		Performance Measure: Initiation/completion of Coxcomb mountains inventory for archeological resources		n/a	**ARCH13**	**Inventory:** Inventory Coxcomb mountains for archeological resources	**Performance Target:** Survey completed	2013: No, no funding request submitted	L
		Performance Measure: Initiation/completion of prehistoric and historic trails and historic roads inventory		n/a	**ARCH14**	**Inventory:** Inventory prehistoric and historic trails and historic roads	**Performance Target:** Inventory underway, completed by 2028	2013: No	M
		Performance Measure: Initiation/completion of prehistoric quarries inventory		n/a	**ARCH15**	**Inventory:** Inventory and record prehistoric quarries utilizing geologic data to identify inventory areas (e.g., minerals for pigment, pottery, tools)	**Performance Target:** Inventory underway, completed by 2033	2013: No	M
		Performance Measure: Initiation/completion of inventory sites from historic maps		n/a	**ARCH16**	**Inventory:** Record sites from historic maps (e.g., mines, mills, homesteads, historic roads)	**Performance Target:** Inventory completed by 2033	2013: No	M
		Performance Measure: Initiation/completion of boundary lands inventory		n/a	**ARCH17**	**Inventory:** Inventory boundary lands	**Performance Target:** 100% boundary inventoried	2013: Partial	H
		Performance Measure: Initiation/completion of cultural landscapes inventory for archeological resources		n/a	**ARCH18**	**Inventory:** Inventory cultural landscapes for archeological resources including outlying features (e.g., Key Ranch wood piles, beehives, corrals, fields)	**Performance Target:** Inventories of cultural landscapes underway; 1 inventory completed every 15 years	2013: No	M
		Performance Measure: Location and recording of short occupancy sites based on oral histories and homesteading records		n/a	**ARCH19**	**Research:** Locate and record short occupancy sites based on oral histories and homesteading records	**Performance Target:** 100% sites recorded by 20XX	2013: No; HRS research portion funded in FY16	L
		Performance Measure: Initiation/completion of climbing areas inventory for archeological resources		Unknown	**ARCH20**	**Inventory:** Inventory climbing related areas to identify archeological resources (routes, bouldering problems, and social trails)	**Performance Target:** First set of climbing areas inventoried	2013: Yes, ongoing	H
		Condition Indicator: Site condition assessments	**Condition Measure:**	2013: TBD			**Condition Target:** As many assessments done per year as feasible	2013: TBD	
Pre-historic and historic archeological sites preserved, protected and monitored for future research (and possibly limited interpretation of these sites)		**Performance Measure:** Conduct condition assessments of recorded archeological sites		Unknown	**ARCH21**	**Monitoring:** Continue condition assessments of recorded archeological sites (in particular, utilizing site stewardship program)	**Performance Target:** Ongoing monitoring of sites as scheduled in ASMIS; condition assessments complete and reliable	2013: Yes, ongoing	M
		Performance Measure: Number of sites treated/stabilized per year			**ARCH22**	**Direct management:** Stabilize and treat threatened or damaged archeological sites (e.g., rock art sites, midden sites, Echo Cove CA-RIV-919); complete cyclic maintenance of archeological sites	**Performance Target:** One funded site stabilized every 2 years	2013: Partial	H
		Performance Measure: Initiation of contact with authors regarding publishing sensitive information		n/a	**ARCH23**	**Collaboration:** Outreach to authors interested in publishing sensitive archeological site location information	**Performance Target:** Contacts made with authors regarding archeological site publishing (ongoing)	2013: Ongoing	H
		Performance Measure: Investigation of methods of graffiti removal from rock art sites		n/a	**ARCH24**	**Research:** Continue research on methods for removal of paint, etching and climbing chalk on rock art and other archeological sites	**Performance Target:** Methods understood and identified for current and future use	2013: One task agreement for Barker Dam was completed	L
		Performance Measure: Maintenance of closures and implementation of additional closures as needed of cultural resource sites		n/a	**ARCH25**	**Administrative management:** Identify culturally sensitive climbing areas, list as closed in the Superintendent's Compendium, and post and maintain signs in the field.	**Performance Target:** Closures in place and new ones added as appropriate	2013: Yes, ongoing	H

FRV/Attribute	Objective	Condition Indicator	Measures	Condition/Trend	Activity Code	Potential Activity	Condition Target	Target met?	Validated Ranking
		Performance Measure		**N/A**			**Performance Target**		
Cultural anthropology									
Cultural Anthropology	Improved understanding and relationship with traditionally associated peoples in the region and respect their traditional practices	**Performance Measure:** Completion of traditional cultural properties documentation		Unknown	**ANTH1**	**Collaboration and Documentation:** In parternship with affiliated tribes, complete Queen Mountain and Oasis of Mara traditional cultural properties (oral histories and archival material)	**Performance Target:** Queen Mountain and Oasis of Mara completed	2013: Project initiated	H
		Performance Measure: Completion of evaluations for potential, additional traditional cultural properties		n/a	**ANTH2**	**Research:** Evaluate and document sites for their potential as traditional cultural properties	**Performance Target:** Evaluations completed	2013: Not started	M
		Performance Measure: Updating rock art study with spatial and ethnographic analysis		n/a	**ANTH3**	**Research:** Revisit rock art study with spatial and ethnographic analysis	**Performance Target:** Rock art study completed	2013: Not started	H
		Performance Measure: Completion of ethnobotany study		n/a	**ANTH4**	**Resource Education:** Complete the ethnobotany study	**Performance Target:** Ethnobotany study completed and available for interpretive use by 20XX	2013: Partial, draft completed	M
		Performance Measure: Development of interpretive materials and make available		n/a	**ANTH5**	**Resource education:** With interpretive division, promote traditional knowledge/uses of the land; implement cultural interpretive programs	**Performance Target:** Material developed and available to visitors	2013: Not started	L
		Condition Indicator: Completeness of documentation	**Condition Measure:** Percent complete of baseline documents	2013: TBD; Cultural Anthropology program should be analyzed and new projects developed to fill in gaps			**Condition Target:** Documents 100& complete	2013: No	
		Performance Measure: Initiation of baseline ethnographic study and traditional use study		n/a	**ANTH6**	**Direct management:** Conduct ethnographic study and traditional use study of local native peoples	**Performance Target:** Ethnographic study completed by 20XX	2013: Not started	L
		Condition Indicator: Consultations with Tribes and traditionally associated peoples	**Condition Measure:** Number of consultations initiated during the calendar year	2013: TBD			**Condition Target:** At least one per year	2013: TBD	
		Performance Measure: Maintenance of tribal relationships and conducting oral histories		n/a	**ANTH7**	**Collaboration:** Continue and enhance tribal communications, including conducting oral histories	**Performance Target:** Ongoing communication and X # oral histories conducted every X years	2013: Partial, ongoing	H
History									
History	Comprehensive knowledge of the history of the region and the park	**Performance Measure:** Completion of research on select history topics		n/a	**HIST1**	**Research:** Complete research on selected history topics (e.g., recreation, popular culture, historic themes, inholdings, National Park Service stories, California Desert Protection Act, Minerva Hoyt, environmental monitoring, management decisions)	**Performance Target:** History documentation initiated by 20XX	2013: Not started	M
		Condition Indicator: Completeness of documentation	**Condition Measure:** Percent complete	2013: TBD; History program should be analyzed and new projects developed to fill in gaps			**Condition Target:** 100% complete	2013: Partial	
		Performance Measure: Initiation/completion of baseline park administrative history		n/a	**HIST2**	**Documentation:** Research and document park administrative history	**Performance Target:** Administrative History completed by winter of 2014	2013: In progress, to be completed FY14	H
		Performance Measure: Conducting oral histories focused on homesteading and mining		n/a	**HIST3**	**Research:** Continue to conduct archival research and oral histories (including identifying people) that pertain to homesteads, mines, park management user groups and popular culture	**Performance Target:** Ongoing program	2013: Partial, ongoing	H
		Performance Measure: Production of publications based on archival material		n/a	**HIST4**	**Documentation:** Gather archival material and produce publications pertaining to JOTR historical topics	**Performance Target:** Publication completed	2013: Not started	L
		Performance Measure: Completion of updates to 1983 historic resource study and homesteading study		n/a	**HIST5**	**Documentation:** Update 1983 historic resources study and homesteading study, with an emphasis on homesteads and other inholdings within park	**Performance Target:** Updates ongoing	2013: Partial	M
		Performance Measure: Completion of history of the Cambells		n/a	**HIST6**	**Documentation:** Complete history of Elizabeth and William Campbell and document their contributions to early archeology in the California desert	**Performance Target:** History completed (ongoing)	2013: Partial	L
		Performance Measure: Completion of history of mining and associated technologies		n/a	**HIST7**	**Documentation:** Complete history of mining, milling and associated technologies utilized at Joshua Tree	**Performance Target:** History completed by 2024	2013: Not started	L

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
Historic structures									
Historic buildings and structures	Protect historic structures and their character defining elements that may contribute to the listing or eligibility for listing on the National Register of Historic Places or provide for public enjoyment/interpretation	**Condition Indicator:** Completeness and reliability of condition assessments and records of treatment (LCS)	**Condition Measure:** Buildings and structures documented in good condition by professional historic architect	2013: Majority are in fair condition, slowly deteriorating (Yellow, unchanging, medium confidence)			**Condition Target:** Maintain current number of LCS structures in good condition	2013: TBD	
		Performance Measure: See condition measure above			**HSTRU1**	**Monitoring:** Conduct ongoing condition assessments for historic structures every five years	**Condition Target:** See condition target above	2013: No, but some will be worked on this fiscal year	H
		Condition Indicator: Structures with improved condition from direct mitigation/treatment actions	**Condition Measure:** Number of structures stabilized	2013: Good condition, improving, high confidence			**Condition Target:** TBD	2013: TBD	
		Performance Measure: See condition measure above		See above	**HSTRU2**	**Direct management**: Stabilize historic structures through ongoing cyclic maintenance program (e.g., Keys Ranch structures)	**Performance Target:** TBD	2013: TBD	H
		Performance Measure: Completion of HSRs and HABS/HAER documentation for historic structures		Slowly deteriorating	**HSTRU3**	**Documentation**: Initiate and complete historic structures reports (HSR), in order to support visitor services at the Historic Keys Ranch and other locations, and continue Historic American Buildings Survey (HABS), Historic American Engineering Record (HAER), Historic American Landscapes (HAL) and other documentation at appropriate locations	**Performance Target:** Documentation completed by 20XX	2013: No	H
		Performance Measure: Conduct reconstruction of select structures or contributing elements to replace important voids in the historic scene		Ruin	**HSTRU4**	**Direct management:** Reconstruct select structures and/or contributing elements to preserve the visual character of cultural landscapes and historic structures (e.g., Mastodon Mill)	**Performance Target:** Pilot reconstruction project selected and plan developed when necessary and only in very select instances	2013: Not started	M
		Performance Measure: Completion of DOE for Mission 66 structures		Improving, <100%	**HSTRU5**	**Documentation:** Evaluate Mission 66 structures for eligibility to the National Register	**Performance Target:** Determinations completed by 2017	2013: No, but funded in FY16	H
Cultural landscapes									
Cultural landscapes	Improved understanding of the historic integrity, significance, landscape characteristics, and other features associated with ranching, homesteading and mining	**Performance Measure:** Identification of potential cultural landscapes		n/a	**CL1**	**Inventory:** Identify previously undocumented cultural landscapes, survey and record associated archeological sites (e.g., Hardesty report in regards to mining districts - Old Dale, Gold Park, Cottonwood)	**Performance Target:** Documentation complete for newly identified cultural landscapes by 20XX	2013: Not started	L
		Condition Indicator: Completeness of Cultural Landscape Inventories	**Condition Measure:** # of inventories completed, % complete for each inventory	2013: TBD			**Condition Target:** All Cultural Landscapes inventoried	2013: TBD	
		Performance Measure: Completion of GIS documentation and update LCS database		n/a	**CL2**	**Documentation:** Ensure that UTM coordinates are correct on all LCS structures and that their condition status is current	**Performance Target:** Updates ongoing	2013: Yes, at Southern Pinyon	M
		Performance Measure: Completion of Hexie Mountain Mining Historic District CLI		n/a	**CL3**	**Documentation:** Complete Hexie Mountain Mining Historic District CLI	**Performance Target:** CLI documentation initiated by 20XX	2013: Not started	M
	Integrity of character and interrelationships between the structures and their historic setting are maintained	**Condition Indicator:** Cultural landscapes	**Condition Measure:** Improved condition from direct mitigation/treatment actions	2013: TBD			**Condition Target:** TBD	2013: TBD	
		Performance Measure: Implementation of treatment actions		TBD	**CL4**	**Direct management:** Improve and maintain the condition of cultural landscapes (e.g., through vegetation management, maintaining structures and landscape features) at Keys Ranch, Northern Pinyon, Lost Horse Mining Historic District, Hexie Mountain, Southern Pinyon	**Performance Target:** All treatments actions implemented that can be reasonably addressed	2013: Task Agreement in place for Barker Dam graffiti removal in Keys Ranch CLI	H

FRV/Attribute	Objective	Condition Indicator	Measures	Condition/Trend	Activity Code	Potential Activity	Condition Target	Target met?	Validated Ranking
		Performance Measure		**N/A**			**Performance Target**		
		Performance Measure: Implementation of treatment actions		TBD	**CL5**	**Direct management:** Implement treatments recommended in Cultural Landscape Reports (e.g., restoring Joshua Tree fence at Keys Ranch)	**Performance Target:** All treatments actions implemented that can be reasonably addressed after Cultural Landscape Reports are complete	2013: There are no CLRs to implement as of 2013	M
		Performance Measure: Updating of Keys Ranch management plan		n/a	**CL6**	**Direct management:** Consider an updated interim Keys Ranch management plan until Keys Ranch CLR is complete	**Performance Target:** Keys Ranch management plan updated	2013: Unknown	M
		Performance Measure: Development of interpretive materials and make available		n/a	**CL7**	**Resource education:** With the interpretation division, provide interpretive materials to the public about preserving features of Cultural landscapes (e.g., Hexie Mountain CLI)	**Performance Target:** X # of interpretive materials developed (ongoing)	2013: Not started	L
		Performance Measure: Completion of CLR documentation to increase number of completed inventories and treatment strategies		n/a	**CL8**	**Documentation:** Initiate Cultural Landscape Reports (e.g., Keys Ranch- FLREA project)	**Performance Target:** CLR documentation initiated (ongoing)	2013: No	H
Museum collections of archives, natural history specimens, and archeological artifacts									
Museum collection information availability	Museum collection readily accessible and researchable while maintaining NPS standards for the preservation and use of collections	**Performance Measure:** Cataloguing of collection		2013: Increasing, high confidence, Good	**MUS1**	**Direct management:** Fully process and catalogue objects and archives into the Interior Collection Management System (ICMS), including catalogue records currently not in electronic format; maintain and update records as needed.	**Performance Target:** 100% fully catalogued; ongoing process	2013: Partial, ongoing	H
		Performance Measure: Cataloguing off-site collection		n/a	**MUS2**	**Documentation:** Ensure cataloging of undocumented or off-site collection; Identify significant objects related to the park that are stored elsewhere or poorly documented, including research, documentation and collections (see "Opportunity to understand, apply, and share this knowledge to benefit the park and beyond" FRV for transfer of knowledge for research program) and	**Performance Target:** 100% off site collection fully catalogued	2013: Not started	M
		Performance Measure: Digitization of portions of the museum collection for expanded availability and use		n/a	**MUS3**	**Administrative management:** Expand museum collection documentation to the web for use by researchers, and include locations of materials housed at other facilities	**Performance Target:** X % of museum materials digitized and available for expanded use	2013: Not started	M
		Performance Measure: Collaboration with interpretive and resource division work to meet exhibit goals		n/a	**MUS4**	**Collaboration:** Work with interpretive division to increase use of museum collections for development of physical exhibits, webpage, emerging technologies, and interpretive programs (e.g., oral history data)	**Performance Target:** Increase number of successful collaborative projects	2013: Not started	M
		Performance Measure: Cataloguing and storage archival backlog		n/a	**MUS5**	**Direct management:** Joshua Tree NP Administrative Records Phase II: Catalog and properly store archival backlog	**Performance Target:** Archival backlog properly catalogued and stored	2013: Not started	M
Fining aids, catalogs and online resources	Park collection searchable via finding aids and significant collection materials digitized for access	**Performance Measure:** Improvement of finding aids for web and in collections		2013: Unchanging, high confidence, caution	**MUS6**	**Direct management:** Improve finding aids (web and in collections) to increase usefulness for both researchers and park staff	**Performance Target:** Finding aids improved in collections and on web through _____ and _____	2013: Not started	L
Collection facility, storage and exhibit materials	Museum collection storage and exhibit facilities maintained to full National Park Service standards	**Condition Indicator:** Physical storage and exhibit	**Condition Measure:** Storage condition	2013: Unchanging, high confidence, caution			**Condition Target:** Condition meets NPS standards	2013: No, ongoing effort	
		Performance Measure: Continuation of **c**yclic maintenance		n/a	**MUS7**	**Direct Management:** Ongoing cyclic maintenance (physical maintenance) of storage and exhibit facilities according to NPS standards	**Performance Target:** Maintenance needs are addressed on an annual basis	2013: Yes, ongoing	L
		Performance Measure: Address deficiencies in museum checklist		n/a	**MUS8**	**Administrative management:** Identify and address deficiencies in the annual museum checklist for preservation	**Performance Target:** All deficiencies addressed that can be reasonably met	2013: Yes, ongoing	M

FRV/Attribute	Objective	Condition Indicator Performance Measure	Measures	Condition/Trend N/A	Activity Code	Potential Activity	Condition Target Performance Target	Target met?	Validated Ranking
		Condition Indicator: Artifact, specimen, and archival material condition	**Condition Measure:** Condition	2013: Stable (good), high confidence			**Condition Target:** Collection objects, specimens, archives and library materials are in good condition	2013: Partial	
Museum objects and specimens, archives and library materials	Collections objects, specimens, archives and library materials preserved	**Performance Measure:** Continuation of cyclic condition assessments		n/a	**MUS9**	**Direct Management:** Perform conservation and preservation of objects, specimens, archives, and library materials, including natural history collection (e.g., rehouse objects, scan photographs, migrate oral history tapes)	**Performance target:** Conservation/preservation performed (ongoing)	2013: TBD	H
		Performance Measure: Completion of cyclic collection assessments		n/a	**MUS10**	**Monitoring:** Complete cyclic collection condition assessments	**Performance Target:** Ongoing assessments	2013: Yes, ongoing	M

4.1 Introduction to the Comprehensive Strategies

4.1.1 Comprehensive Strategy Timelines

The *comprehensive strategy timelines* present possibilities for sequencing the performance of activities over the next 15 years. These timelines are subject to change and revision as necessary. As knowledge is gained or unforeseen events occur, priorities may shift; in addition, changing levels of funding and staff introduce other elements of uncertainty. However, these timelines represent the park's best approximation of what can be accomplished in resource management in the next 15 years. The comprehensive strategies are part of a living document and are designed to be updated and adapted to changing circumstances.

A timeline has been created for each FRV. Each timeline is divided into two sections. The upper section of each timeline contains those activities that have a discrete beginning and end within the 15 year time-frame, while the bottom section contains those activities that are ongoing throughout the 15 years. Each timeline is preceded by comprehensive strategy details.

For a small number of FRVs, the ranking process resulted in a low number of high ranking activities. In these instances, medium and low ranking activities were added to timelines as appropriate to show a more comprehensive strategy.

4.1.2 Comprehensive Strategy Details

In order for the Joshua Tree NP RSS to be a useful tool in guiding resource management, it needs to be comprehensive, realistic, and strategic. Joshua Tree NP has ensured these standards are met by asking the following questions for each high ranking activity underneath every *fundamental resource and value*: why, who/partnerships, when, where, and how. The detailed information is summarized in narrative form – each narrative attempts to encompass as much information as the park currently has available.

Why: Each activity narrative attempts to explain the necessity of performing a particular activity and affirms that there is a clear link between the management objective and an activity the park has identified.

Who/Partnerships: The narratives attempt to answer the question of who is available to conduct activities over the next 10-15 years. This includes park natural and cultural resource staff; other staff in the park; other NPS staff in the network, region, or beyond; other federal and state agency personnel; Cooperative Ecosystem Studies Units (CESU) and other university partners; other park partner organizations; and members of the public that might volunteer to perform citizen science or citizen stewardship activities. This reflects a pragmatic approach to partnerships and is not confined to who has been engaged in the past. This process also identifies types of expertise that will need to be augmented either through engaging new partners, building staff capacity, filling vacancies, training existing staff, or seeking base increases.

When: The activities are prioritized according to which ones are immediately needed

to manage each *fundamental resource and value*, and which can realistically be tackled during the next 15 years. Certain activities are prerequisites for other activities, and managers need to identify year-by-year who will be available to perform the work. In this way, the RSS charts a tentative course for the next 15 years, recognizing that environmental compliance may be needed before certain decisions are made and that intervening events and knowledge will require adjustments to the strategies. In prioritizing activities, the park considered how plausible climate change scenarios might affect these strategies and which activities yield "no regrets" results (i.e. they would be useful regardless of which of the plausible futures ensue).

Where: Some activities apply park wide. Others pertain to certain geographic areas of the park. To ensure a comprehensive perspective, the park reviewed all of the activities and ensured that high priority areas were not overlooked. The park also looked beyond park boundaries to address habitat fragmentation and connectivity issues, development potential, etc.

How: In crafting strategies for each *fundamental resource and value*, the park considered how to accomplish the activities in such a way that they forward other park objectives. Activity narratives, when applicable, also address:

- Integrating park operations (e.g. opportunities to use interdisciplinary teams and to better understand the historic relationship between humans and the environment in the area).
- Establishing best management practices for park operations to reduce costs and protect park resources.
- Preparing for climate change.
- Promoting relevancy by engaging currently underserved populations.
- Building strong personal bonds with the public through citizen science and stewardship programs.

In addition, a rationale follows each *management objective* to explain, using applicable science and scholarship, why the park should meet an objective.

In the *comprehensive strategy details* sections for each FRV, medium and low priority potential activities are not included; see Table 5 for information related to medium and low ranking potential activities. Those *management objectives* (and the rationales supporting them) whose activities are all currently low and medium priority only are also included in this section. Documenting these rationales provides insight into why a *management objective* was articulated during the initial development of this document, even if activities supporting an objective are not currently high priority. This documentation also serves as a starting point for future strategic planning as medium and low priority activities become higher priority in future years.

4.2 Adaptive Management Strategies with Climate Change Considerations

While adaptive management strategies to address climate change are rapidly being developed, the relative effectiveness of these strategies for mitigating climate change impacts is unclear, partly because there is considerable uncertainty regarding how different species will respond to the effects of climate change (e.g., Eviner & Chapin, 2003), or how interactions among species will be affected (e.g., Peterson et al., 2002).

The Joshua Tree NP scenario planning effort in 2007 enabled park management to develop and test strategies under a range of plausible climate futures. Doing this proactively, essentially rehearsing for multiple futures, strengthens the park's ability to recognize, adapt to, and take advantage of changes over time (Global Business Network, 2009). The three climate scenarios generated during the 2007 workshop (Appendix C) provide a view into the range of plausible future conditions to support development of management strategies, some of which may entail novel approaches. Outcomes from the climate change scenario planning effort are used to feed the RSS process including: *1. Wind Tunnel Testing, 2. Robust Strategy Development, and 3. Monitoring.*

Wind Tunnel Testing

When considering existing, or developing new management strategies at Joshua Tree NP, managers can use the climate scenarios to ask, "Does the strategy make sense under the scenarios?" Seen through the context of the scenarios, it may be apparent that continuing some current activities is an unwise expenditure of time/resources, while other activities may warrant additional effort. In some cases, entirely new approaches may also be prudent. Scenarios enable park managers to make better informed decisions regarding what level of risk they are willing to take with future park investments. The term used to describe this process is sometimes referred to as "wind tunnel" testing (Van Der Heijden, 2005).

Robust Strategies

"Robust" or "no regrets" strategies are those strategies that make sense under all three of the park's climate scenarios as appropriate in the *comprehensive strategy details*. "R" labels are listed in brackets following the activity title. These strategies provide good preparation for future events, and represent low risk with respect to influences from the three plausible climate futures. The approaches for adaptation (seven Rs) listed below provide a starting point for strategy development within the context of a changing climate (West et al., 2009):

1. Reduce: Reduce existing anthropogenic threats and stressors.
2. Resilience: Protect key ecosystem and cultural resource features that promote resilience and sustainability.
3. Representation: Maintain representation of important species, communities, physical environments, and cultural resources.
4. Replication: Replicate species, genotypes, and habitats to reduce extinction risk.
5. Restore: Restore degraded ecosystems and cultural resources to maximize adaptive capacity sustainability.
6. Refugia: Identify/protect refugia or important landscape connections or corridors that facilitate migration.
7. Relocation: Relocate species and populations or "assist" migration.

8. Reconnaissance: Inventory to understand baseline conditions or ongoing monitoring to assess effects of climate change adaptation strategies.

9. Relationships: Cultivate relationships between the park and partners in order to understand each others' missions and work towards similar climate change strategic goals.

If applicable, an activity is labeled with one or more of the Rs listed above. These Rs were applied only to potential activities with a ranking level of "high priority". The two additional Rs (8 and 9) not associated with West et al. (2009), were determined to be relevant in preparing for climate change at Joshua Tree NP and are included for purposes of the Joshua Tree NP RSS. The definitions for Rs 1-7 were modified in order to consider cultural resources. They vary slightly from the definitions presented in West et al. (2009). The potential activities are also categorized by Rs in Appendix G.

A list of robust strategies for consideration in the Joshua Tree NP RSS are found in Table C.6 of Weeks and Gross (2013), Appendix C. This list was generated from the 2007 Joshua Tree NP workshop outcomes and recommendations found in Sanders, Easly and Spencer (2010) and Loehman (2010). Robust strategies without an asterisk were not addressed in the RSS, but serve as a reminder for additional activities to consider in the future. The climate scenarios for the park can further help to set priorities among the strategies generated in the RSS.

Monitoring

"Monitoring," is another critical element in scenario planning. Climate change scenario work is an adaptive living process that requires review of new information and understanding to further develop, validate, or potentially invalidate a given scenario. Monitoring the climate variables (temperature, precipitation, storm events, drought, extreme temperature events) as well as the effects that form the climate change scenarios is important in tracking how the future unfolds relative to the scenario projections, so that decisions use the most current information possible. Monitoring recommendations for the park are found in Weeks and Gross (2013) (Appendix C). Potential activities that evaluate climate-driven effects for Joshua Tree NP's resources (i.e., the monitoring component) are listed in Appendix G (Table G.6) under "Reconnaissance".

4.3 Comprehensive Strategy Timeline and Details

4.3.1a Comprehensive Strategy Details: Biological Diversity and Healthy Ecosystem Function (Vegetation)

Biological Diversity Objective #1: Improve knowledge of trends in Joshua tree distribution and resilience to environmental change

Rationale: Joshua trees (*Yucca brevifolia*) are the park's namesake and a primary visitor attraction; sustaining Joshua tree populations at the park in the face of changing climate is of primary importance to park management (NPS, 2011). While multiple climate modeling efforts predict that Joshua trees will be vulnerable to the effects of climate change (Cole et al., 2011; Barrows & Murphy-Mariscal, 2012) the park has no current long-term Joshua tree monitoring program. Thus, demographic trends are poorly understood and vulnerability of populations to climate change is uncertain but suspected. Based on the park's *Vulnerability Assessment* (Hoines et al., 2014), the Joshua tree will be responsive to climate change and distribution is expected to reduce in size, with recruitment and long-distance seed dispersal also compromised.

BIO1: Monitoring: Monitor Joshua tree abundance, reproductive success, associated temperature regimes, fire extent and invasive species in Joshua tree woodlands. [Reconnaissance]
Monitoring Joshua tree populations will allow the park to track abundance, reproductive success and demographic trends. These metrics will serve as indicators of population health and guide the park in taking direct management actions in the future, if necessary. Repeat monitoring should take place once every five years and will occur at sites identified in the Hogan report (1977) on Joshua trees. These stands of Joshua trees are spread throughout the western portion of the park. The park's vegetation branch manager can poll available resources and determine if the monitoring can be done in-house or can be implemented with an external research team. Data from a robust demographic monitoring program will allow natural resource managers and interpretive staff to discuss how Joshua trees are responding to climate change and other threats.

Biological Diversity Objective #2: Understand and minimize threats to Joshua trees within park

Rationale: Threats to Joshua tree populations in the park currently include invasive species, altered fire regimes, changing temperature and precipitation patterns and air pollution (Barrows & Murphy-Mariscal, 2012). Some threats are not within the realm of direct management by the park, but other threats, including altered fire regimes and invasive species (Rao et al., 2010), can be minimized through effective park resource management.

BIO4: Direct Management: Control non-native annual grasses associated with Joshua tree stands in order to minimize threats from fire. [Reduce], [Resilience], [Representation], [Restore]
Non-native annual grasses increase fuel loads for fire in the park and alter fire regimes. Increased fire return intervals and the size and intensity of fires in the desert all contribute to declining Joshua tree populations (Defalco et al., 2010). Barrows and Murphy-Mariscal (2012) modeled Joshua tree habitat in the park; this work predicted that remaining habitat for Joshua trees, even with a three degree increase in summer temperatures, may contract and be co-located in areas of high fire-likelihood at Joshua Tree National Park. Finding effective control measures for invasive grasses will help remaining Joshua tree habitats be resilient to fire and allow Joshua tree populations to persist into the future.

This ongoing activity will be performed by an invasives species technician in conjunction with the *Exotic Plant Management Team* (EPMT) and supervised by the vegetation branch manager. Focal areas are select Joshua tree stands with high-vulnerability to fire or recent fire-damage.

Through this activity, practices outlined in *Spread of Invasive Plants: Best Management Practices for Land Managers* (California Invasive Plant Council, 2012) can be integrated into park operations, including maintenance and fire operations.

BIO6: Investigate sources and timing of N deposition and other airborne pollutants and impacts on native flora, including Joshua Trees. [Reconnaissance]
Portions of Joshua Tree National Park are experiencing anthropogenic nitrogen deposition loads above the critical load limit (the point at which detectable changes in ecosystem processes occur) for the California deserts (Allen et al., 2009; Rao et al., 2010). At Joshua Tree NP, the critical load of nitrogen occurs when native annuals are no longer able to compete with non-native grasses for excess nitrogen. In areas of higher nitrogen, non-native grasses proliferate, which in turn can alter fire regimes (Allen et al., 2009; Rao & Allen, 2010) and impact native flora. Altered temperature and precipitation regimes may also amplify invasive abundance, further impacting native flora. For these reasons, further work to understand impacts of increased nitrogen should be performed, particularly in collaboration with external research partners.

Biological Diversity Objective #3: Improved knowledge of trends in distribution of juniper woodlands, Mojave mid-elevation mixed desert scrub, and California mesic north-slope chaparral and resilience of these communities to environmental change

Rationale: The park has limited knowledge of abundance and distribution of species included in the juniper woodland, Mojave mid-elevation mixed desert scrub, and California mesic north-slope chaparral. Plant species representative of these communities include single-leaf pinyon pine (*Pinus monophylla*), California juniper (*Juniperus californica*), blackbrush (*Coleogyne ramosissma*), big-berry manzanita (*Arctostaphylos glauca*), and scrub oaks (*Quercus* spp.). These communities may be especially vulnerable to altered precipitation regimes (in particular, drought) caused by changing climate (Gitlin et al., 2006).

BIO8: Track trends in abundance and reproductive success of pinyon/manzanita/oak communities, and associated temperature regimes, fire extent, invasive species. [Reconnaissance]
Based upon the park's *Vulnerability Assessment*, species common in these communities, including blackbrush (*Coleogyne ramosissma*), single-leaf pinyon pine (*Pinus monophylla*), and California juniper (*Juniperus californica*) may be highly impacted by direct and indirect effects of climate change (Hoines et al., 2014). Each of the vulnerable plants has episodic reproduction and projected changes in temperature and precipitation will likely push these systems out of the range of variability that is required to induce reproduction and/or germination. Many of these species are susceptible to prolonged drought through direct mortality and indirectly through the loss of mycorrhizal symbionts. Additionally, changes in the timing and amount of precipitation were shown to impact these species dramatically at different life stages. Decreased soil moisture caused mortality of adults in several studies; each of these species is documented (literature or anecdotally) to require a chilling period for reproduction or germination. Projected increases of the average minimum temperatures are likely to disrupt the population dynamics for these species. Most notably, increased fire activity dramatically reduces the abundance and cover for each of these species and will play a large role in shaping community and population dynamics (Hoines et al., 2014).

Species from this community should be targets for monitoring to understand the effects of climate change. Monitoring of this community will take place in conjunction with the "*Managing biodiversity along transition zones in the face of climate change*" project (see activity # EXP 7). In addition, opportunistic seed collection will be necessary if the park wants to attempt habitat restoration or create new and novel communities in response to climate change.

Biological Diversity Objective #4: Improved knowledge of plant/animal/microorganism interactions in west-park, higher elevation habitat communities (i.e. juniper woodland, Mojave mid-elevation mixed desert scrub, and California mesic north-slope chaparral), and potential novel plant/animal associations emerging there

Rationale: New plant/soil microbial associations may be emerging in these communities; for example many plant species maintain soil microbial symbiotic relationships to acquire nitrogen and other nutrients. Research suggests a decrease in soil microbial biomass with nitrogen fertilization (Treseder, 2008) and that soil microbes play an important role in regulating plant communities, diversity, and abundance (van der Heijden et al., 2008). Developing an understanding of these important relationships may help explain aboveground community changes and identify a suite of management actions for mitigating or ameliorating their impacts.

Biological Diversity Objective #5: Increased knowledge of community structure, distribution and trends of Colorado Desert flora

Rationale: The park has limited knowledge of community structure and species distributions and trends in the Colorado Desert. These communities may be especially vulnerable to altered precipitation regimes (in particular, drought) caused by changing climate (Miriti et al., 2007; McAuliffe & Hamerlynck, 2010).

BIO12: Monitoring: Track trends in the distribution and species composition of plants/animals/microbial communities in the Mojave/Colorado Desert transition zone. [Reconnaissance]
As climates warm, species' ranges may shift northwards or towards higher elevations, tracking those climate conditions to which they are adapted. In the park, Colorado Desert species may expand in abundance and range; while species indicative of the Mojave Desert may contract. Community dynamics in the transition zone are likely to be driven by climate extremes in drought and precipitation.

Monitoring activities should become a priority for the park and the Resource Management division at Joshua Tree NP and integrated into annual work plans. Monitoring of this community will take place as part of the ""*Managing biodiversity along transition zones in the face of climate change*" project (see activity # EXP 7). Selected plots in the Mojave/Colorado Desert transition zone can be read every 3-5 years. These climate change monitoring projects can incorporate volunteers and are a direct link to developing better education programs. Monitoring this transition zone is important for developing a range of management alternatives and describing the effects of climate change to park visitors.

BIO13: Monitoring: Track trends in Ocotillo abundance (as representative of a larger plant community) and migration. [Reconnaissance]
The distinctive ocotillo plant *(Fouquieria splendens)*, may be used as an indicator species for Joshua Tree NP's Mojave/Colorado desert transition zone. Selected sites in the ocotillo patch and other locations along the Mojave Desert Transition zone may be monitored. See BIO12 description for more information.

Biological Diversity Objective #6: All known populations of rare, threatened and endangered plants stable or increasing; high quality habitat; human impacts on rare plant populations minimized

Rationale: Two federally listed plant species, *Erigeron parishii* and *Astragalus tricarinatus*, and 44 state-listed plant species are currently present within the park. While the park has documented the presence of these species and has some baseline information for the two federally listed species

and 4 state-listed species *(Monardella robisonii, Calochortus striatus, Polygala acanthoclada, Penstemon thurberi and Wislizenia refracta),* abundance and distribution information is uncertain.

BIO15: Research: Improve knowledge of two federally-listed plant species. [Reconnaissance]
Increased knowledge of *Erigeron parishii* and *Astragalus tricarinatus* is needed for effective conservation; knowledge gaps include complete location and abundance information, identification of genetic markers, establishment of baseline seed germination information and other ecology studies. Currently, managers have documented two populations of *E. parishii* in the Little San Bernardino Mountains and 50 individuals of *A. tricarinatus* in the Little San Bernardino Mountains. More information and actions will be described in forthcoming (FY14) management plans for these two federally listed species.

BIO16: Administrative management: Complete management plans for federally listed plant species (including addressing how to minimize human impacts, e.g., N deposition).
A management plan will outline a long-term monitoring program, establish population thresholds and identify direct management actions if necessary. Management plans are slated to be complete at the end of FY14.

BIO17: Monitoring: Document continued presence of 44 state-listed plant species (continue mapping and inventory). [Reconnaissance]
Populations of the park's 44 state-listed plant species exist at locations throughout the park. Most data the park currently has is casual and observations are added to the park's geodatabase as they are obtained. The park should strive for thorough documentation of abundance and distribution of these state listed species in the park. However, with current limitations in current staff and funding, documentation must be completed opportunistically by available staff. All Resource Management staff should be educated on identification of these species and trained in data collection.

Biological Diversity Objective #7: Native plant communities resilient; non-native plant richness and abundance declining

Rationale: "Alien plant invasions constitute one of the most pervasive, fast-moving and often visually striking manifestations of global change" (Arroyo et al., 2000). Alien plant invaders are species that establish beyond their natural distributional ranges often through intentional and accidental transportation of whole plants or plant propagules. Invasive plants are often escapees from cultivation and subsequently become naturalized, or piggyback within crops or on domestic animals or even on the soles of nature lovers out for a hike (Arroyo et al., 2000). Regardless of the pathway for introduction, invasive species are widely recognized as a major threat to native species, only behind that of habitat loss (Wilcove et al., 1998; Levine et al., 2003; Thompson, 2005).

There have been many well documented, wide spread plant invaders to the Mojave Desert ecosystem, such at red brome (*Bromus madritensis*), cheat grass (*Bromus tectorum*), and salt cedar (*Tamarisk ramosisima*). At the time of writing, 63 plants (~8%) on Joshua Tree's plant list are considered non-native, 41 of which are classified as invasive.

BIO18: Monitoring: Continue active early detection program to inventory and control noxious novel weeds and track changes in behavior of existing invasive plant populations (in conjunction with MOJN I&M work). [Reconnaissance], [Reduce]
Because resources for dealing with invasive species are limited, it is essential to select cost-effective methods for control. Once established within a natural area it is widely recognized that invasive plant populations are difficult, if not impossible, to eradicate. Invasive plants can reduce or displace native species and have been shown to alter ecosystem function; they are therefore recognized as significant conservation concerns (Vitousek, 1986; Schofield, 1989; Hobbs & Huenneke, 1992). Weed invasions have been linked with the extinction of several endemic plant species and continue to threaten the existence of others (Briggs & Leigh, 1996; Matarczyk et al., 2002). Rare species with small populations

or restricted geographic ranges may be particularly vulnerable to weeds (Walck et al., 1999; Matarczyk et al., 2002).

Resources Management staff, specifically vegetation staff supervised by the vegetation branch chief, will perform early detection, and control actions as necessary on an ongoing, cyclic basis. Weed surveys are especially critical for the success in early detection and rapid response efforts (Dewey & Andersen, 2004). Weed surveys and inventories can be described as single point-in-time observations or searches to determine the occurrence (location and abundance) of one or more weed species within a delineated management area (North American Invasive Species Management Association, 2002; Dewey & Andersen, 2004). The objective of a weed survey is to sample a representative portion of a greater weed population, while a weed inventory is intended to account for the entire population of the targeted plant species within a defined geographic area (Moore & Chapman, 1986; Pugnaire & Valladares, 1999; Dewey & Andersen, 2004). At Joshua Tree NP, a systematic approach will begin with areas of high likelihood for invasion such as disturbance corridors. These corridors could be natural, as in the case of riparian zones, or anthropogenic, as in roads, trails, or pipelines, and frequently facilitate the spread of non-indigenous species into undisturbed habitats (D'Antonio et al., 1999). Within the southwest deserts, roads appear to have allowed exotic annual grasses and forbs to invade and pose a major conservation challenge (Gelbard & Belnap, 2003). Additionally, this systematic approach will include valuable areas or areas with high conservation value (e.g., rare plant habitat, areas of high biodiversity).

Invasive species prevention can be integrated into all aspects of park operations. Park staff should be educated to the detrimental impacts associated with invasive species and better informed on actions each employee can take. Resources Management staff will utilize *Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers* (California Invasive Plant Council, 2012).

BIO19: Administrative management: Complete invasive species management plan.
An invasive species management plan will formally identify high-priority species and population locations, a framework for annual monitoring, necessary research activities to increase the park's invasive plant knowledge base and authorized treatment methods.

The vegetation branch manager will complete this activity within the next five years. The plan will apply park-wide with specific focus on prevention, park operations, early detection and rapid response, treatment options, and education. Invasive species prevention can be integrated into all aspects of park operations. Park staff should be educated on the detrimental impacts associated with invasive species and better informed on actions each employee can take. Resources Management staff will utilize *Preventing the Spread of Invasive Plants: Best management Practices for Land Managers* (California Invasive Plant Council, 2012).

Biological Diversity Objective #8: Improved knowledge and documentation of plant communities and species

Rationale: The park has recently made great strides in increasing knowledge and documentation of plant species in the park, including near-completion of web-based floras, vegetation community maps, and lichen and bryophyte inventories. The park will continue to build on these efforts.

Biological Diversity Objective #9: Improved knowledge of ecosystem adaptation in the park

Rationale:

BIO25: Monitoring: Track trends in phenology of key plant and pollinator species (in conjunction with University of California at Santa Barbara (UCSB) and the National Phenology Network through the NPS California Phenology Project). [Reconnaissance]

Phenology is the study of seasonal or periodic biological events such as plant leaf-out, flowering, insect emergence, and animal migration. Put simply, phenology is the science of the seasons. Since 2010, Joshua Tree NP has participated in the California Phenology Project, collecting nearly three years of continuous phenological monitoring data on seven park plant species. The park is currently monitoring 64 sites along 4 different trails or roads with the help of volunteers; this project is a prime example of using citizen science to help further the park's scientific knowledge.

The phenological status of plants and animals across the seasons is dynamic and is closely linked to climatic and ecological variables. Consequently, tracking the phenology of plants and animals is a compelling way to study how living systems are functioning in response to climate variability and, over the long-term, to climate change. Phenological knowledge will inform natural resource managers about the seven monitored species' response to the effects of climate change. Phenological monitoring data should be periodically reviewed and shared with Joshua Tree NP interpretation and education staff for use in interpretive programs.

This is an ongoing activity that will be performed by a Student Conservation Association (SCA) intern and/or volunteers supervised by the vegetation branch chief, following protocols created for the California Phenology Project and entering and storing data through the National Phenology Network's *Nature's Notebook* website.

Biological Diversity Objective #10: Improved knowledge of phosphorous deposition from fire retardant use and effects on plant communities

Rationale: Phosphorous additions to desert ecosystems have been shown to increase the abundance of non-native grasses. Fire retardants have been improved over the years, but many still contain high levels of phosphorous. The addition of phosphorous from fire retardant use, in combination with increased anthropogenic nitrogen (N) deposition, may result in an increase in non-native plant fuel loads greater than what would be caused by nitrogen deposition alone. The essential question is "does using fire retardant to minimize fire size make future fuel loads worse?"

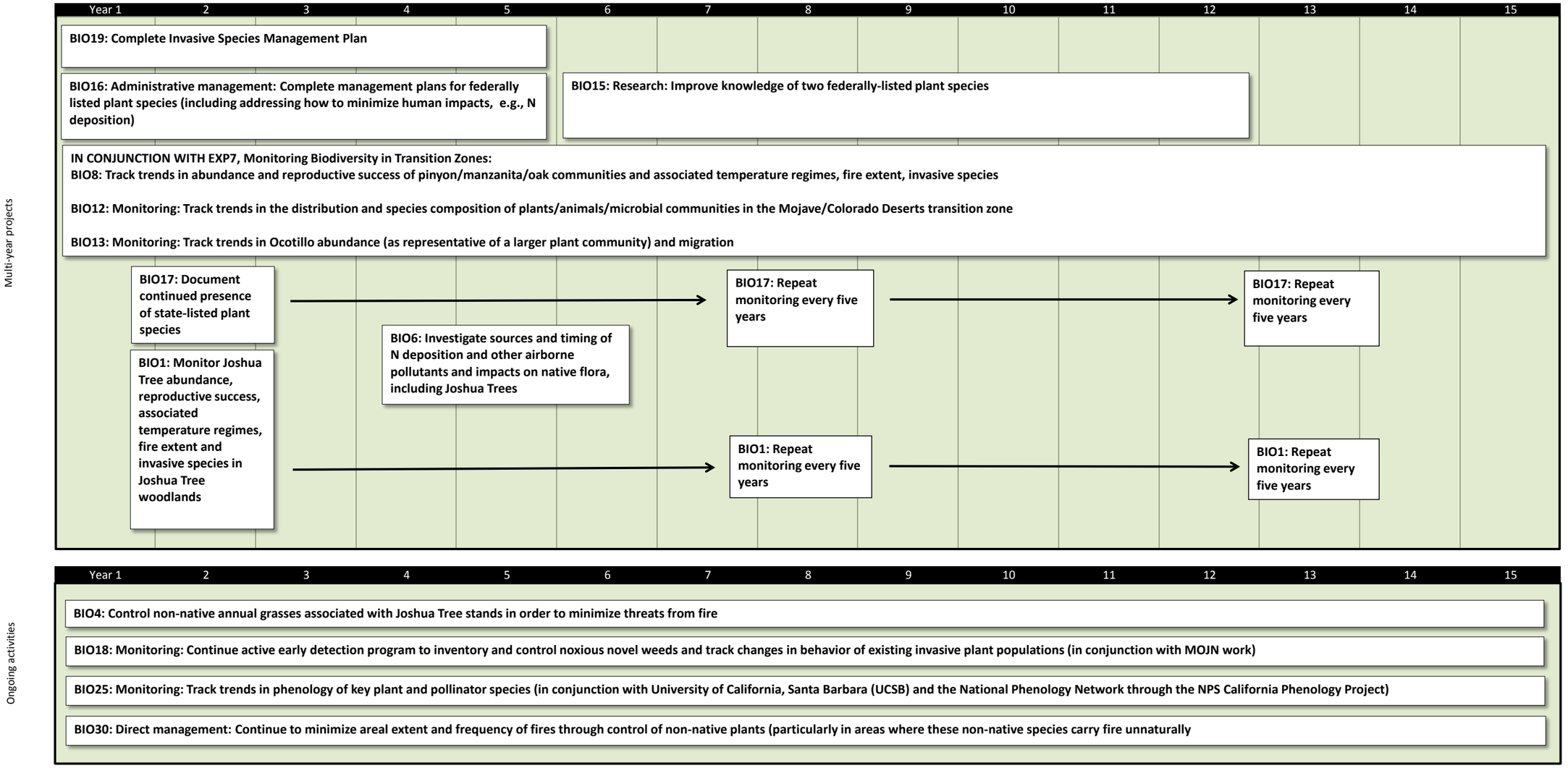
Biological Diversity Objective #11: Minimize impacts to native flora and fauna from perturbed fire regime

Rationale: The park suspects an altered fire regime will type-convert many of the shrublands to annual, invasive grasslands with a fire return interval short enough to eliminate most of the perennial shrubs from these locations. Unpublished data from Joshua Tree NP shows changes in percent cover between areas that have not burned, burned once, and locations that have burned two times. This preliminary data set shows a significant increase in invasive cover between all three treatments.

BIO30: Direct management: Continue to minimize areal extent and frequency of fires through control of non-native plants (particularly in areas where these non-native species carry fire unnaturally). [Reduce], [Resilience], [Restore]

Non-native plants create fine fuel loads which carry fires farther than they would have been carried historically. Fires reduce native plant cover and increase invasive plant loads, thereby increasing the likelihood of additional fires (Brooks & Pyke, 2001). This ongoing activity will be conducted by Resources Management staff supervised by the vegetation branch manager.

4.3.1b Comprehensive Strategy Timeline: Biological diversity and healthy ecosystem function (Vegetation)



4.3.1b Comprehensive Strategy Details: Biological Diversity and Healthy Ecosystem Function (Wildlife)

Biological Diversity Objective #12: Improved knowledge of abundance and distribution of desert tortoise in the park

Rationale: The Mojave population of desert tortoise was listed as threatened under the Endangered Species Act and the first recovery plan was published in 1994. In 2011, the recovery plan was updated to include new information relating to population decline and to outline recovery actions (U.S. Fish and Wildlife Service, 2011). Joshua Tree NP contains some of the best protected habitat for the desert tortoise as the park is relatively free of many of the threats that plague desert habitats found outside of its borders (Lovich & Ennen, 2011). Even with this greater protection, the populations in the park have been in steep decline and may have only recently stabilized.

BIO35: Monitoring: Continue to assist USFWS with range-wide monitoring of desert tortoise. [Reconnaissance]

The USFWS is challenged with the recovery of the desert tortoise and the park contains some of the best protected desert tortoise habitat within the species' range. However, the desert tortoise is one of the reptiles in the park most vulnerable to the effects of climate change (Hoines et al., 2013). Possible effects include reduction of food abundance due to drought, skewed sex ratios due to more males being produced at higher temperatures, and potential for seasonal mismatch with tortoise forage in terms of spring wildflowers (i.e. preferred wildflower forage is unavailable during times of tortoise activity).

The park has supported the USFWS with range-wide monitoring of desert tortoise since 2001 by provision of funds and/or field assistance for monitoring efforts. Desert tortoise monitoring takes place at randomly assigned plots within the park; assistance to the USFWS for this ongoing effort is provided by the park's wildlife ecologist and wildlife technicians. In addition, the park has many tortoises with transmitters that can be used to help create G_0 estimations (i.e., the proportion of tortoises that can be detected by line-distance sampling) for the USFWS desert tortoise dataset.

BIO36: Collaboration: Work with USFWS Desert Tortoise Recovery Implementation Team to promote goals of the plan. [Relationships]

The *Revised Recovery Plan for the Mojave Population of the Desert Tortoise* (U.S. Fish and Wildlife Service, 2011) created *Recovery Implementation Teams* (RIT) in which representatives of land management agencies collaborate within designated Recovery Units to implement recovery actions that will have the most positive impact. This ongoing action is performed at the park by the wildlife ecologist, who will continue to collaborate with the RITs to assist with the recovery of the desert tortoise. It is likely that some of the recovery actions delineated by the RIT will include public outreach.

Biological Diversity Objective #13: Minimization of impacts to tortoises from human activities

Rationale: Current impacts to desert tortoise from human activities in the park include road mortalities, poaching, disease spread and indirect threats from subsidy of predatory raven populations (NPS, 2013). Energy developments represent another human activity that may affect tortoise populations (Lovich & Ennen, 2011).

Biological Diversity Objective #14: Improved understanding of range and meta-population dynamics of desert bighorn sheep

Rationale: It is unlikely that the park's desert bighorn sheep populations can continue to exist without open corridors to neighboring mountain ranges. The metapopulation dynamic which is often used to describe bighorn sheep populations relies on immigration and emigration of sheep from neighboring to mountain systems to maintain genetic integrity as well as to supplement local populations that may become depressed. By understanding where these important corridors exist or existed, the park can work with other land managers to maintain or reopen these movement corridors.

BIO45: Inventory: Evaluate existing water sources for desert bighorn sheep.
Greater understanding of all available water sources for bighorn sheep (especially those sources that have water during the hot summer months) would provide the park with a better idea of how much critical summertime habitat is available for this species. Specifically, data from MOJN I&M-initiated springs monitoring will be utilized to create updated models predicting current suitable habitat for sheep. This activity will be performed by the wildlife ecologist with support from wildlife staff.

Biological Diversity Objective #15: Minimize disturbance to bighorn sheep from park visitors at selected locations

Rationale: Springs and other water sources are very important to bighorn sheep, especially during the hot summer months (Longshore et al., 2008). These water sources are also highly visited locations in the park as they are biodiversity hot spots. Human presence may disturb sheep at close proximity and may prevent sheep from accessing important habitat (MacArthur et al., 1982). According to numerous personal observations by researchers and others, the Barker Dam groups and Anza Borrego's Palm Canyon group appear unaffected by people (C. Barrows, personal communication, September 12, 2013). As climates shift, the sheep may need to move up in elevation and drought and limited access to water will restrict their habitat (Hoines et al., 2013). This migration would remove sheep from areas near humans, such as the oases, but also put sheep in a difficult situation for water/prey/forage. Finding a balance that allows for visitation and undisturbed access during the summer months for bighorn sheep is a goal (Hicks & Elder, 1979).

BIO47: Direct management: Maintain closures to human visitation at Cow Camp and Keys Ranch. Implement measures to protect sheep populations from visitor impacts at 49 Palms Oasis, Barker Dam, and other water sources. [Reduce]
It has been documented that in certain instances, bighorn sheep will not access water sources if humans are present. Sheep rely on these water sources throughout the year and lack of access could impact population size through the reduction of critical summertime habitat (Longshore et al., 2008). The wildlife ecologist will work in conjunction with park management to maintain closures and implement protection measures at water sources as needed.

Biological Diversity Objective #16: Minimize disturbances to eagle and raptor nesting from recreation activities

Rationale: Recreational activities including climbing, bouldering, and hiking are known to disturb eagle and raptor nesting (Richardson & Miller, 1997). The park has enacted temporary closures of recreational use areas to allow for uninhibited nesting.

BIO49: Direct management: Maintain climbing and hiking route closures during raptor nesting season; track compliance with closures and nesting presence and nest success.
Raptors (eagles, hawks, falcons, vultures, ospreys, harriers, kites and owls) are birds of prey and excellent indicators of ecosystem health. The park has closed areas in the past for the protection

of nesting raptors; however the success rate of these closures is not fully known. The wildlife ecologist will work in ongoing collaboration with park law enforcement staff to maintain and enforce closures as needed during nesting season at nest sites vulnerable to disturbance from climbing and hiking. A major goal of this program is to involve the climbing community to assist with nesting locations found near climbing routes.

Biological Diversity Objective #17: Better understand impacts of development near park boundaries (specifically energy developments) on raptors and eagles

Rationale: It is suspected that renewable energy developments may have impacts on raptor and eagle populations, but the full impacts are not well understood (Smallwood, Rugge, & Morrison, 2009; Pearce-Higgins, Stephen, Langston, Bainbridge, & Bullman, 2009).

BIO51: Collaboration: Work with park partners, including USFWS, to track and minimize impacts to eagles and raptors (e.g. collaborating with BLM & USFWS on research about large scale renewable resource development effects on raptors). [Partnership]

Large scale development of desert lands directly reduces foraging habitat available to raptors. It is not directly understood what impact this development will have on raptor populations as a whole. The park is involved with and comments on these issues and will continue to do so. The area under the most consideration for development is adjacent to the eastern boundary of the park. The chief of resources, with assistance from the wildlife ecologist, will continue involvement with multiple agencies.

Biological Diversity Objective #18: Maintain, where possible, California treefrog in historically occupied habitat, with demonstrated reintroduction success

Rationale: In the 1960s, California treefrogs were found in seven drainages; currently, they are only found in three. The California treefrog may be at risk for extirpation from the park within the next few years (Phillipsen, 2006). In order to sustain populations in the park, management will study the extirpation of, maintain, and re-introduce where necessary populations of California treefrogs.

BIO53: Admin Management: Develop a California tree frog reintroduction plan. This includes studying and understanding the reasons for extirpation in previously inhabited California treefrog habitats of the park.

A California treefrog reintroduction plan will evaluate the extirpation of populations, suitable habitat/areas for re-introduction at extirpated sites, methods for re-introduction and monitoring, and minimum population thresholds. Based upon the park's *Vulnerability Assessment*, the California treefrog was identified as one of the most vulnerable reptile species to climate change (Hoines et al., 2014). Habitat areas for this species are likely to shrink with decreasing precipitation and drought. In addition, this species has a limited ability to colonize new areas. Water temperature may affect egg survivorship in areas of suitable habitat. The California treefrog reintroduction plan will be built on previous efforts by Oufiero et al. (2008) that examined current threats and long-term protection measures for the park's population of frogs. Timing of reintroduction efforts will be dependent on precipitation-levels.

Biological Diversity Objective #19: Maintain high quality natural and artificial habitat for bats

Rationale: The twelve bat species that have been documented in the park not only use natural habitat such as caves and overhanging rock but have also come to use artificial habitat such as mines.

BIO56: Direct management: Evaluate mine openings for bat habitat and visitor safety; gate mine openings where necessary; maintain existing gates.
In order to maintain visitor safety and maintain habitat for bats, the park will continue to evaluate mine opening for bat habitat and use bat gates when necessary. Wildlife staff will work in conjunction with physical science staff to gate mine openings; this activity will only be performed when mine closures are deemed necessary for safety purposes.

BIO60: Monitoring: Track trends in bat species richness at open water habitat and palm oases. [Reconnaissance]
Some bat species at Joshua Tree National Park rely on rare riparian habitat and palm oases as water sources. A monitoring program will indicate the continued persistence of bat species at riparian areas across the park. This activity will be performed at selected riparian areas by the wildlife ecologist and wildlife technicians. It may also be completed through the assistance of external partners. The park can track covariates, such as finescale precipitation and temperature monitoring, which may explain any changes in occurence or abundance of bat populations that may be detected.

Biological Diversity Objective #20: Improved understanding of trends in bird species richness in park

Rationale: Bird species occurrence is generally well-documented in the park; however, the park does not have formal year-round monitoring programs in place and has limited information about dynamics in bird species abundance and distribution.

Biological Diversity Objective #21: Improved understanding and persistence of reptile and amphibian species richness in park

Rationale: Reptiles and amphibians are included in the suite of taxa the park will monitor to understand the effects of climate change in the park's transition zones.

BIO63: Monitoring: Track trends in reptile and amphibian distributions, ranges, and abundances across the transition zone (community trends and response to climate change monitoring). [Reconnaissance]
Based upon the park's *Vulnerability Assessment*, Blainville's horned lizard (*Phrynosoma blainvillii),* the western fence lizard *(Sceloporus occidentalis),* and the yucca night lizard *(Xanatusia vigilis vigilis),* along with the aforementioned desert tortoise and California treefrog, represent the five amphibians and reptiles most vulnerable to climate change (Hoines et al., 2014). While reptiles are cold-blooded organisms, warmer temperatures appear to be a common cause for disruption in species populations. Increased temperatures may have four broad impacts. First, increased temperatures are likely to reduce the area of available habitat as plants and animals are forced to move upslope in search of more favorable climates. Second, increased temperatures during different seasons may lead to a mismatch in reproduction or prey availability. The third implication of increased temperature on vulnerable reptiles is possible impacts on reproduction. Increased soil temperatures have been associated with altered sex ratios and loss of egg survivorship. Last, increased temperatures for many vulnerable species would be above the documented physiological tolerance for many of these species. In addition to temperature, limited dispersal abilities may amplify the effects of climate change. Another common theme is the impact of drought on prey/forage availability and the direct relationship with growth, size and survivorship (Hoines et al., 2013).

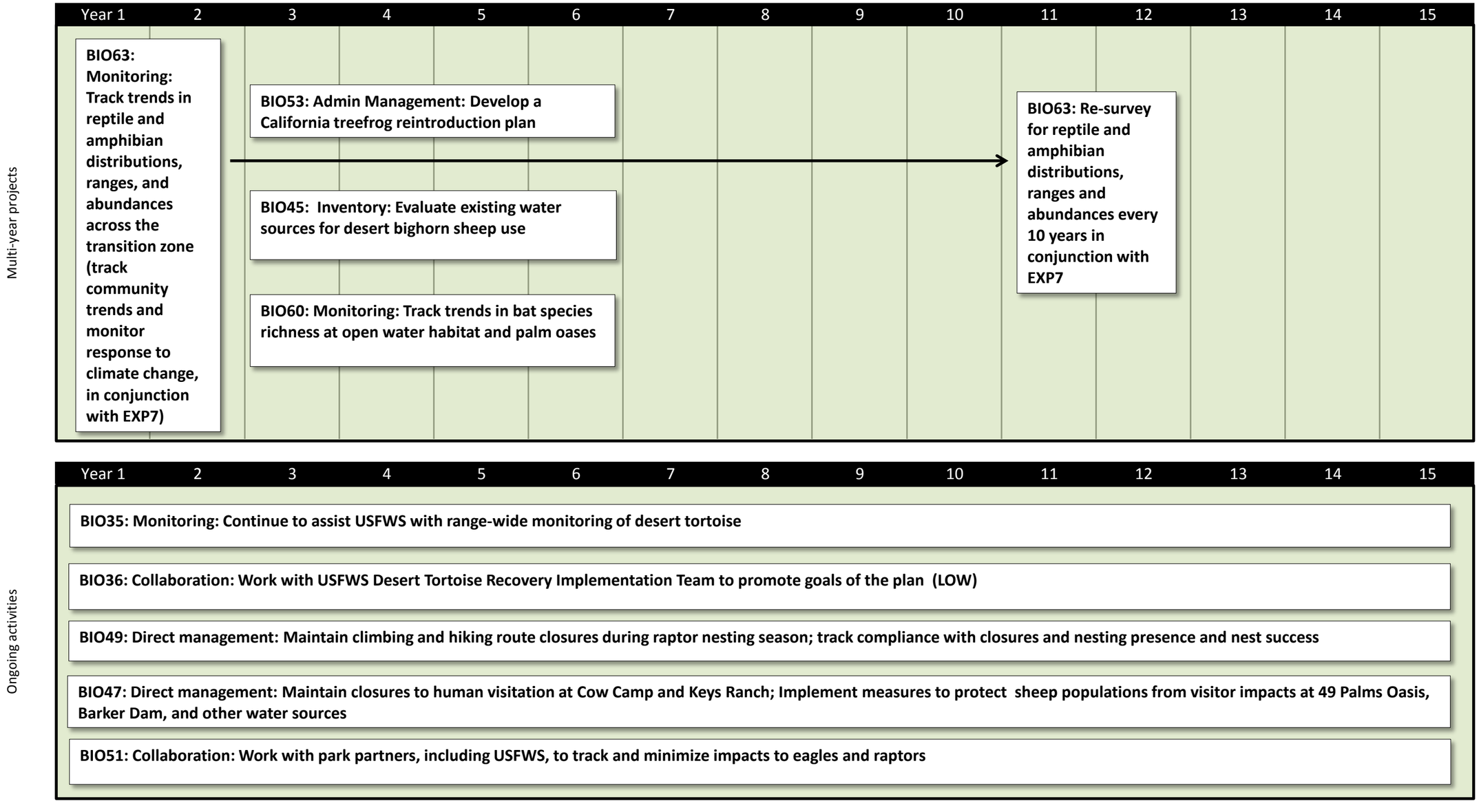
The wildlife ecologist, wildlife technician and external research partners will work to understand trends in reptile and amphibian distributions in conjunction with the "*Managing biodiversity along transition zones in the face of climate change*" project (see activity # EXP 7). Arrays and transects will be monitored in FY14 with hopes to re-open arrays in one decade to examine trends.

Resampling along a ten year timeframe would be desired to show species reaction to shifts in climate patterns. The park can also track covariates, such as finescale precipitation and temperature monitoring, which may explain any changes that may be detected.

Biological Diversity Objective #22: Increased knowledge on native and non-native invertebrate species diversity and interactions

Rationale: Joshua Tree NP's invertebrate fauna remains poorly characterized and a verified, voucher-supported list of species is far from complete. Some progress has been made through recent, riparian focused citizen science diversity surveys, including short-term bioblitz-style "BioDiversity Hunts" and Smithsonian Insect Diversity surveys. However, these studies are limited in spatial and temporal scope, and due to time and funding constraints have produced high-level (to family or above) identifications for many specimens collected. Continued work is needed to more fully understand the park's invertebrate fauna. This basic knowledge is necessary to understand important characteristics of park resources, including plant-insect interactions, especially in regards to rare and non-native (invasive) flora, ecosystem change over time and occurrence of invertebrate endemism or invasive species within the park.

4.3.1d Comprehensive Strategy Timeline: Biological diversity and healthy ecosystem function (Wildlife)



4.3.2a Comprehensive Strategy Details: Interconnectivity of California Desert Lands

Interconnectivity Objective #1: Improve connectivity for vertebrate species by maintaining migration corridors extending out from park boundaries

Rationale: Populations of vertebrate species that inhabit the park, including bighorn sheep *(Ovis canidensis),* desert tortoise *(Gopherus agasizii)*, and kit fox *(Vulpes macrotis)*, among others, may be dependent on resources contained in habitats beyond park boundaries and may rely on connectivity between these habitats for sustained population viability. The park strives to promote habitat connectivity through a variety of strategies enhanced by collaboration with neighboring governments and stakeholders. Landscape conservation approaches include connectivity modeling and represent one useful strategy to apply towards conservation of focal species (Penrod, 2012; Sawyer et al., 2011).

Interconnectivity Objective #2: Protect habitat and minimize impacts from activities originating outside park boundaries

Rationale: Human activities originating outside park lands, including illegal roads and trails crossing park boundaries, as well as developments adjacent to the park, have impacts on resources within the park. Illegal roads, trails and associated driving activities damage and fragment habitat, disturb wildlife, introduce non-native flora and fauna and alter connectivity (Ouren, 2007). In addition, developments near park boundaries can disturb biota within the park, alter or block key migration corridors, and cause habitat destruction/fragmentation on lands adjacent to the park. (Lovich & Ennon, 2011; Ennon, Lovich, Meyer, Bjurlin, & Arundel, 2012; Rudnick et al., 2012). Joshua Tree National Park will work collaboratively to ensure that these developments have minimal impact on park biota.

INC 3: Inventory: Map illegal roads and trails within park boundaries and evaluate off-highway vehicle (OHV) incursions into the park; update map as needed. [Reconnaissance]
Joshua Tree NP offers large, intact tracts of nearly pristine desert habitats. OHV incursions into the park fragment these vast expanses and can transport invasive species to the interior of the park which might have remained resilient to invasion if not for the incursion. In order to effectively mitigate impacts of illegal incursions, the park must first document location and intensity of these incursions.

Resources Management will work in conjunction with the Protection division. A biological sciences technician, with the assistance of a geographic information systems (GIS) specialist and law enforcement personnel, will be responsible for mapping boundary incursions. Park staff can work with local OHV and recreational organizations. Any Best Management Practice (BMP) in place regarding boundary incursions can be strengthened with better information about locality, type and frequency of incursions.

Current levels of incursion are undocumented but believed to be higher in locations with proximity to urban locations, such as the northwest boundary near Yucca Valley or Long Canyon (which is adjacent to the municipality of Desert Hot Springs). Other locations believed to be at risk are more remote and include the Old Dale district and the southern boundary from Chiriaco Summit to Pinto Wells.

INC4: Collaboration: With neighboring governments and agencies, work to minimize impacts to biota from developments near park boundaries. [Relationships]
Park boundary development may have negative consequences on park biota (see *Management Objective* rationale). Park management (superintendent, assistant superintendent, and chief of resources) can work collaboratively to reach out to neighboring governments and agencies to develop strategies for minimizing impacts to the park. Neighboring governments and agencies

include the Bureau of Land Management, U.S. Fish and Wildlife Service, Marine Corps Air Ground Combat Center (MCAGCC), and municipalities of Coachella Valley and Morongo Basin. Management can attend meetings, give presentations, and provide input on documents for potential developments. Division chiefs can provide input as necessary regarding topics associated with their discipline.

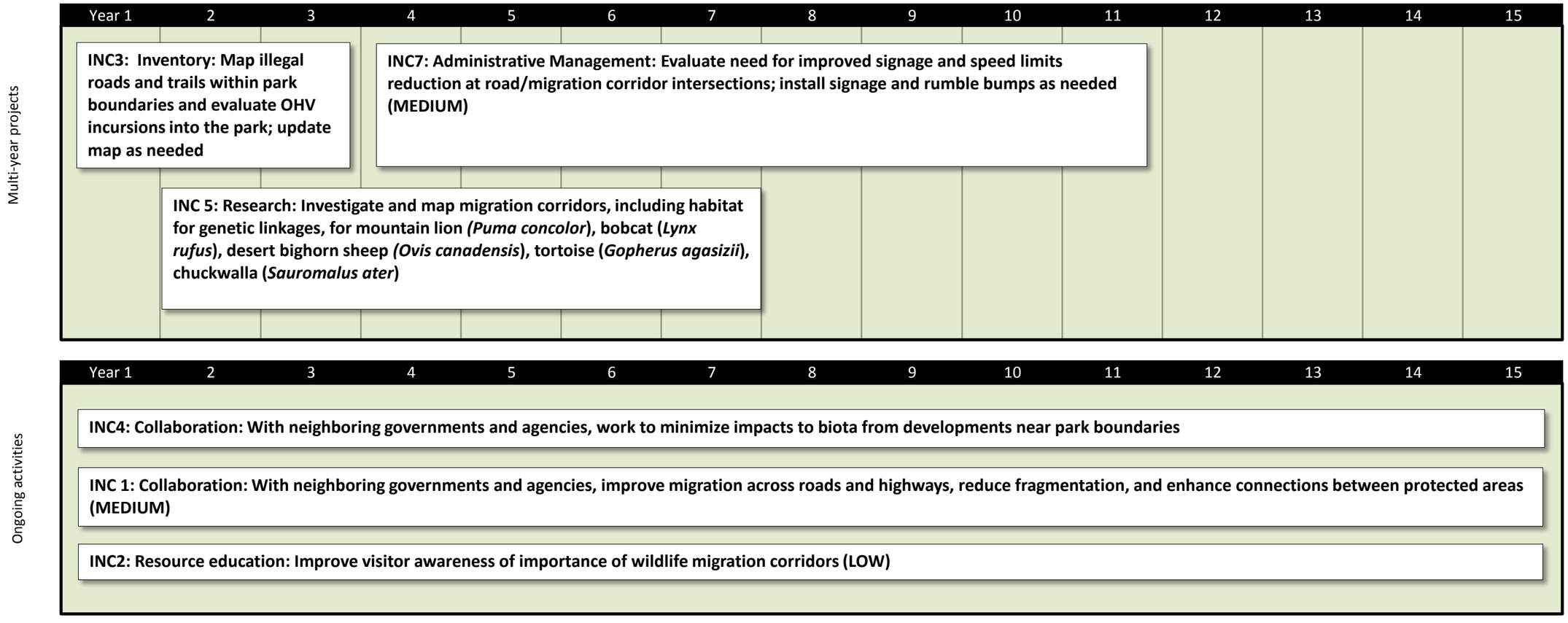
In addition to cultivating ongoing relationships, a series of fact sheets can be developed that can be made readily available to proponents of projects, external to the park, that could negatively impact park resources. Resources Management staff could also create a list of park-friendly landscape plants for use in surrounding development and establish a process for working with local communities to "outlaw" certain invasive plants such as salt cedar or fountain grass. Working collaboratively, the park can be seen in a positive light: as an entity that works towards regional conservation efforts and as a partner in sustainable/responsible economic development.

Interconnectivity Objective #3: Improve understanding of migration corridors within park boundaries and regionally

Rationale: In order to minimize impacts from boundary developments and illegal incursions, the park needs to concentrate efforts on preserving migration corridors that are key to sustaining park populations. Mule deer often seasonally migrate 50-100 km; it is predicted that loss of migration routes will have population-level impact (Sawyer, Kauffman, Nielson, & Horne, 2009).The park needs more specific knowledge about migration corridors to and from the park.

INC5: Research: Investigate and map migration corridors, including habitat for genetic linkages, for mountain mountain lion (Puma concolor), bobcat (Lynx rufus), desert bighorn sheep (Ovis canadensis), tortoise (Gopherus agasizii), chuckwalla (Sauromalus ater). [Reconnaissance], [Refugia]
Increased understanding and documentation of migration corridors can help the park target areas for collaboration to build connectivity with lands managed by other entities. The park will work to investigate migration corridors with research partners from local universities and non-profit partners such as the Sonoran Institute, and Science and Collaboration for Connected Wildlands.

4.3.2b Comprehensive Strategy Timeline: Interconnectivity of California desert lands



4.3.3a Comprehensive Strategy Details: Oases and Other Riparian Areas

Oases and Riparian Objective #1: Better understanding of human connections and traditional associations with spring, oasis, and riparian areas and transportation routes between these water sources

Rationale: Riparian areas, including springs and oases, were key resources for humans both prior to and post-arrival of European settlers (Rodgers,1996). The park aims to further understand the significance of riparian areas within larger cultural landscapes and communicate this knowledge to the public. In addition, better understanding of the cultural aspects of riparian areas will help the park to protect cultural resources in these areas while allowing for continued visitation and research.

Oases and Riparian Objective #2: Improve management of selected oases

Rationale: Oases at Joshua Tree National Park continue to draw plant and animal life as islands of water in a large "sea" of desert. The five oases found in the park are management priorities for protection of natural and cultural resources. However information gaps in hydrogeology limit park management's ability to manage vital surface and groundwater. For example, the supplemental water used to irrigate the Oasis of Mara lowers the groundwater table; meanwhile, natural fault line shifts could block/reduce spring flows. For the Oasis of Mara, two management plans (NPS, 1984; Rodgers, 1996) have been completed but are vegetation-centric and need to be updated. Maintaining the Oasis of Mara as a cultural resource may depend on direct management actions including continued irrigation.

Oasis and Riparian Objective #3: Aquatic plant and animal habitat is maintained or improved to support all native life and natural processes

Rationale: The park protects 5 fan palm oases and over 100 springs; these desert riparian areas are among the most rare/endangered habitat types on the North American continent. Spring, oases and riparian areas are important water sources for park fauna. Water-dense areas are highly susceptible to invasive species; drought-tolerant non-natives such as tamarisk may be more resistant to climate-induced droughts (Perry, Andersen, Reynolds, Nelson, & Shafroth, 2012). Those oases that are more accessible to visitor use, such as 49 Palms oasis, are susceptible to recreation-related disturbance such as trampling. Joshua Tree NP aims to maintain high quality habitat in these areas through increased baseline biological knowledge. This knowledge will allow the park to effectively mitigate threats to these areas.

OAS4: Administrative management: Complete comprehensive spring, oasis, and riparian area management plan.

Research on and management of spring, oasis and riparian areas has been done on an ad hoc basis to date; no comprehensive, park-wide management plan exists. Baseline knowledge is patchy. A comprehensive management plan would identify research needs, provide the framework for collection of baseline knowledge, specify direct management actions to maintain high quality habitat and include mitigations for anthropogenic impacts including trampling and change in water availability. This plan can work in concert with the MOJN I&M *Selected Large Springs Protocol*. This activity will be led by the chief of resources with support from resource branch chiefs including vegetation, wildlife, physical science and cultural branch chiefs. Riparian areas may be impacted by changes in precipitation and temperature due to climate change. A comprehensive management plan can help park management plan under various climate change scenarios.

OAS6: Monitoring: Track trends in oasis palm recruitment, palm demographics, and other high-priority oasis plant species. [Reconnaissance], [Refugia]

The park seeks to increase its baseline knowledge of the ecology of California fan palms

(*Washingtonia filifera*) and other high-priority oasis plant species. California fan palm is a foundation species for the park's oases and provides habitat structure for a multitude of species. Other important species, including cottonwood (*Populus fremontii)*, willow (*Salix spp.)*, and honey mesquite (*Prosopis glandulosa)*, also offer important habitat structure. The vegetation branch manager would lead this palm/oases flora monitoring project with the aid of a biological science technician or SCA intern. External research partners can also be incorporated into this project. There may be possibilities for citizen science type collaborations to understand aspects of palm ecology. The park can also track covariates, such as finescale precipitation and temperature monitoring, which may explain any changes that may be detected.

*OAS9: Direct management: Continue monitoring and control of invasive plant species in riparian habitat (e.g., Tamarisk (*Tamarix *spp.), fountain grass (*Pennisetum setaceum*), perennial pepperweed (*Lepidium latifolium*). [Reconnaissance], [Reduce], [Resilience], [Restore]*
Once established, invasive species pose threats to native species and can disrupt ecosystem processes. In riparian areas, invasive species compete with native plants for water and space and may alter water levels and disturbance regimes such as flooding and fire frequency; thus leading to subsequent changes in vegetation community dynamics. Continued monitoring and control of invasive species in riparian areas is key to minimizing threats posed by invasive species.

This ongoing activity will be performed by an invasives technician in conjunction with other vegetation staff at riparian areas throughout the park. Invasive species prevention at riparian and other areas should be integrated into all aspects of park operations. Park staff should be educated on the detrimental impacts associated with invasive species and better informed on actions each employee can take. This project incorporates the utilization of best management practices including *Preventing the Spread of Invasive Plants: Best management Practices for Land Managers*. Removal of invasive species can be staged as volunteer events, creating stewardship opportunities and informing the public about invasive species within the park.

OAS11: Direct management: Evaluate impacts from social trailing/human trampling in riparian habitat on a seasonal basis. [Reduce]
Riparian habitats are popular sites for visitors and are experiencing increasing levels of visitation. The park has some anecdotal evidence that suggests prohibiting visitors from entering the understory at 49 Palms Oasis (and thus eliminating trampling of the understory) contributed to an increase in abundance of the stream orchid (*Epipactis gigantea*). Visitors may not understand that walking through and loitering in these areas has negative impacts, yet this level of direct management can have dramatic results for preserving park resources. Seasonally, bighorn sheep use of these areas may require additional management actions to minimize visitor impacts, specifically during calving season. A biological science technician can monitor impacts to riparian areas on a seasonal basis, potentially using photo-points.

OAS12: Monitoring: Track trends in surface water area extent in selected oases. [Reconnaissance]
Surface water in oases is variable and subject to changing precipitation patterns. Accurate baseline data and trend information on surface water will enhance the park's ability to manage for surface and groundwater protection.

This activity can be performed by a resources technician in conjunction with the MOJN I&M network. Personnel will monitor these springs utilizing the *Selected Large Springs Protocol* or additional protocols that may be developed. Target areas could include 49 Palms Oasis, Smithwater Canyon and Johnson Spring.

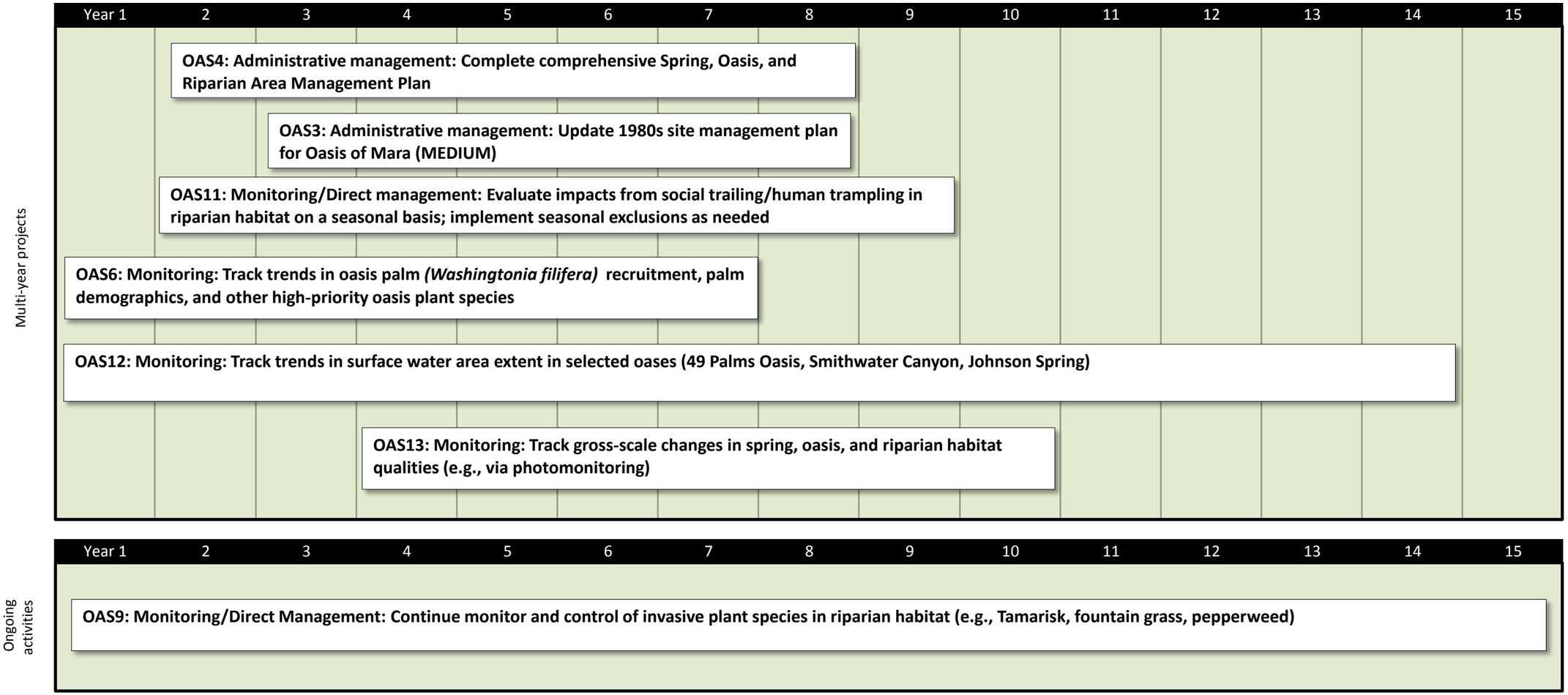
OAS13: Monitoring: Track gross-scale changes in spring, oasis, and riparian habitat qualities (e.g., via photomonitoring). [Reconnaissance]
The park lacks baseline data on gross-scale indicators of palm oases condition such as vegetation community composition and surface water expression. These indicators should be monitored to provide baseline data and track changes in riparian area health over time. This activity will be

performed by Resources Management staff; monitoring program/protocols will be designed by the vegetation branch chief, wildlife ecologist and/or research partners building on previous work by the MOJN I&M. Opportunities for citizen science may be built into this activity, especially in terms of monitoring that involves simple data-collection types such as taking photo-points.

Oases and Riparian Objective #4: Increased knowledge of species dependent on aquatic and riparian habitat

Rationale: The park will work to increase knowledge about species dependant on riparian habitat. These species may be the most at-risk for decline and extirpation from changes in riparian habitat due to climate change and other anthropogenic stressors (Perry et al., 2012). Warming-induced drought will likely affect typically drought tolerant vegetation species such as cottonwoods and willows. Small animals such as elf owls and bats, which also depend on riparian areas, may be more susceptible to heat stress and dehydration; anticipated heat waves may affect the animals' ability to prevent overheating through evaporative cooling. Reproduction of riparian dependent bat and bird species may also be effected by a reduction in surface water availability (Perry et al., 2012).

4.3.3b Comprehensive Strategy Timeline: Oases and other riparian areas



4.3.4a Comprehensive Strategy Details: Recreational Opportunities and Values

Recreation Objective #1: Increased understanding of the impacts of recreational activities to natural and cultural resources

Rationale: Best management of park resources means balancing present-day visitor use with conservation of resources for future generations. The park seeks to increase understanding of how visitor use, including popular activities such as climbing, horseback riding and backcountry travel, is impacting both cultural and natural resources (NPS, 2010c). This knowledge will help the park initiate and maintain effective policies and management practices. In addition, understanding visitor perceptions and their desired experiences can help the park craft effective visitor-use policies that help achieve a high-level of resource protection while still providing visitor enjoyment. Increased understanding of perceptions and desired experiences will also help create more effective visitor messaging about conservation of sensitive park resources, especially for threatened species such as the desert tortoise.

REC1: Research: Research impacts of recreation on archeological resources, vegetation, soil, wildlife (e.g., climbing, bouldering, horseback riding, off-road vehicles, backcountry camping). [Reconnaissance]

While important to the park's mission in providing enjoyment for park visitors, recreational activities also cause resource impacts. In recent decades, rock climbing and bouldering have exploded in popularity, with accompanying impacts such as social trailing, destruction of cultural resources and rock defacement through bolting, chalk use, and abrasion from shoes. Other recreational activities such as horseback riding and backcountry travel, while not as prevalent in the park, also cause resource impacts, including spread of invasive species and trampling of soil and vegetation, and channeling of water along trails. Off-road travel is illegal in the park but does take place as evidenced by illegal boundary incursions. It is vital that the park understands and documents trends in recreation-related impacts to set best management practices for recreation.

The park climbing ranger, biological science technicians, and SCA interns can work in conjunction with park law enforcement staff and user groups such as the Access Fund and volunteers to conduct research on impacts of recreation. Increased knowledge of impacts from recreational activities will help to set policy and management practices for these activities. Most work will be concentrated in the more heavily used west-end of the park. In addition, citizen science and stewardship opportunities can be built into this activity, such as cultural site stewards or trail monitors.

Recreation Objective #2: Provide appropriate recreational opportunities that are consistent with the park's purpose and values, without causing unacceptable impacts

Rationale: Certain recreational activities, such as hiking, climbing and back-country travel following leave-no-trace ethics, are consistent with park purpose and values (NPS, 1995). The park will continue to provide these opportunities and promote a leave-no-trace ethic while gathering information about current levels and modes of recreational activity to determine new policy or modifications to existing policy.

REC6: Research: Investigate visitor and ecological carrying capacity studies to understand how the number of visitors affects visitor experiences and resources. [Reconnaissance]

Carrying capacity studies will allow the park to understand the level and types of visitor uses it can permit, and in what quantity. Establishing both a social and ecological carrying capacity is essential to providing guidance on acceptable visitor use management, from closure (to protect rare species, wildlife habitat, and other sensitive areas), or use dispersal (such as hiking and camping), to concentrating use (such as high density visitation with developed facilities) for the long-term

protection and preservation of park natural and cultural resources (Manning & Budruk, 2006). Knowledge generated by these studies will help to establish what levels of use are appropriate in different areas of the park to provide quality visitor experiences. Resources Management staff can work in conjunction with the Maintenance, Interpretation and Protection divisions as well as external research partners. A carrying capacity study would examine the entire park but concentrate on high-use areas in the park's northwest.

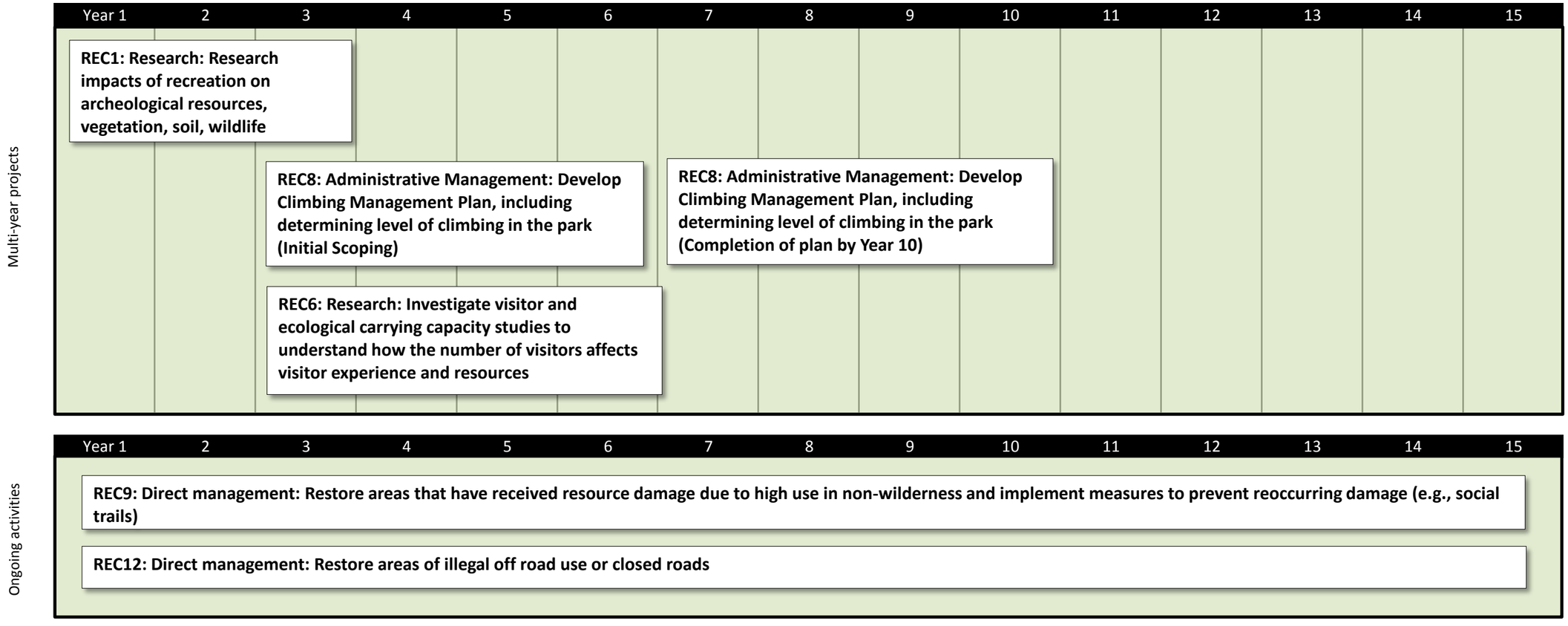
REC8: Administrative Management: Develop climbing management plan, including determining level of climbing in the park.
A comprehensive climbing management plan will direct the park in dealing with climbing-specific impacts including social trailing, search and rescue operations for climbers, fixed anchors, chalk use, and noise impacts to wildlife and visitors. The plan will also detail current modes of outreach for promoting minimal-impact climbing and ways to increase outreach effectiveness. As part of this plan, the park should document baseline climbing information, including metrics to measure the amount, intensity and types of climbing in different locales throughout the park. The plan will incorporate and clarify recommendations as outlined in the Record of Decision for the Joshua Tree NP Backcountry and Wilderness Management Plan.

The chief of resources will work with the climbing ranger, vegetation branch manager, wildlife ecologist, and law enforcement personnel. Park staff will seek input from the NPS Pacific West Region, NPS Washington-level staff and external partners (including the Access Fund, Joshua Tree Search and Rescue, etc.). The climbing management plan will cover the entire park but will concentrate on areas of high climber use, particularly western-portions of the park with higher quantities of monzogranite formations popular with climbers.

REC9: Direct management: Restore areas that have received resource damage due to high use in non-wilderness and implement measures to prevent reoccurring damage (e.g., social trails). [Reduce], [Restore], [Resilience]
Restoring areas damaged by high-use will not only reduce current habitat fragmentation but may halt proliferation of damage in the future by discouraging continued impacts by park users. This ongoing activity is accomplished by Resources Management staff, particularly in areas of high-use, western portions of the park. Restoration efforts will include volunteer groups, involving the public in park stewardship and spreading the message about the necessity of minimal-impact practices.

REC12: Direct management: Restore areas of illegal off road use or closed roads. [Reduce], [Restore], [Resilience]
Restoring areas damaged by illegal off road use will not only reduce current habitat fragmentation but may halt proliferation of damage in the future by discouraging continued impacts by park users. This ongoing activity will be accomplished by park staff and will concentrate on park boundaries where vehicles illegally enter the park. The park should develop a consistent reporting procedure for all park staff to utilize when disturbances are found. Restoration efforts can involve the public in park stewardship through incorporation of volunteer groups.

4.3.4b Comprehensive Strategy Timeline: Recreational opportunities and values



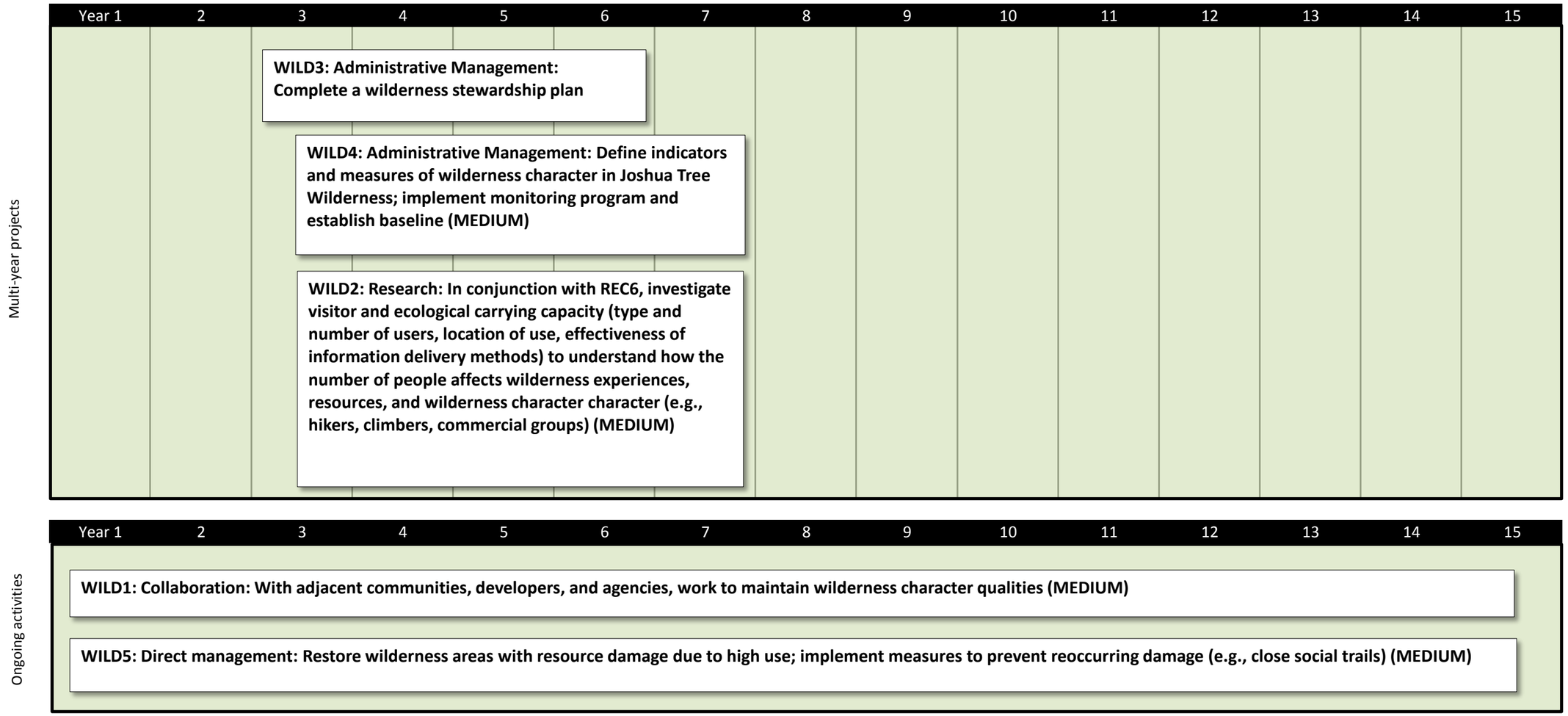
Wilderness Objective #1: Joshua Tree National Park Wilderness – including physical resources, intangible values, and wilderness character qualities – protected, preserved and access maintained

Rationale: Joshua Tree National Park contains approximately 595,000 acres of designated wilderness; possible threats to wilderness character qualities (see Appendix D of this document and NPS, 2012 for a list and explanation of these qualities) include large-scale renewable energy developments adjacent to the park, continued urban expansion on the northern and southern borders of the park, and recreational use that is incompatible with wilderness qualities/park mission. The park will work to minimize these threats.

WILD3: Complete a wilderness stewardship plan.

A wilderness stewardship plan would update the 2000 *Backcountry and Wilderness Management Plan*. It would establish a monitoring program for wilderness character, improve internal wilderness administrative processes to better incorporate wilderness character, and treat wilderness as a holistic resource.

4.3.5b Comprehensive Strategy Timeline: Wilderness values and wilderness accessibility



Knowledge Objective #1: Research activities in the park further park management goals and scientific understanding

Rationale: Since the park's designation in 1936, an estimated 1200 studies have taken place within park boundaries. Research topics have covered the breadth of Joshua Tree NP's resource management fields (cultural, biological and physical resources), but much of this work has been based on goals specific to university or institution research programs and results are not directly applicable to current park management challenges. The park will work collaboratively with external researchers to help tailor future science done in the park to park management needs, while still meeting the program goals of external researchers.

EXP1: Administrative management: Restructure the research reporting process and improve data management.

All research done at the park must be permitted through the NPS Research Permit and Reporting System (RPRS); as part of this system, researchers are required to report to the park on a yearly basis for the duration of their permit and are required to submit a final report upon completion of their study. However, a portion of permit holders fail to submit interim or final reports in a timely manner, if at all. The park can create systems to work in conjunction with RPRS in order to ensure that research going on within the park is incorporated into the park's knowledge base to improve management and policy. In particular, the park research list should be updated regularly with relevant information and a park-specific data management plan should be created to capture and integrate all information generated by external and in-house research activities. Park data management should also be coordinated with the MOJN I&M data management plan. This activity will be performed by the research permit coordinator.

EXP4: Administrative management: Develop a plan for successful transfer of information from researchers to the park network wide, with potential shared database (e.g., renew permits that meet reporting requirements and data delivery. [Relationships]

See EXP1, "Restructure the research reporting process and improve data management" for details that also apply to this activity.

Knowledge Objective #2: Improved understanding of changing climate and its impact on park natural and cultural resources and incorporation of adaptive management strategies

Rationale: Park resources are impacted by elements beyond the control of park management, including changing climate. Research to date has shown that species such as the Joshua tree, the park's namesake, may be particularly susceptible to impacts of climate change. Research supports that desert tortoises may reproduce and produce more clutches in a year if rainfall is sufficient to produce an abundance of food plants (Lovich, Medica, Avery, Meyer, Bowser, & Brown, 1999; Lovich et al., 2012). Threats such as habitat degradation and fragmentation could limit food availability and contribute to lower reproduction output (Ennen, Lovich, Meyer, Bjurlin, & Arundel, 2012). Similar to the desert tortoise, the desert kit fox (*Vulpes macrotis arsipus*) is also one of the most vulnerable species, based upon the park's *Vulnerability Assessment*, to climate change because of restricted habitat due to changes in precipitation and loss of prey impacting overall population size (Hoines et al., 2014). Both tortoises and kit foxes appear to track either prey or available water. Other systems, such as riparian areas (Perry et al., 2012) and higher elevation montane scrub (Murphy-Mariscal et al., 2013) in the park also face threats with warming-induced drought. The Muller's oak (*Quercus Cornelius-mulleri*) was identified as a species most vulnerable

to climate change based upon the park's *Vulnerability Assessment* (Hoines et al., 2014). Three bird species have also been identified as being most vulnerable to climate change, based upon the park's *Vulnerability Assessment*: Phainopepla (*Phainopepla nitens*), pinyon jay (*Gymnorhinus cyanocephalus*), and bushtit (*Psaltriparus minimus*) (Hoines et al., 2014). As a life form, birds appear to be more resilient to the effects of climate change due to their ability to migrate to new locations. A reduction in preferred bird habitat is occurring throughout bird species' ranges and species are responding. Should these species remain in their current locations, they are all approaching their physiologic limits for maximum temperature and the increase in the minimum temperatures may jeopardize nestling success.

EXP7: Monitoring: Monitor the effects of climate change through pitfall traps. [Reconnaissance]
Pitfall traps provide a simple method to capture information about changes in species occurrence along an elevational gradient within the park. This activity builds on previous work done by the United States Geological Survey. By comparing captures over time, the park hopes to elucidate changes in faunal species occurence. As the arrays are situated across elevational gradients, the dataset should be able to document shifts elevational shifts in species as they react to climate change. Resampling along a ten year timeframe would be desired to show species response to altered climate patterns. This activity will be performed through collaboration between the park's vegetation and wildlife staff, in partnership with University of California, Riverside. Citizen science opportunities have been integrated into this project. This activity also includes monitoring climate change variables including precipitation, temperature and extreme events.

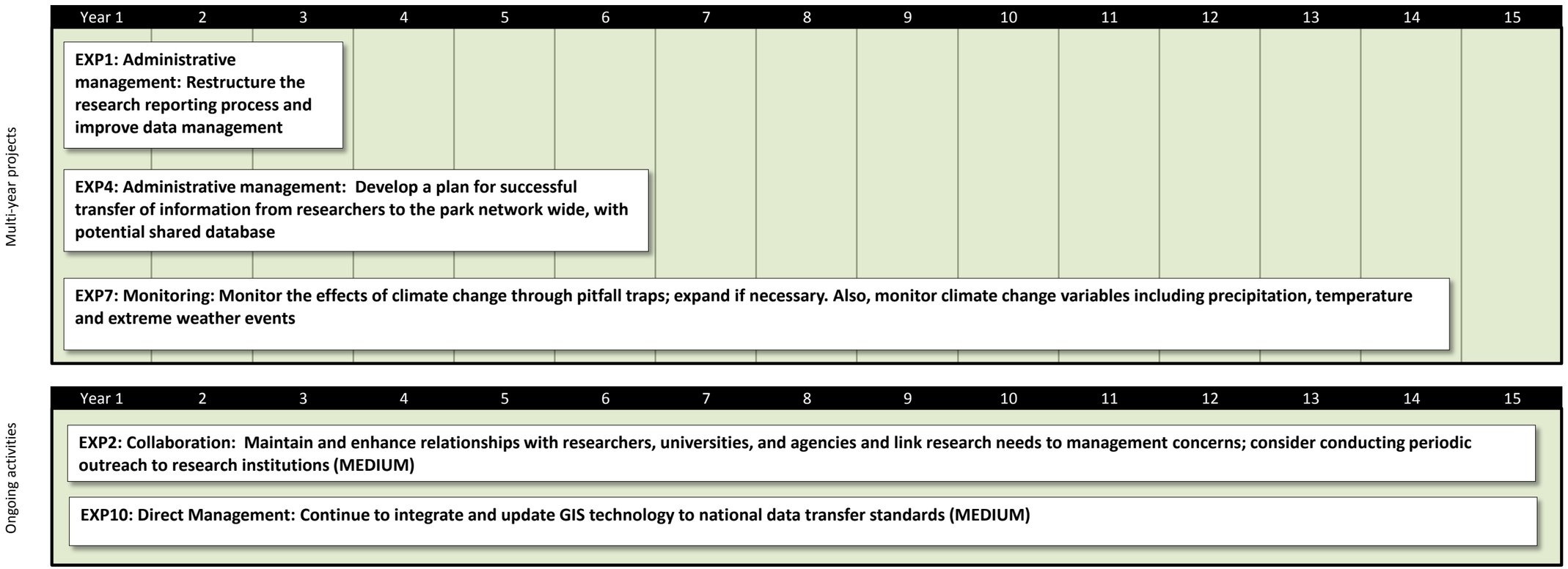
EXP8: Administrative management: Complete vulnerability assessment. [Reconnaissance]
Vulnerability assessments examine the susceptibility of resources to climate change and identify the most vulnerable areas within the park as well as potential refugia within and beyond park boundaries (Glick et al., 2011). They provide scientific information needed to prioritize the location and timing of climate change adaptation and management measures (Hoines et al., 2014).

This activity should be completed by FY14 but continued work to incorporate new findings and refine analyses should be ongoing. In addition, findings from the vulnerability assessment should be reviewed for incorporation into yearly updates of the *Resources Stewardship Strategy* and activities based on this strategy.

Knowledge Objective #3: Data stored appropriately and available for use

Rationale: In order to be of greatest use to park management, data generated both internally by NPS personnel and externally by research partners must be systematically indexed and readily accessible to current and future personnel.

4.3.6b Comprehensive Strategy Timeline: Ever-expanding knowledge base



4.3.7a Comprehensive Strategy Details: Opportunity to Understand, Apply and Share Knowledge to Benefit the Park and Beyond

Knowledge-sharing Objective #1: Improve and enhance quality and quantity of information provided by the NPS to the public and partners about park natural and cultural resources

Rationale: Effective resource education is key to promoting stewardship of the park by the visiting public (Papageorgiou, 2001). However, many interpretive materials, including materials explaining threats to resources, understanding of natural and cultural processes, and species lists, are out of date.

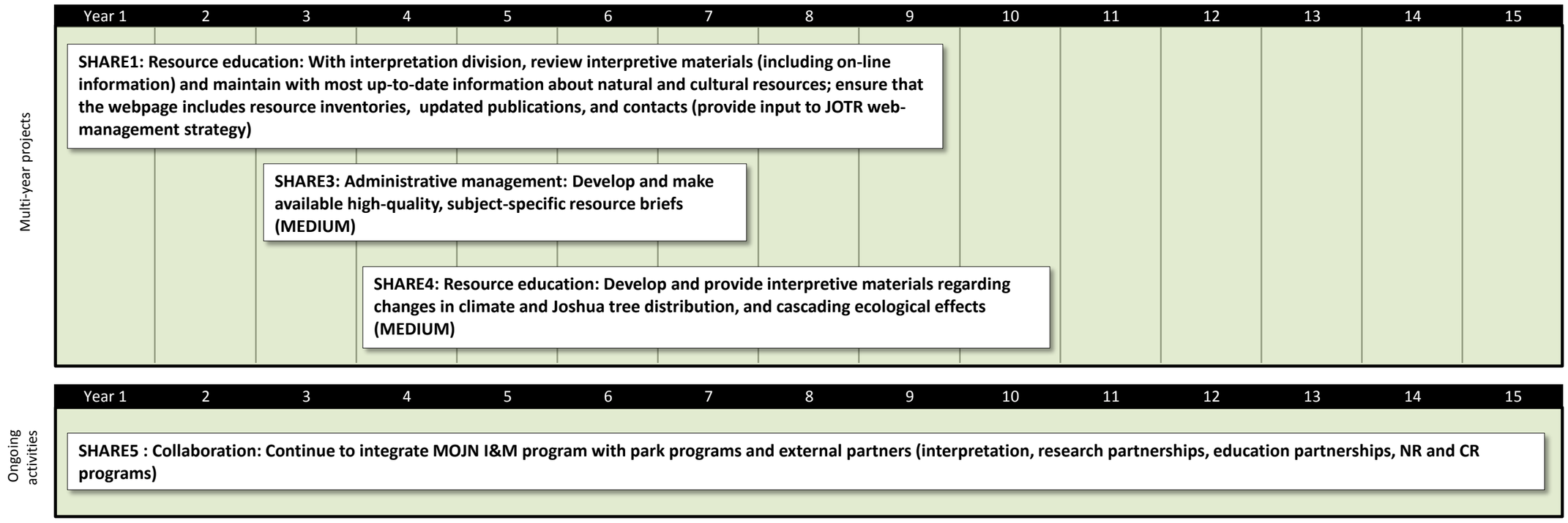
SHARE1: Resource education: With Interpretation division, review and maintain interpretive materials (including on-line information) with up to date information about natural and cultural resources; ensure that the webpage includes resource inventories, updated publications, and contacts (provide input to park web-management strategy).

The Resources Management division, in conjunction with the Interpretation division, must ensure that the public has the most accurate, up-to-date, and engaging information to inspire stewardship of park resources. Effective interpretation is key to maintaining connections with visitors and the public at large. This ongoing activity will require close collaboration between resources management and interpretive staff.

SHARE5: Collaboration: Continue to integrate MOJN I&M program with park programs and external partners (interpretation, research partnerships, education partnerships, natural and cultural resources programs).[Relationships]

Information generated by the MOJN I&M Program, including data generated through the *Selected Large Springs Protocol*, the *Integrated Uplands Protocol* and the *Arid Lands Spring Protocol*, should be integrated with park-generated data to create a more comprehensive "picture" of resource status at the park. This ongoing activity will require close collaboration between park resources management staff and MOJN I&M personnel.

4.3.7b Comprehensive Strategy Timeline: Opportunity to understand, share and apply knowledge to benefit the park and beyond



4.3.8a Comprehensive Strategy Details: Geological Resources and Desert Landforms

Geological Objective #1: Understand processes that create desert landforms

Rationale: The park functions as a geological laboratory and provides outstanding opportunities for geological research.

Geology Objective #2: Joshua Tree NP boulders and rock formations are protected from human caused alteration while allowing natural processes to occur

Rationale: The park's unique monzogranite rock formations are key visitor attractions. Visitors climb, scramble on, photograph and admire these formations; however, increased visitation/ appreciation has been accompanied by increased impacts, including defacement through vandalism and recreational use such as fixed-anchor climbing. The park will preserve these formations for future generations through monitoring, outreach and enforcement.

GEO2: Resource education: Prevent vandalism and manage use of bolting on rocks, boulders, and landforms through enforcement and outreach.

The park's climbing ranger can work collaboratively with the Protection division to perform community outreach to climbing groups. This activity will be initiated by 2020 and continued on an ongoing basis. It will take place in areas with the heaviest climber use, including western, higher-elevation areas of the park.

Geology Objective #3: Paleontological resources protected, preserved and managed for resource education, science, and interpretation

Rationale: Paleontological resources are prevalent in the park's Pinto Basin; researchers suspect they are likely to be present in other areas throughout the park. To date, large and small horses (*Equus* spp.), large and small camels (*Camelops hesternus* and *Hemiauchenia* sp.), sheep (*Ovis* sp.), mammoth (*Mammuthus* sp.), dwarf pronghorn (cf. *Capromeryx* sp.), bison (*Bison* sp.), and even waterfowl such as common teal (*Anas crecca*), among other taxa representing the Pleistocene and Neogene epochs, have been uncovered in the park (Jefferson, 1973; Jefferson, 1986; Scott et al., 2006). Fossils from earlier time periods predating the ice ages have also been discovered; rock units containing these earlier Neogene fossils require more thorough study. These paleontological resources are fragile and easily degraded by exposure to weathering elements. The park will support park partners including the San Bernardino County Museum in efforts to expand recovery and preservation of paleontological resources in the Pinto Basin and throughout the park.

GEO5: Direct management: Work with research partners to protect paleontological resources through cyclic prospecting; correlate cyclic prospecting with rain events (bi-annual basis). [Reconnaissance], [Relationships]

Cyclic prospecting allows researchers to systematically survey and recover paleontological remains and preserve fossils that may be degraded by weathering elements, particularly after exposure from rain events. The park will work with partners, including the San Bernardino County Museum, on an ongoing basis, focusing on the Pinto Basin but expanding to other areas of the park. Cyclic prospecting will help protect paleontological resources vulnerable to weathering, erosion and other direct and indirect impacts of climate change.

Geology Objective #4: Improved understanding of paleontological deposits in the context of climate change

Rationale: Understanding how paleo-fauna responded to fluctuations in climate can provide insights into possible responses of modern-era species to climate change.

Geology Objective #5: Increased knowledge of the geology and tectonic processes of the park in order to integrate knowledge into operations, planning, and interpretation for park visitors

Rationale: Geological knowledge, including location of important minerals, faults and water sources can enhance research in areas from archeology to paleontology.

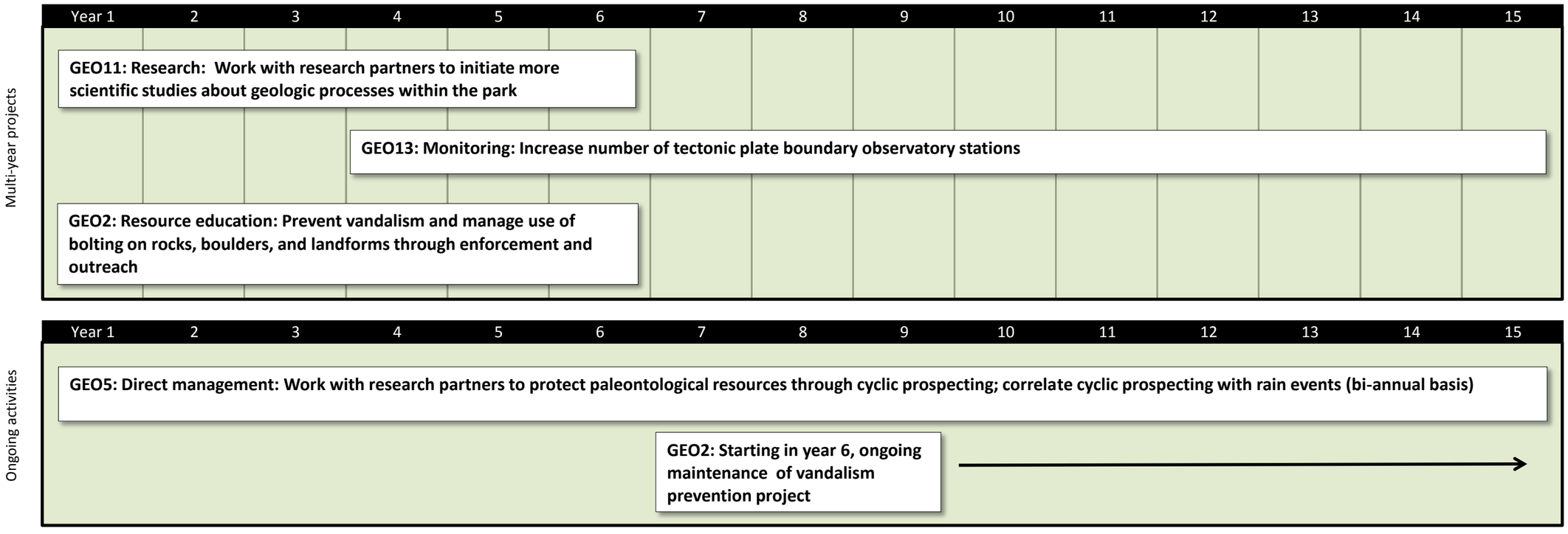
GEO11: Research: Work with research partners to initiate more scientific studies about geologic processes within the park. [Relationships]

Understanding of seismicity, tectonics and faults (both active and inactive) in the park provides a better understanding of the evolution of landscape features. In addition to providing valuable data for research and early warning seismic systems, geologic evolution provides a link to prehistoric and historic cultural uses. Physical sciences staff will work in ongoing collaboration with external research partners to initiate more scientific studies throughout the park. Findings may be shared with the public to improve interpretation of the park's geological resources.

GEO13: Monitoring: Increase number of tectonic plate boundary observatory stations.

Tectonic plate boundary observatory stations study the motion across the active boundary between the Pacific and North American plates in the western United States. Data gathered from these stations improves knowledge of the San Andreas fault and the deformation associated with oblique transform boundaries. Physical science staff will work in partnership with the USGS, the UNAVCO Plate Boundary Observatory, University of Arizona, graduate students and geologists in parks. This activity will be initiated by 2017.

4.3.8b Comprehensive Strategy Timeline: Geological resources and desert landforms



Hydrological Objective #1: Impoundments managed for wildlife use, wildlife viewing, cultural resources management and safety and so as to minimize negative impacts to other park values and resources

Rationale: Man-made impoundments, including tanks and guzzlers, have become important water sources for fauna including bighorn sheep, mountain lions and deer. They are also considered cultural resources as many were installed over 50 years ago, the standard age for inclusion as a historic structure/object. Management of these resources must integrate each aspect of their significance.

Hydrological Objective #2: Improved understanding of trends in quantity and quality of surface water

Rationale: Surface water from both ephemeral and permanent sources is essential for desert flora and fauna; in addition, areas with consistent surface water are known to contain the highest levels of biodiversity within the desert. Documenting trends in and underlying causes of fluctuation in quantity and quality of surface water will determine if management actions must be taken to preserve water resources in the park.

HYD2: Monitoring: Track trends in water quality and quantity at a random sample of springs through the MOJN I&M Program. [Reconnaissance]

The MOJN I&M Program has initiated monitoring protocols for large springs and arid lands springs within the network. Surface water dynamics are considered a vital sign, or indicator of environmental health, of park ecosystems. Comprehensive monitoring must be initiated as soon as possible to help the park track trends in surface water dynamics. Park Resources Management staff will provide ongoing support to MOJN I&M personnel to track selected springs throughout the park.

Hydrological Objective #3: Improved understanding of locations and trends in springs, including interannual variability

HYD3: Monitoring: Repeat inventories of locations and hydrology characteristics of springs (Citizen Science: "Wet Hands" survey). [Reconnaissance]

Volunteer scientists ("citizen scientists") may collect data using simple methods to provide information about hydrological characteristics of springs throughout the year, over multiple years, and at multiple locations throughout the park. This is especially important as NPS/MOJN I&M personnel may not be available to gather this volume of data. Comprehensive monitoring must be initiated as soon as possible to help the park track trends in surface water dynamics. "Citizen scientists" can be utilized to inventory/monitor select springs throughout the park. Engaging the public in this type of stewardship fosters greater understanding of the importance of hydrological resources.

HYD4: Research: Comparison of present day locations and conditions of springs with historical surveys. [Reconnaissance]

Comparison of historical data to present day data will allow the park to understand significant changes over time, including disappearance of water sources or fluctuation in water quantity. The physical science technician will perform this activity in FY14 and '15 and focus on springs throughout the park. Understanding trends in surface water expression may help predict future changes in surface water expression.

Hydrological Objective #4: Increased knowledge of local and regional groundwater hydrology

Rationale: Groundwater hydrology is classified as a vital sign, or environmental health indicator, by the MOJN I&M Network. With less than 7 inches of rainfall per year, aquifer recharge in the park is essentially nonexistent. Waters from the Pinto Basin and other basins around the park date back to 15,000+ years confirming no modern recharge. Management of this critical resource is essential with the potential for less precipitation modeled with climate change (Appendix C).

HYD6: Research: Characterize groundwater outflow from the Pinto Basin into the Chuckwalla Basin in order to better understand impacts of water withdrawal by neighbors (potential impacts to park ecosystems).

The Chuckwalla aquifer, underlying the Palen and Chuckwalla Valleys east of park lands, may be in hydraulic communication with the Pinto Basin aquifer located beneath park lands. The effects of pumping in the the Chuckwalla aquifer on the Pinto Basin aquifer have not been investigated. A groundwater model is needed to determine the potential effects of the proposed water withdrawals on park resources. The model will be developed by the USGS in collaboration with the Physical Scientist, the BLM, and the National Lawrence Laboratory.

HYD7: Research: Characterize Cottonwood aquifer (water balance, faulting system, withdrawal rate, life of well, ecological impacts of human water use).

Cottonwood aquifer currently supplies water for the Cottonwood Visitor Center, Cottonwood Campground and other park infrastructure located in the Cottonwood Spring area. This aquifer has not been modeled for sustainability.

This activity will be performed by the physical scientist with support from the physical science technician, the USGS, the BLM and the National Lawrence Laboratory. This activity will establish BMPs relating to sustainable use of water by both the park and external entities.

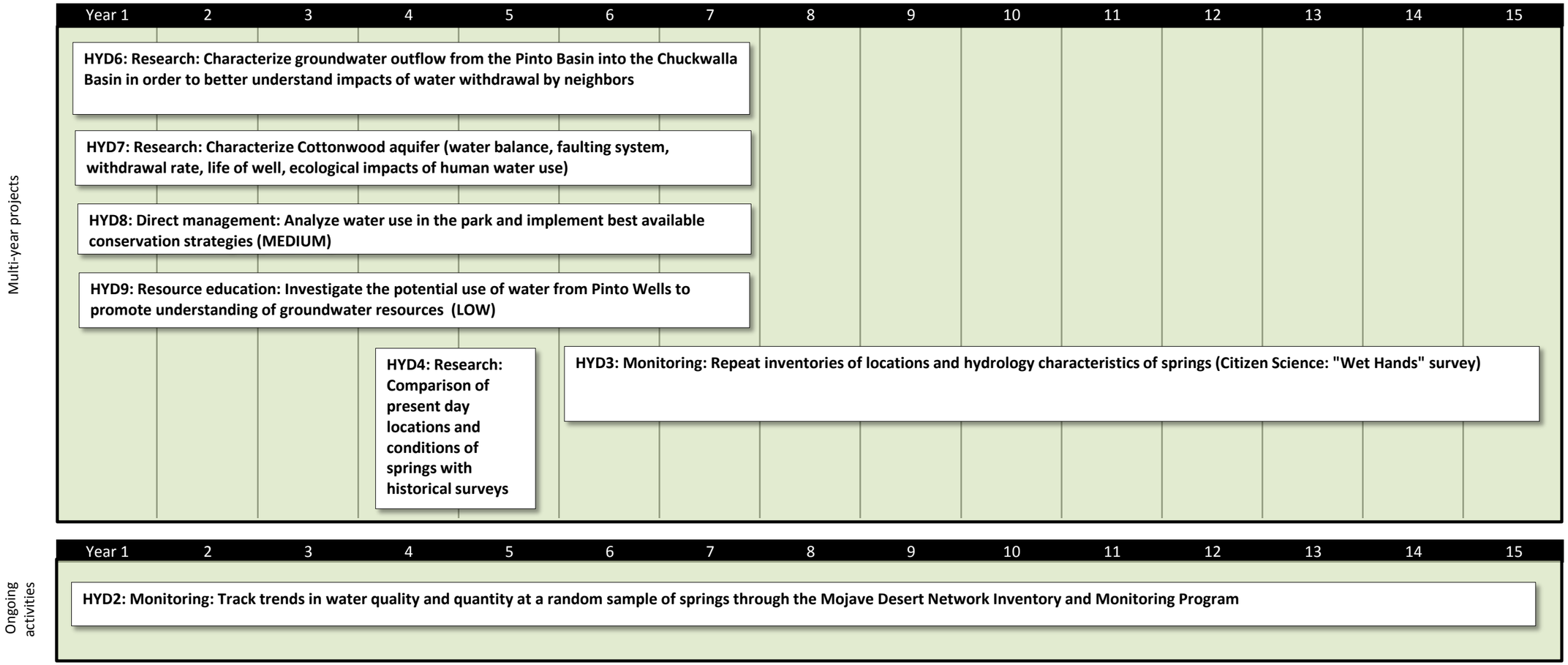
Hydrological Objective #5: Minimize human use of groundwater resources in the park

Rationale: Groundwater supplies are subject to limited and variable recharge; water conservation efforts must be put into place to ensure that this resource is sustainable.

Hydrological Objective #6: Resource education promoting better understanding of water for human consumption

Rationale: Interpretation about water use in the park can be used to promote more awareness among the general public about the importance of water conservation in the desert.

4.3.9b Comprehensive Strategy Timeline: Hydrological resources



4.3.10a Comprehensive Strategy Details: Night Sky

Night Sky Objective #1: Decrease light pollution emanating from sources outside of park boundaries, as feasible

Rationale: Dark skies are a valued resource, particularly surrounding natural and cultural resources protected in national parks. The park aims to maintain or restore historical levels of darkness through monitoring and outreach. Light pollution can have negative effects on nocturnal species, visitor experience, and cultural values (Minard, 2010; Rogers & Sovich, 2001).

NIGHT1: Collaboration: Work with surrounding communities and agencies to restore dark night skies through mitigation of impacts of light pollution on park

This activity will help restore night skies to early 20th century darkness conditions and decrease light pollution threats to park biota. The superintendent, chief of resources and physical scientist will maintain relationships with the BLM, MCAGCC, and the municipalities of the Coachella Valley and the Morongo Basin. The Resource Management division, the Interpretation division, and the superintendent will be part of an interdisciplinary team that will attend meetings and educate municipalities and surrounding agencies on how to reduce light pollution. For example, the Interpretation division's Night Skies program continues education and outreach to the public through evening programs and visitor encounters. This collaborative effort should be a regular part of the annual work plan until dark sky conditions are significantly improving and local municipalities are conforming to dark sky ordinances.

NIGHT2: Inventory: Quantify light pollution produced by surrounding communities and agencies (Yucca Valley, 29 Palms, San Bernadino, MCAGCC); establish baseline for light pollution.

In order to scientifically track dark sky condition, a baseline inventory must be established to detect change. Establishing a baseline in surrounding communities and agencies will provide information on how light pollution emanating from these areas affects the park's ability to meet dark sky management objectives. Physical science staff will initiate this project, but new park partnerships may need to be established to involve municipalities in assisting with baseline data collection. Baselines need to be developed for MCAGCC and Morongo Basin over the next 5 years. Citizens from surrounding communities may potentially assist in collecting ongoing monitoring data for dark night skies after baselines are established.

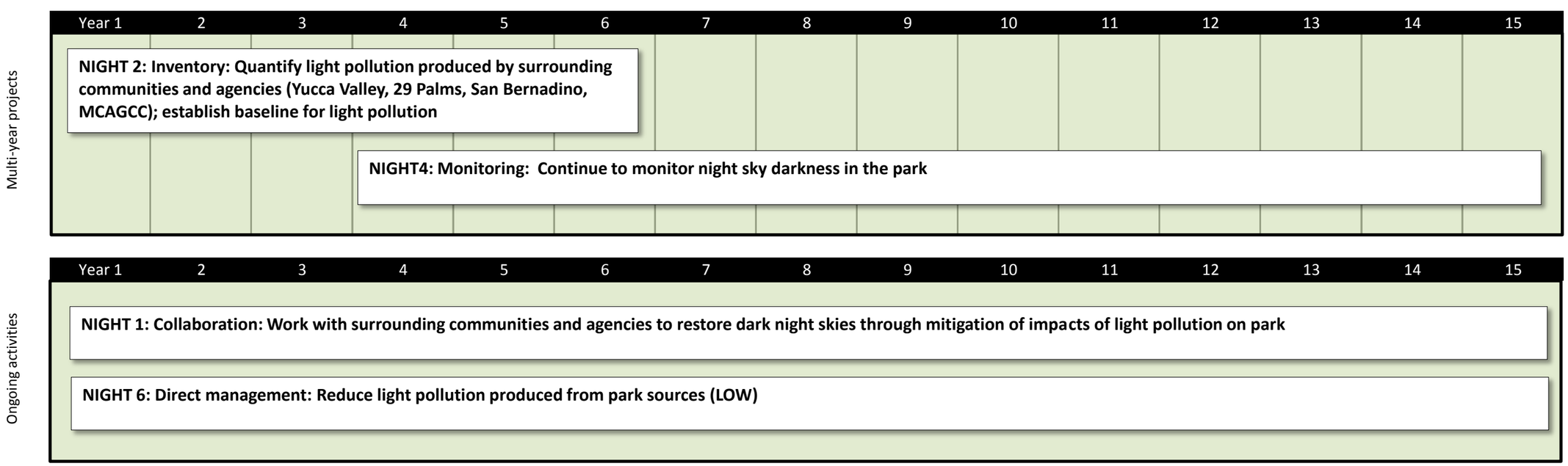
Night Sky Objective #2: Maintain natural darkness and minimize light pollution within park boundaries

Rationale: See rationale for Night Sky Objective #1.

NIGHT4: Monitoring: Continue to monitor night sky darkness in the park

Monitoring will give the park information regarding changes in the condition of the dark night sky and inform management as to the direction of the trend. Ongoing monitoring of night sky will be performed by physical science staff, volunteers and citizen science groups. Monitoring sites include Keys View, the Hexahedron Mountains and the Pinto Basin.

4.3.10b Comprehensive Strategy Timeline: Night Sky



4.3.11a Comprehensive Strategy Details: Clean and Breathable Air

Air Quality Objective #1: Air quality protected in the park and neighboring lands; trends in air quality condition understood

Rationale: The Clean Air Act mandates protection of air quality at Joshua Tree National Park; the park is designated as a Class I airshed which requires the highest level of protection. Development in neighboring lands poses an ongoing threat to air quality in the park. Air quality affects the visitor experience, public health and plant and animal life within the park.

AIR1: Monitoring: Inventory, monitor, and document the condition of air quality related values for Joshua tree NP. [Reconnaissance]
Trends in air quality condition must be understood so that the park can identify those air quality related values (AQRV)that are changing and the underlying causes of these changes. This ongoing activity will continue to be performed by the physical scientist and physical science technicians at Black Rock, Cottonwood and Pinto Wells air quality stations.

AIR2: Monitoring: Expand air quality monitoring throughout the park. [Reconnaissance]
The park can collect more comprehensive data from multiple points throughout the park through the installation of additional air quality monitoring stations. Additional monitoring stations will better inform the park on air quality levels, collect standard meteorological data and identify changing air patterns or new sources of air pollution. Locations of these stations may correlate with areas of increased development. Wilson Canyon could be one potential new monitoring site. This activity will be performed by the physical scientist and physical science technician. Maintenance may be required to ensure equipment is functioning properly.

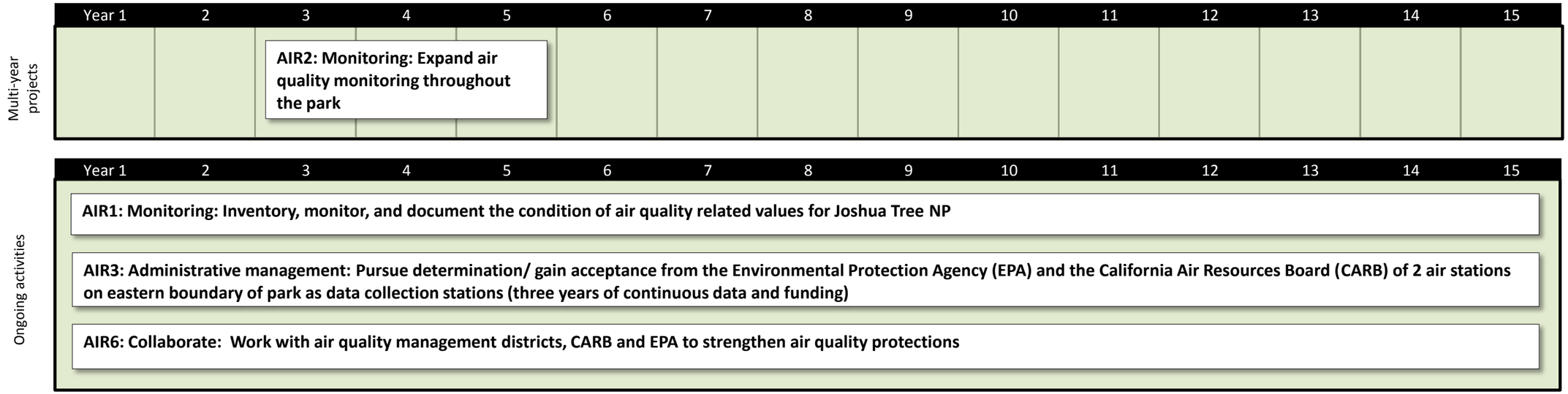
AIR3: Administrative management: Pursue determination/ gain acceptance from the Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) of two air stations on the eastern boundary of park as data collection stations (three years of continuous data and funding).
Determination and acceptance of the two air stations on the eastern boundary of the park as data collection stations will fill data gaps for the EPA, CARB and the National Oceanic and Atmospheric Administration. This ongoing activity will be performed by the physical scientist and physical science technicians in partnership with park management.

Air Quality Objective #2: Work with surrounding communities and agencies to minimize air pollution

Rationale: The majority of impacts to air quality at Joshua Tree NP originate from outside the park. Chronic air pollution has the potential to affect the health of park visitors and staff and harm plants and animals throughout the park. Air quality conditions have improved since the 1960's but have stabilized – without improvement – over the past decade. During the summer months, Joshua Tree NP is still in violation of the 8hr standard for particulate matter (10 microns and smaller) and ozone.

AIR6: Collaborate: Work with air quality management districts, CARB and EPA to strengthen air quality protections. [Relationships]
Improved air quality will decrease threats to biota and human health in the park. The chief of resources, superintendent and physical scientist will maintain relationships with the BLM, MCAGCC, South Coast Air Quality Management District (SCAQMD), Mojave Desert Air Quality Management District (MDAQMD) and the municipalities of the Coachella Valley and the Morongo Basin. They will attend meetings, give presentations, and provide input on documents for potential developments. This is an ongoing activity and should be a regular part of the annual work plan. The Resource Management division, the Interpretation division and the superintendent are part of an interdisciplinary team that will work together to attend meetings and educate municipalities and surrounding agencies on how to reduce air pollution.

4.3.11b Comprehensive Strategy Timeline: Clean and breathable air



4.3.12a Comprehensive Strategy Details: Soundscape

Soundscape Objective #1: Soundscapes relatively unimpacted by anthropogenic sources from beyond park boundaries

Rationale: Park visitors and wildlife seek areas of natural quiet for solitude and habitat requirements, respectively (Weisenberger, Krausman, Wallace, De Young, & Maughan, 1996; Krasuman & Herver, 1983; Barber, Crooks, & Fristurp, 2009; Pilcher, Newman, & Manning, 2009). A tranquil experience is a high ranking value among many visitors to many national parks (Pilcher et al., 2009). These experiences are spoiled by the buzz of commercial and military overflights and other modern sound disruptions (Benfield, Bell, Troup, & Soderstrom, 2010).

SOUND1: Collaboration: With municipalities and/developments, work to maintain or improve natural quiet.

In order to preserve natural quiet in the region, the park must work with communities, agencies and other entities that occupy surrounding lands. The Interpretation division, the Resources Management division and the superintendent are part of an interdisciplinary team that works together to educate municipalities and surrounding agencies on how to reduce noise pollution. Park management will maintain relationships with the BLM, MCAGCC, and municipalities of the Coachella Valley and the Morongo Basin through meeting attendance, presentations, and input on documents for potential developments. Interpretation programs educate the public through evening programs and visitor encounters. This is an ongoing activity and should be a regular part of the annual work plan.

SOUND5: Inventory: Collect baseline data to quantify levels of noise pollution produced outside of the park.

In order to scientifically track the current condition of the soundscape, a baseline inventory must be established to detect change. Establishing a baseline for noise pollution produced outside the park will provide information as to how much the surrounding communities and agencies are impacting park soundscapes. This activity will be performed by the physical scientist and physical science technician. Once a baseline is established, a monitoring phase would continue over 20 years.

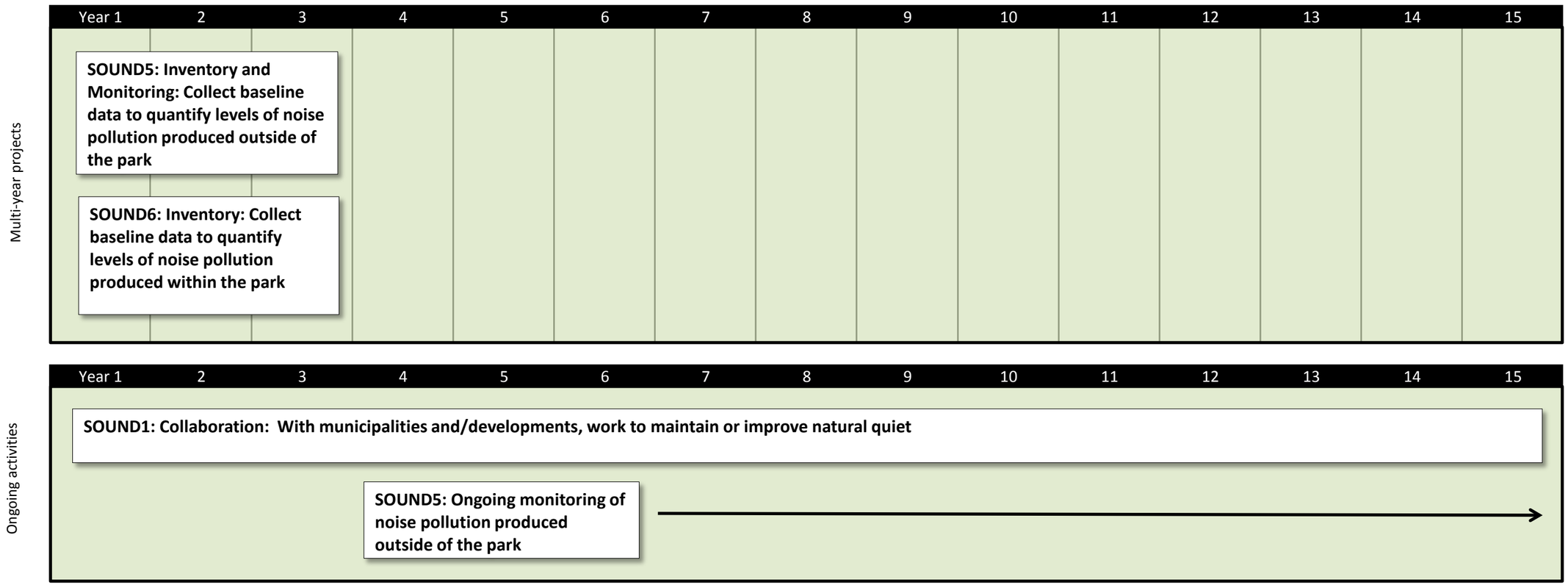
Soundscape Objective #2: Soundscapes relatively unimpacted by anthropogenic sources from within park boundaries

Rationale: Anthropogenic sounds such as automobile traffic and generators are common in developed areas of the park and can degrade otherwise pristine soundscapes. Keeping these sounds at a minimum protects biota and enhances the visitor experience (Weisenberger et al., 1996; Krausman & Herver, 1983; Benfield et al., 2010).

SOUND6: Inventory: Collect baseline data to quantify levels of noise pollution produced within park.

In order to scientifically track the current condition of the soundscape, a baseline inventory must be established to detect change. Establishing a baseline for noise pollution produced inside the park will provide information as to whether or not visitor or park management activities are impacting park soundscapes. This activity will be performed by the physical scientist and physical science technician. Once a baseline is established, the monitoring phase would continue over 20 years.

4.3.12b Comprehensive Strategy Timeline: Soundscape



4.3.13a Comprehensive Strategy Details: Viewsheds

Viewsheds Objective #1: Scenic views and integral vistas within boundaries of Joshua Tree National Park preserved

Rationale: The long views and wide panoramas offered by Joshua Tree NP's viewsheds are a draw for many visitors and are an essential component of the park's wilderness character. Protecting these views and vistas from intrusions and obstructions is a key part of preserving the park's landscapes for future generations (NPS, 2010c).

VIEW1: Research: Complete visual resource inventory. [Reconnaissance]
This inventory will guide park planning and management decisions with the goal being to maintain current viewshed conditions and if necessary mitigate for new developments. The visual resource inventory will be completed by the physical scientist and physical science staff in critical viewshed areas including Eureka Peak, the Coxcomb Mountains, Pinto Mountain, Belle Mountain, Ryan Mountain, Keys View, Geotour Road, the Cottonwood Mountains and Lost Horse Valley.

VIEW2: Administrative management: Develop and implement a visual resource management plan.
Establishing a visual resource management plan will provide guidance to the park on acceptable levels of impacts to park viewsheds. It may also recommend actions to improve viewsheds in certain areas. This one-time activity will be performed by the physical scientist staff in conjunction with other Resources Management staff and will address multiple areas of the park. The plan will be a decision making document that is open to public comment. Other agencies and communities will be involved in the scoping process.

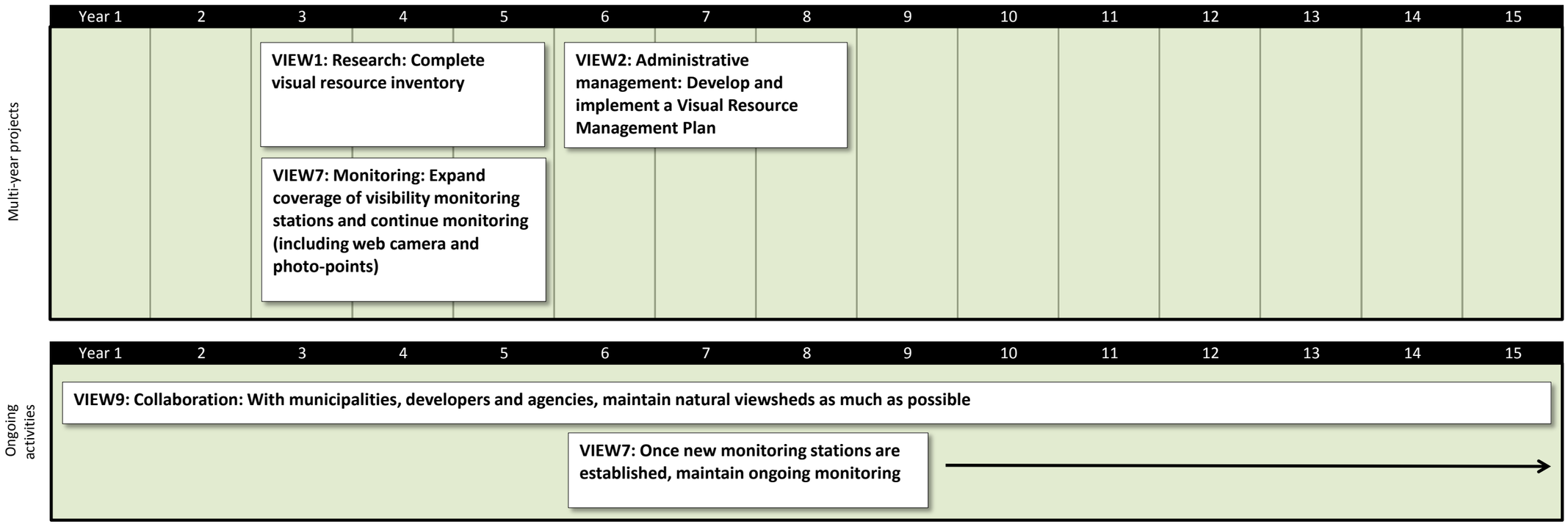
VIEW7: Monitoring: Expand coverage of visibility monitoring stations and continue monitoring (including web camera and photo-points). [Reconnaissance]
Additional visibility monitoring stations will provide more comprehensive data on the current condition of visibility and track any future visibility changes. This activity will be performed by the physical scientist. Installation of monitoring stations is a one-time activity while monitoring and maintenance of stations will be ongoing. Possible monitoring station locations include Black Rock Canyon, the Cottonwood Mountains or Pinto Wells.

Viewsheds Objective #2: Scenic views and integral vistas preserved for vistas extending beyond the park boundaries

Rationale: With vast, open basins and low ground cover, views in the desert are easily fragmented by developments or installations. To preserve views and vista observed from within the park that extend beyond park boundaries, park management must work with agencies and stakeholders in surrounding areas to mitigate any impacts from development to the region's viewsheds.

VIEW9: Collaboration: With municipalities, developers and agencies, maintain natural viewsheds as much as possible. [Relationships]
This ongoing activity will be performed by the physical scientist and will examine all park boundary areas threatened by encroachment. In addition, the Interpretation division, the Resource Management division and the superintendent are all part of an interdisciplinary team that works together to attend meetings and educate municipalities and surrounding agencies on how to reduce impacts to park vistas and viewsheds.

4.3.13b Comprehensive Strategy Timeline: Viewsheds



4.3.14a Comprehensive Strategy Details: Archeology (Historic and Prehistoric)

Archeology Objective #1: Increased knowledge of the human past at Joshua Tree NP through adequate research, fieldwork, recording, and evaluation to the National Register

Rationale: Ninety-six percent of Joshua Tree NP remains unsurveyed at any level for cultural resources. This data gap needs to be filled in order to have a cultural resources program that meets NPS standards. Additional research, fieldwork and evaluations will provide information valuable to management, interpretation, education, and be of overall benefit to understanding human land use over time at Joshua Tree NP.

ARCH2: Documentation: Complete Determination of Eligibility for management purposes.
Areas including Indian Cove, Barker Dam, Hidden Valley Campground, Oasis of Mara, Mission 66 structures and various mines and mills either contain pre-National Historic Preservation Act (NHPA) park developments on top of archeological sites or may have necessary safety-related undertakings conducted in the near future. In order to more easily manage the areas and utilize the 2008 Programmatic Agreement, a Determination of Eligibility (DOE) to the National Register for each site is first needed. To understand and document a site's cultural resources the significance of the sites/districts must first be analyzed and documented. The cultural resource manager will manage this project or establish a task agreement with an external partner. This is a one-time activity; however, updates may be needed as more information is obtained, or individual sites may be incorporated into a district or cultural landscape.

ARCH4: Documentation: Data recovery and update of National Register Determination of Eligibility for Cottonwood Spring Oasis. [Reconnaissance]
Cottonwood Spring Oasis is a very significant site that was partially destroyed by a flash flood in 2011 and again altered in 2013. This flood created a two meter cut bank and diagnostic artifacts are eroding out of this bank. The site is located by one of the few springs in the park and contains a Native American midden deposit as well as two historic mills. Data recovery and a DOE update, to adequately address National Register criteria, need to be conducted at this site before it is entirely destroyed by erosion, looting and effects of climate change. This site has already been determined eligible to the National Register but data recovery is urgently needed within the next five years. The record also needs to be updated because an arrastra and midden has been found since the DOE was written in 1971. The cultural resource manager will manage this project or establish a task agreement with an external partner.

Archeology Objective #2: Prehistoric and historic archeological sites professionally inventoried and recorded

Rationale: Parks are responsible for meeting all statutory and regulatory compliance obligations and for ensuring overall stewardship of these resources within their parks, this includes identification and documentation of archeological sites (NPS 1998a; NPS, 1998b; NPS, 2006).

ARCH5: Inventory: Inventory springs and other water sources for archeological resources. [Reconnaissance]
Springs and other water sources would have been crucial for human inhabitants in the desert in past times. These areas were along travel routes and will likely contain trade items and may have evidence of long term settlements. Increasing the knowledge level through an archeological inventory of these areas and detailed site recording may reveal details of the past that have remained unknown. However the resources are managed, an increased level of awareness and protection will be dedicated to such areas as the location and nature of archeological sites are discovered and recorded, especially as many are susceptible to loss. As the climate changes and more extreme weather events are predicted to occur, the loss of resources is a strong possibility.

Cottonwood Spring Oasis is a glaring example as a flash flood cut a two meter high bank through the archeological site and destroyed a large portion. Sites near water sources need to be located and recorded and eventually tested prior to possible destruction. Even less dramatic water erosion is damaging to sites and moves or buries artifacts and features.

The archeological technician will serve as a lead for this project, along with the cultural resource manager; a task agreement or contract may be an option with an external partner. This is a one-time inventory that presents an opportunity to integrate the cultural resource program with the natural resource or the MOJN I&M program. If any of the sites identified for archeological inventory are the same springs that MOJN I&M personnel intend to visit, it would be an ideal situation to combine efforts and provide mutual assistance.

ARCH9: Documentation: Collect baseline documentation on known but unrecorded archeological sites. [Reconniassance]
Many sites have been documented over time with a GPS location and are plotted on a GIS layer. Beyond a location and a very brief description, there is nothing else to document these sites. These sites need detailed records that thoroughly document the resource. A primary reason to record the sites is to have baseline records for research and to monitor condition. Many of the sites have already been vandalized or looted and these baseline records would help with prosecutions if any citations were made for these reasons. The most vulnerable sites would be recorded first (e.g. midden, rock art, historic sites with collectable artifacts). Comprehensive, professionally documented data is also valuable for management, interpretation, and the cultural resources program.

The archeological technician and cultural resource manager would lead this project. These sites span the entire park, but the Wonderland of Rocks area is a priority because there is a concentration of sites and the public is having a high impact on those sites. Other foreseeable threats include erosion and/or fire. The duration of this activity is difficult to estimate because the number of unrecorded sites is an estimated 23,200.

ARCH10: Inventory: Inventory in park developed area cultural resources. [Reconniassance]
Many of the developed areas used today were established prior to the 1966 National Historic Preservation Act and are on top of, or near, prehistoric and historic sites. People have the tendency to choose many of the same places to congregate for similar reasons (scenic views, shelter, out of the wind, near water) so this occurrence can be fairly common. Because these areas are in or close to present day public use areas they are also highly susceptible to loss through looting, vandalism, and inadvertent damage through maintenance of park infrastructure. In addition, as the climate continues to change, the loss of resources is a strong possibility. Specifically, these sites could be susceptible to fire and/or erosion. Any information gained through inventory will assist the cultural resource staff with management. Staff can establish appropriate protection measures for these sensitive resources. Some cultural resources may even be appropriate for interpretation.

The archeological technician and cultural resource manager would lead one-time inventories for each of the selected developed areas, including dirt roads, trails and campgrounds. Activity duration is estimated to be upwards of 20 years, and is thus considered ongoing.

ARCH11: Inventory: Conduct archeological surveys in areas subject to increased wildland fires (e.g. pinyon/juniper areas). [Reconniassance]
Areas subject to increased wildland fire have little inventory and the park does not know what type of cultural resources might exist there. Increases in invasive plant species, exacerbated by effects of climate change, can cause unnatural fire frequency and intensity in the desert environment. These wildland fires can destroy the native vegetation, habitat, and cultural resources. Specifically, these sites could be susceptible to burning and erosion. Wood structures or artifacts would be highly susceptible to loss and spalling of rock art or ground stone could happen if brush were not kept clear. Any information gained through inventory will assist the cultural resource management program and establish appropriate protection measures for these sensitive resources.

The archeological technician and cultural resource manager would manage one-time inventories for selected areas; a task agreement or contract may be an option with an external partner. Selected areas could include sample areas in Pinyon-Juniper vegetation zones. Activity duration is estimated to be three years. Cultural resources staff will collaborate with the fire management and vegetation management programs to identify sites with increased potential for wildland fire and develop measures to prevent damage in case of fire.

ARCH17: Inventory: Inventory boundary lands. [Reconniassance]
The boundary lands along the edges of Joshua Tree NP, as well as closed roads leading into the park from the boundary, face increasing threats from urban encroachment. Energy developments and municipality expansion in areas adjacent to the park lead to more people recreating in these areas and this increased use, along with the damage caused, is becoming more common. Archeological resources that exist in the boundary lands are susceptible to loss through looting, vandalism, and inadvertent damage. In addition, effects of climate change could exacerbate damages due to increased possibility of fire and or/erosion.

Because of limited staffing, it is not possible for all boundary lands to be patrolled on a regular basis, leaving these sites vulnerable. Any information gained through inventory will assist the cultural resource management program and help establish appropriate protection measures for these vulnerable sites. An example is that when sites are known and recorded they can be monitored and therefore better protected or sometimes stabilized when damage is discovered. Regardless, they will always be preserved on paper after recordation. The archeological technician and cultural resource manager, in consultation with park law enforcement staff, can lead one-time inventories for selected boundary areas. In the first three-year phase, portions of the southwest and northeast boundary will be inventoried; many other areas still need to be inventoried as well.

ARCH20: Inventory: Inventory climbing related areas to identify archeological resources (routes, bouldering problems, and social trails).
The park currently has an inventory of 1,012 bouldering problems with more routes sure to be published in future books. 19% of these routes have archeological resources within 50 feet. Twenty-eight of these bouldering problems are known to directly impact rock art; these areas have been closed to all forms of climbing. These statistics support the possibility that there are many more bouldering problems and climbing routes that are affecting unknown or unrecorded archeological sites. The park is issuing climbing permits to commercial users to climb anywhere they like (except the closed climbs) but they are no doubt traversing unknown archeological sites, climbing on rock art and leaving a buildup of climbing chalk. Because of certain climbing routes and their proximity to cultural resources, these areas are highly susceptible to loss through looting, vandalism, climbing bolts, social trailing, erosion, and inadvertent damage. The park must record these sites and close them if necessary before any further damage occurs. Rock art conservation is very costly and can never completely repair damage.

The archeological technician and cultural resource manager, in consultation with the climbing ranger, vegetation branch manager and park law enforcement staff, will lead this activity. Cultural resources staff will perform one-time inventories for each of the selected climbing routes; the larger project itself should be considered ongoing as more routes and problems are discovered and published.

All climbing routes and bouldering problems in published books should be inventoried. Joshua Tree NP staff should work with authors to inventory sites prior to publication of routes so that areas of cultural concern can be excluded from future climbing books. This activity can be integrated with archeological crews that do surveys for social trails, vegetation trampling and other damage associated with trampling.

Archeology Objective #3: Prehistoric and historic archeological sites preserved, protected and monitored for future research (and possibly limited interpretation of these sites)

Rationale: Parks are responsible for meeting all statutory and regulatory compliance obligations and for ensuring overall stewardship of these resources within their lands. This includes research, preservation, and protection of archeological sites (NPS, 1998a; NPS, 1998b; NPS, 2006).

ARCH22: Direct management: Stabilize and treat threatened or damaged archeological sites (e.g., rock art sites, midden sites with social trails such as Echo Cove CA-RIV-919); continue cyclic maintenance of archeological sites.

It is poor management practice to allow unsightly damage to archeological sites to remain untreated. If treatment is neglected, problems will continue to accelerate. Leaving human-caused damage at a site suggests to visitors the park allows this damage to take place. The cultural resources manager and archeologist will work in consultation with the vegetation crew, trails crew, law enforcement staff, and professional rock art conservators. Work can also be accomplished through a CESU or other type of task agreement. Stabilization and treatment should be performed as soon as possible after damage is discovered at an archeological site.

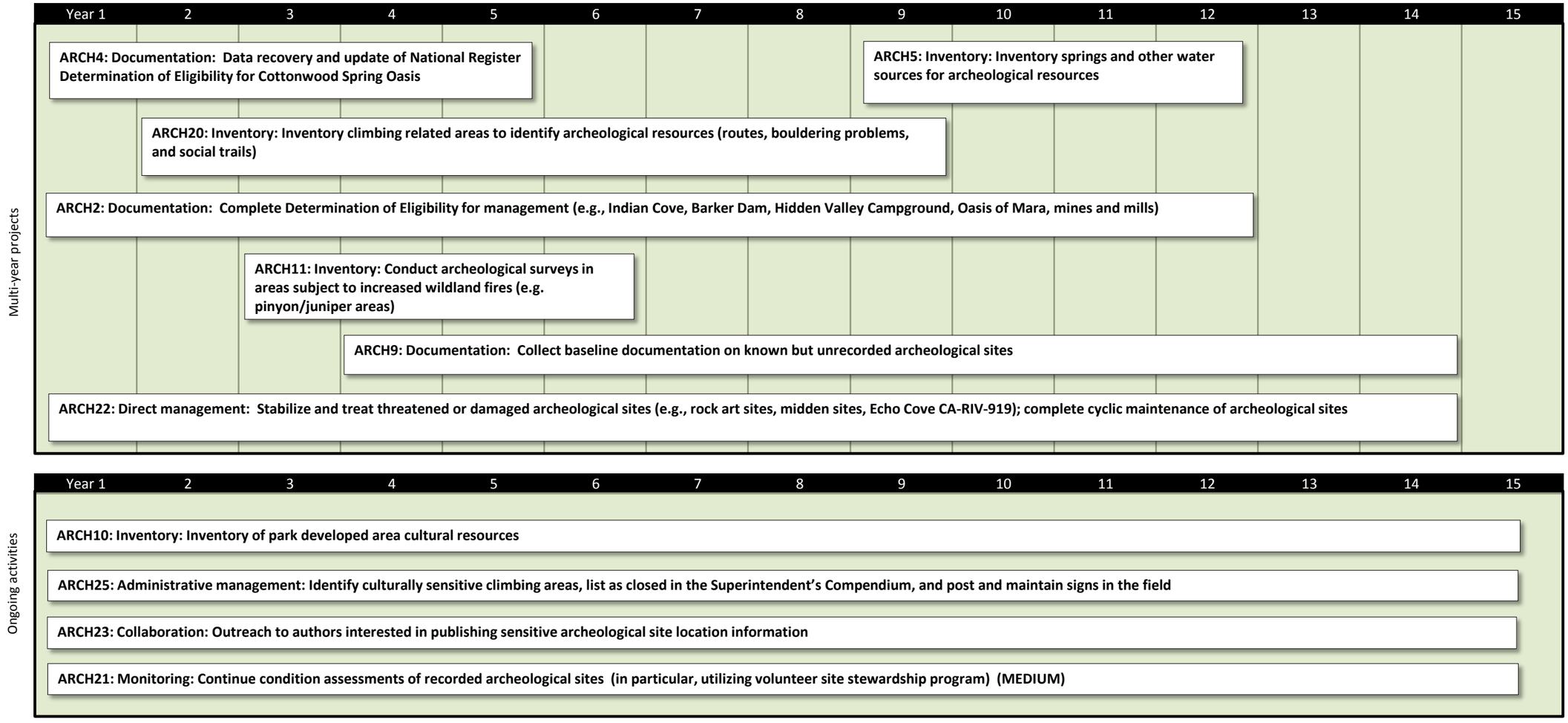
ARCH23: Collaboration: Outreach to authors interested in publishing sensitive archeological site location information.

Publicizing information about sensitive archeological sites draws a high level of attention and visitation to these sites. Though many visitors may only observe, others are not as conscientious. Archeological sites are highly susceptible to loss through looting, theft, and vandalism. Educating print and online authors about the significance of these resources may protect them from future harm. This ongoing activity to protect archeological sites can be performed by the climbing ranger in consultation with the archeological technician, cultural resource manager and law enforcement staff.

ARCH25: Administrative management: Identify culturally sensitive climbing areas, list as closed in the Superintendent's Compendium, and post and maintain signs in the field.

Sites within culturally sensitive climbing areas are highly susceptible to permanent loss if climbing and bouldering were allowed to continue in these areas. The park is also legislatively mandated to protect significant archeological sites from damage. The archeological technician and cultural resource manager will work with park management, park staff and external stakeholders towards ongoing education, interpretation, sign development and production, closure, and enforcement. Internal cross-divisional teams can be established to help determine and maintain closure areas.

4.3.14b Comprehensive Strategy Timeline: Archeology (historic and prehistoric)



4.3.15a Comprehensive Strategy Details: Cultural Anthropology

Cultural Anthropology Objective #1: Improved understanding and relationship with traditionally associated peoples in the region and respect for their traditional practices

Rationale: The National Park Service promotes the identification, evaluation, documentation, and interpretation of ethnographic resources (NPS, 1998a). Joshua Tree NP intends to manage a program that facilitates research about park ethnographic resources and their importance to traditionally associated peoples today. With this information, the park can better protect and preserve these resources, partner with traditionally associated peoples, and educate the public.

ANTH1: Collaboration and Documentation: In partnership with affiliated tribes, complete Queen Mountain and Oasis of Mara traditional cultural properties (oral histories and archival material). [Reconnaissance]

A traditional cultural property is eligible for inclusion in the National Register of Historic Places because of its significant association with cultural practices or beliefs and its importance to maintaining a sense of identity (NPS, 2006). These traditional cultural properties may have oral histories and archival material associated with them that needs professional assessment and documentation. A series of previously initiated but unfinished oral histories need continued work through collaboration between the park, or contractors for the park, and members and leaders of the Cahuilla, Serrano, Chemehuevi and Mohave Indians as traditionally associated peoples. Having this complete information for both Queen Mountain and Oasis of Mara will assist the cultural resource management program in establishing appropriate protection measures, building partnership opportunities, and enhancing educational options for these sensitive resources. Work will be performed in partnership with the affiliated tribes and may include the cultural resource manager, associated project managers, the regional cultural anthropologist, park and regional historian and/or contractors. The activity itself is one-time but may be completed in phases. Through this activity, oral history development protocols can be established for future projects.

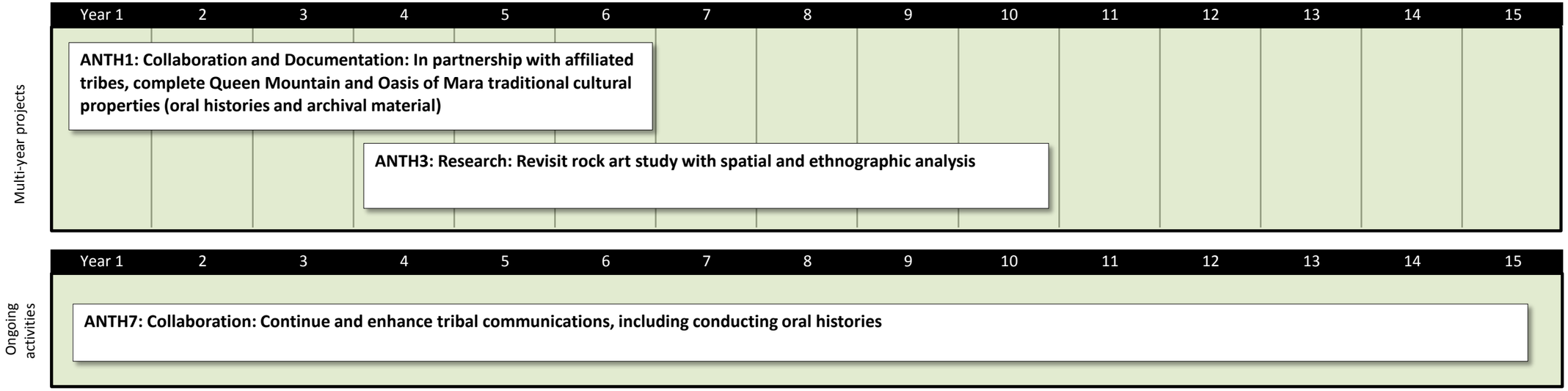
ANTH3: Research: Revisit rock art study with spatial and ethnographic analysis.

The park's known rock art sites have been recorded and most are documented to a high standard. Spatial analysis on these recorded sites can provide predictive modeling on where rock art sites tend to be located and what the design elements reveal as far as site function, location and traditional association. A complete analysis will provide more dimension to the understanding of past human use that can be used for interpretation and improved cultural resource management. This activity can be performed by cultural resources staff with supervision from the cultural resource manager and in conjunction with GIS specialists and affiliated tribes. This is a one-time activity for each recorded site containing rock art.

ANTH7: Collaboration: Continue and enhance tribal communications, including conducting oral histories. [Relationships]

The National Park Service is responsible for documenting, preserving and sharing the diverse human heritage and resources that characterize lands within the NPS system. Present-day peoples have cultural practices and identities associated with the resources found in the park. Maintaining relationships with these groups is a high priority for the park and includes informing groups on operations, closures, and management of cultural resources. Obtaining oral histories helps to preserve the cultural and historical memory. These histories support the cultural resource program but are also important for interpretive programs, products and park management. Preserving the tribal history is sometimes only possible through oral tradition and songs. Elders hold a vast knowledge of their cultural tradition. If stories are not captured through collaboration and oral history the stories may be lost as elders die and the collective knowledge fades. This activity will be facilitated by the cultural resource manager and in collaboration with the regional historian, park interpretation staff and affiliated tribes.

4.3.15b Comprehensive Strategy Timeline: Cultural anthropology



4.3.16a Comprehensive Strategy Details: History

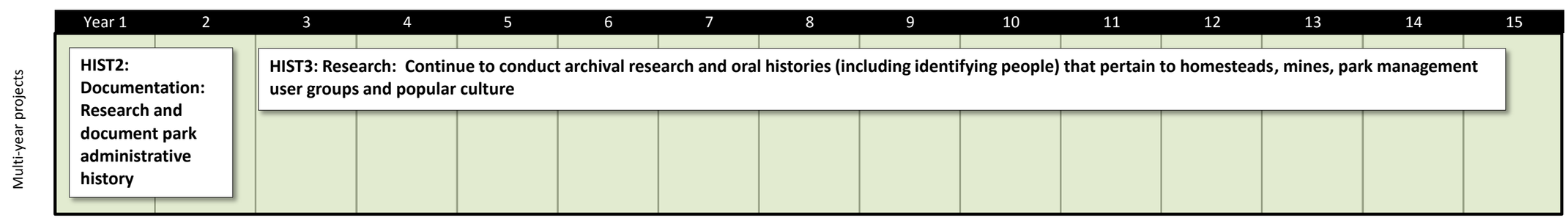
History Objective #1: Comprehensive knowledge of the history of the region and the park

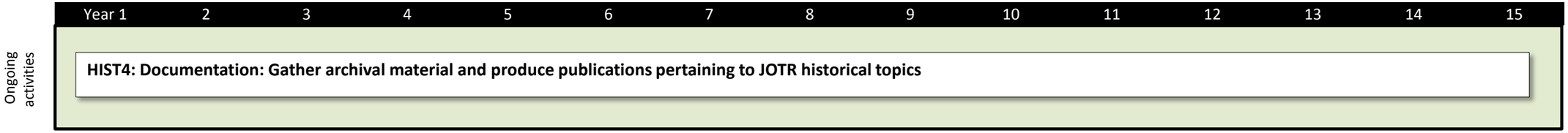
Rationale: The park is responsible for gathering and using accurate historical information to inform management actions such as compliance review and to create programs for visitor education. The park's archives and research library currently contain valuable individual bits of information but much of the data has not been pulled together in a readily useable format. Knowledge gaps have been identified which should be addressed for a more complete picture of the human history of the park the result being richer, more vibrant visitor education programs.

HIST2: Documentation: Research and document park administrative history.
The administrative history is a required baseline document for the history program as outlined in Director's Orders 28. The administrative history will focus on specific questions such as legislative changes in park boundaries and the reasons for these changes, changes in key park staff and resultant policy transitions, changing natural resources in response to human influences and the impact of management decisions over time. As the history of the organization, the report will illustrate how the park's administration/management developed, how primary goals and objectives were identified and addressed and what successes and challenges were identified and managed. A project lead/principal investigator can be assigned to complete the administrative history and can work in collaboration with the regional historian as well as volunteer researchers. This project is due to be completed in the winter of 2014. This activity will be completed with the aid of park archives, other NPS archives, non-park archives and oral histories with former and current employees park-wide.

HIST3: Research: Continue to conduct archival research and oral histories (including identifying people) that pertain to homesteads, mines, park management user groups and popular culture. [Reconnaissance]
The National Park Service is responsible for documenting and engaging the public with the diverse human story and human interactions that characterize each unit. Obtaining oral histories helps to preserve the cultural and historical memory of the time period associated with ranching, homesteads, mines, and mills. These histories support the cultural resource program and one way this information will eventually be used is to field check areas where there may be physical remains (e.g. short term homesteads that do not show up on maps). The oral histories are also important for interpretive programs and products and may inform management administrative functions. This activity will be lead by the park cultural resource manager in collaboration with the regional historian, cultural anthropologist and volunteer researchers. This activity should be ongoing but will be dependent on funding and staffing.

4.3.16b Comprehensive Strategy Timeline: History





4.3.17a Comprehensive Strategy Details: Historic Structures

Historic Structures Objective #1: Protect historic structures and their character defining elements that may contribute to the listing or eligibility for listing on the National Register of Historic Places or provide for public enjoyment/interpretation

Rationale: Protecting and preserving historic structures is part of the park service mission (NPS, 1998a). Many of these structures are eligible or listed on the National Register of Historic Places.

HSTRU1: Monitoring: Conduct ongoing condition assessments for historic structures.
Structures included on the NPS *List of Classified Structures* (LCS) require a condition assessment every five years. Structures that are listed in the Facility Management System Software require a condition assessment every six years. These condition assessments are critical to be able to determine treatment needs and produce detailed and justifiable project statements for funding requests so that needed work can be conducted. This activity will be performed by the park historic structures specialist on a five year schedule at each of the LCS listed structures.

HSTRU2: Direct management: Stabilize historic structures through ongoing cyclic maintenance program (e.g., Keys Ranch structures). [Restore], [Representation]
If historic structures are not maintained on a regular basis they will fall into poor or ruined condition. As structure condition worsens, a structure becomes harder and more expensive to maintain. In addition, climate change can degrade structures by accelerated desiccation of wood elements. Further, as invasive grasses invade the park and increased rains facilitate growth of vegetation, the risk of fire increases. The cyclic maintenance program helps prevent structures from deteriorating at an unacceptable rate. Cyclic maintenance includes the application of products to help reduce the desiccation of wood and the removal of vegetation close to structures.

This activity will be performed by the historic structures specialist, with supervision by the cultural resource manager and in consultation with the regional historical architect, Vanishing Treasures staff and park maintenance staff with some of the work coordinated through cooperative agreements. The duration of this activity is defined in the park's cyclic maintenance schedule (every 2 to 10 years). Keeping these structures in good repair enhances interpretation of the park's historical resources and moves the park towards the ultimate goal of maintaining historical structures as exhibits.

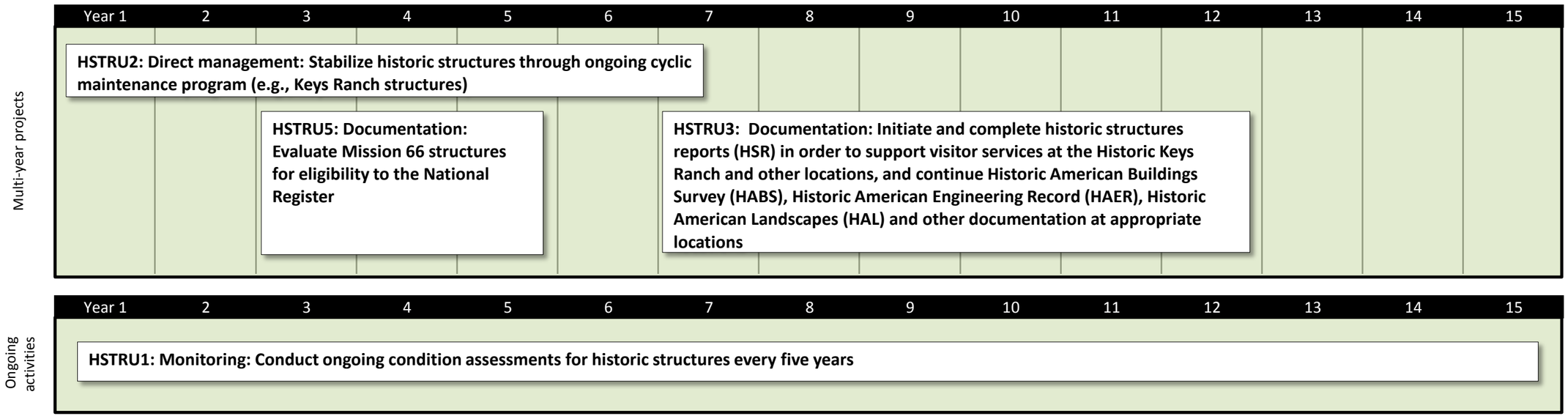
HSTRU3: Documentation: Initiate and complete Historic Structures Reports (HSR), in order to support visitor services at the Historic Keys Ranch and other locations, and continue Historic American Buildings Survey (HABS) and Historic American Engineering Record (HAER), Historic American Landscapes (HAL) and other documentation at appropriate locations.
Historic Structures Reports will provide guidance to the park managers on stabilization and treatment for specified structures. The HABS and HAER documents are important types of documentation required for certain structures. These reports will be performed by the historic structures specialist and cultural resource manager in consultation with the regional historian, historical architect and possibly contracting firms.

HSTRU5: Documentation: Evaluate Mission 66 structures for eligibility to the National Register.
Some alterations have been made over time to Mission 66 (ca. 1956-1966) era structures. If these structures still retain their integrity and the character of the era in which they were built, they may be eligible for the National Register of Historic Places. If the structures have been altered to a point where they do not possess the majority of their original character defining features, then the park may decide to remove or adaptively reuse them. Even if they are eligible, it is possible they

can be adaptively reused as offices, homes, or whatever use is desirable and appropriate. However, before any work or compliance can be completed for these buildings, an evaluation is needed. This project will be completed by the historic structures specialist in conjunction with the regional historical architect and needs to occur as soon as possible; it is formulated for funding in FY16.

An interdisciplinary team can be formed when the structures have been evaluated to determine the BMPs for repair/maintenance on Mission 66 era buildings and determine which, if any, buildings are suitable for stabilization, demolition or adaptive reuse.

4.3.17b Comprehensive Strategy Timeline: Historic structures



4.3.18a Comprehensive Strategy Details: Cultural Landscapes

Cultural Landscapes Objective #1: Improved understanding of the historic integrity, significance, landscape characteristics, and other features associated with ranching, homesteading and mining

Rationale: Managers must first understand a cultural landscape's significant characteristics and features in relation to each other and to events, persons, and the landscape as a whole in order to designate and interpret an entire cultural landscape as a cultural resource. This will allow for appropriate levels of preservation, stewardship, research, and planning (NPS, 1998a).

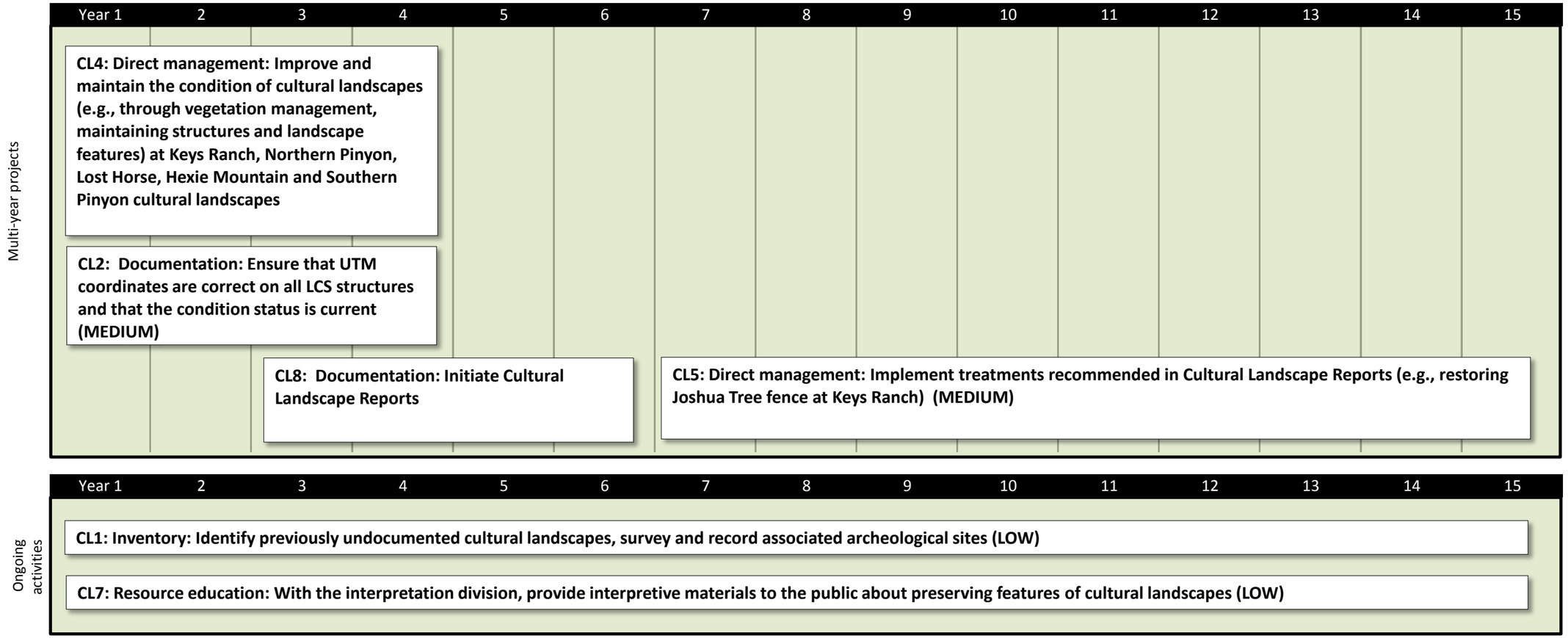
Cultural Landscapes Objective #2: Integrity of character and interrelationships between structures and their historic setting are maintained

Rationale: A cultural landscape contains intertwined patterns of natural and constructed elements and this relationship needs to be maintained to convey the historic feeling of a place. Any modern intrusions should be removed if possible so as to not intrude on a cultural landscape's viewshed.

CL4: Direct management: Improve and maintain the condition of cultural landscapes (e.g., through vegetation management, maintaining structures and landscape features). [Restore], [Representation]
The condition of cultural landscapes, including both natural and historic built features, is important for preservation and interpretation purposes. Constructed modern elements distract from the historic relationship and there are cases when their elimination is necessary. When certain features are in poor condition, restoration is more costly and it is less likely that the resource can be recovered to good condition. Improvement and maintenance of cultural landscapes including Keys Ranch Historic District, Hexie Mountain Mining Historic District, Northern Pinyon Mining District, Lost Horse Mining Historic District and Southern Pinyon Mining Historic District can be performed by the historic structures specialist and supervised by the cultural resource manager, in consultation with the regional historical architect and regional cultural landscape program manager.

CL8: Documentation: Initiate Cultural Landscape Reports (e.g., Keys Ranch). [Reconnaissance]
The park has five eligible *Cultural Landscape Inventories* (Keys Ranch Historic District, Hexie Mountain Mining Historic District, Northern Pinyon Mining District, Lost Horse Mining Historic District and Southern Pinyon Mining District) but no *Cultural Landscape Reports* (CLRs). Having these CLRs will provide guidance to park managers on specific treatments of cultural landscapes. Treatment recommendations could include erosion control, removal of inappropriate vegetation and removal of recent graffiti. Recommendations could encompass such features as fences, small stand alone pens, wagons, vehicles, equipment, landscaping elements, and circulation networks (i.e. roads, trails). Keys Ranch is one of the most visited and interpreted cultural landscapes and would be the first one documented. Preservation of this important landscape is crucial due to its high visibility to the public. This activity will be performed by the historic structures specialist in conjunction with the cultural resource manager and in consultation with the regional historical architect, regional cultural landscape coordinator, and the Keys family.

4.3.18b Comprehensive Strategy Timeline: Cultural landscapes



4.3.19a Comprehensive Strategy Details: Museum Collections of Archives, Natural History Specimens, and Archeological Artifacts

Museum Objective #1: Museum collection readily accessible and researchable while maintaining NPS standards for the preservation and use of collections

Rationale: Museum collections are a valuable resource to park staff, external researchers, partners, and the public. Department of the Interior and NPS regulations require that museum collections and specimens collected during scientific studies be documented in the Interior Collections Management System (NPS, 1998a). In order for individuals and groups to utilize the information within, the museum collection needs to be accessible and up to date.

MUS1: Direct management: Fully process and catalogue objects and archives into the Interior Collection Management System (ICMS), including catalogue records currently not in electronic format; maintain and update records as needed.

Objects and archives must be catalogued for data management and access. A number of objects not currently in the ICMS system need to be re-catalogued into digital format. Uncatalogued backlog, including archives, need to be fully processed. Objects and natural history specimens currently held in collections elsewhere need to be fully documented. Having all files up to date and in an electronic database will assure ease of access. In addition, collections have the potential to provide baseline data and document changes to natural resources; collections also provide materials for interpretive exhibits and research. This ongoing activity will be performed by the museum curator in conjunction with the cultural resource manager.

Museum Objective #2: Park collection searchable via finding aids and significant collection materials digitized for access

Rationale: Museum collections are valuable for the information they provide, as well as being important park resources. The Research section of the *Checklist of Management of Museum Objects* states that "All objects are accessioned and cataloged. Archival and manuscript collections are surveyed, appraised, accessioned, cataloged, re-housed, arranged, and described, and finding aids are produced" (NPS, 1998a). Finding aids are an effective tool to assist park staff and researchers in locating specific items.

Museum Objective #3: Museum collection storage and exhibit facilities maintained to full National Park Service standards; additional exhibit spaces planned and constructed

Rationale: The Joshua Tree NP museum collection and exhibit facilities provide the infrastructure and housing for significant objects, specimens, archives, and library materials. Maintaining the collection and exhibit facilities to NPS standards is an important step in protecting and preserving the entire museum collection. Storing the museum collection appropriately protects the collection from exposure. Cyclic maintenance and monitoring ensures that deficiencies in protection, preservation, and documentation of the collection are corrected in a timely manner (NPS, 1998a).

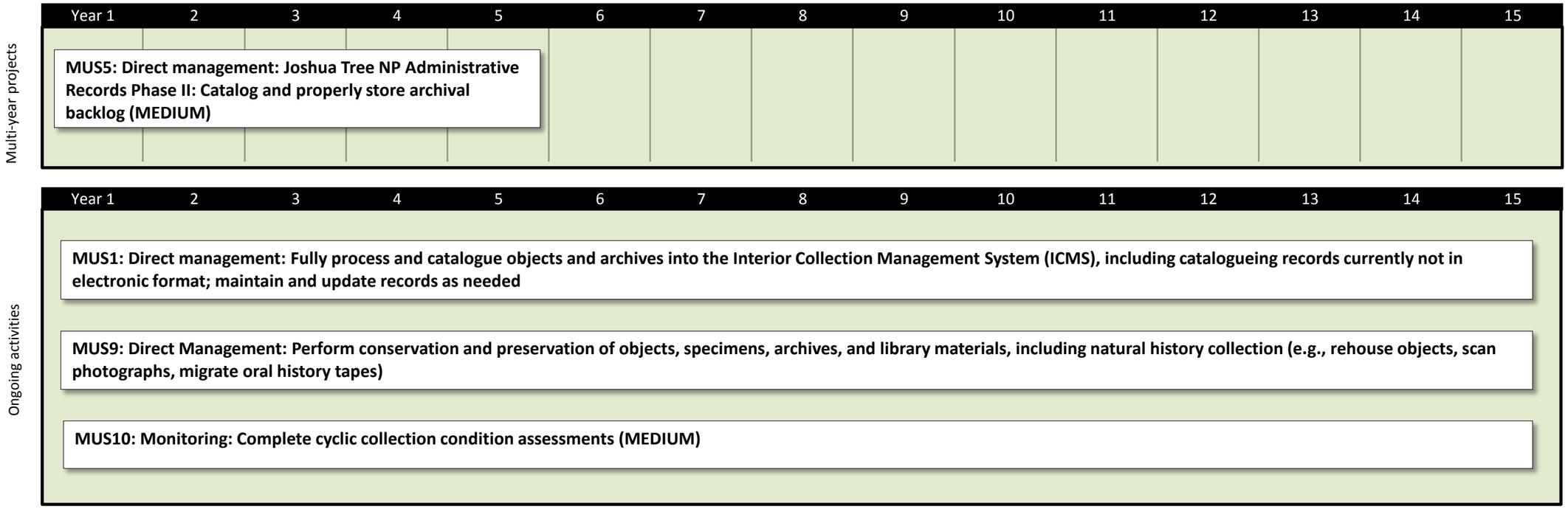
Museum Objective #4: Collections objects, specimens, archives and library materials preserved

Rationale: These objects, specimens, and archives are mostly all one of a kind and cannot be replaced. Their preservation is critical to having an intact museum collection that lasts into the future (NPS, 1998a). The library holdings include published books, rare out-of-print books, journals, park-specific and other relevant research reports, ephemera, videos, etc., that are vital to research and understanding.

MUS9: Direct Management: Perform conservation and preservation of objects, specimens, archives, and library materials, including natural history collection (e.g., re-house objects, scan photographs, migrate oral history tapes). [Restore], [Representation]

Museum collections are required to be maintained to National Park Service standards in a way that preserves them for as long as possible. The condition of these resources should be assessed by a professional on a cyclic basis and preservation should be performed as needed. Storage and exhibit spaces may require different strategies to maintain a stable environment. This ongoing activity will be supervised by the cultural resources program manager and museum curator, and may be accomplished through contractors. The estimated yearly time commitment is 10% of the museum curator's hours. Maintaining stable storage and exhibit environmental conditions may require different sustainable strategies if weather conditions change.

4.3.19b Comprehensive Strategy Timeline: Museum collections of archives, natural history specimens, and archeological artifacts, including the Campbell collection



Implementation and Reporting

5.1 Expert Review

The RSS Development Team arranged for a comprehensive review of this document by an interdisciplinary group of NPS specialists - including natural resource, cultural resource, and planning specialists. Expert reviewers were asked to look at methods for determining management objectives, indicators of condition, methods for measuring change in resources over time, current conditions, and development and sequence of potential activities that are needed to achieve management objectives and management targets (as appropriate). The reviewers ascertained whether the strategies are credible, feasible, and practicable given best available scholarship and science in resource management.

Members of the expert review team are listed in Appendix A.

5.2 Finalization and Updates

This document will be approved by the park superintendent prior to implementation, and then will provide a logical sequence of potential activities to attain management objectives. These implementation activities will be the subject of appropriate environmental planning and compliance documentation when specific actions or undertakings are considered. RSS implementation will proceed as funds are made available.

This RSS is designed specifically to facilitate ongoing adaptive management. The RSS team intends for the activities, measures of success, and strategies presented here to be subject to regular internal review and update. The Resource Stewardship Strategy contains several large and complex tables presenting objectives, indicators, measures, potential activities, as well as additional tables with timelines for each FRV. Data in these tables is currently maintained in Microsoft (MS) Excel but can be coordinated through a project-specific MS Access database, which can be exported to MS Excel files for editing and presentation by park staff. Table 5 should, ideally, be reviewed and updated annually by park staff and partners, to reflect changes in management. Reviews will also allow park staff to evaluate progress and resource condition, useful for the park, the public, and reporting purposes.

When updates are made, the revised tables should be printed separately and manually inserted as an addendum to the 2013 RSS document. Additional tables may be ammended and updated on an as needed basis. Upon receipt of the electronic files, the park should create a work folder and archive folder to ensure there is a backup. Because of the potential for file corruption, a backup copy should be made in the separate archive folder after each update. Each backup should be clearly labeled as a new iteration of the strategy/tables and be retained in the archive folder. The archival folder can then serve as an administrative or historical record for documenting the implementation of the *Resource Stewardship Strategy*.

The park may also consider reviewing certain sections at periodic intervals. An update is recommended once the Natural Resources Condition Assessment is complete. Once in every five to ten years managers may review the *attributes* that represent the park's *fundamental resources and values*, and consider if new knowledge or policy warrants removing or adding *attributes* in order to fully protect park resources. After 10 years, managers may wish to revisit the structure of the document, and evaluate the success of its design.

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Appendix A: Interdisciplinary Team

The creation of this document has been a collaborative task, leaning heavily on the expertise of park staff and park partners who are committed to excellent management for Joshua Tree National Park.

The Core Development Team is responsible for the overall structure, presentation, and content of this document. Subject Matter Experts attended planning workshops, contributed content, and provided written feedback to improve the final draft of the document.

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Appendix B: Status of Knowledge

This appendix provides a detailed overview of the current knowledge of park resources, including the history of research and management, current knowledge and programs, resource threats, and references. Information is organized by f*undamental resource and value*; those *fundamental resources and values* containing numerous or very distinctive *attributes* are further divided by *attribute*. References listed under each topic represent important sources of information and/or the most recent research in the respective field.

B.1 Biological Diversity and Healthy Ecosystem Function

B.1.1 Joshua Trees and Mojave Desert Flora

Joshua trees *(Yucca brevifolia)* are one of the most conspicuous plants in the Mojave Desert. As the namesake for Joshua Tree National Park, this species is regarded as iconic and a priority for conservation measures. Habitat models have been created to show current range of Joshua trees and future distributions with climate change (see Barrows & Murphy-Mariscal, 2012; Cole et al., 2011). Currently, the park is conducting a vulnerability assessment for Joshua trees to examine their sensitivity, exposure, and adaptive capacity to impacts of climate change. In both models, Joshua trees display sensitivity to a changing climate and subsequently a contraction in population size and distribution. Additional threats to the park's ability to maintain viable populations include elevated nitrogen deposition and fire. The Barrows and Murphy-Mariscal model projects that even with a 3°C increase in summertime temperatures, a small percentage of Joshua tree habitat will still exist within the current park boundary. Unfortunately, the remaining habitat is co-located with the portions of the park which are likely to be impacted by fire based on historical trends. The current distribution of Joshua trees and other Mojave Desert plant species coincides with the park's areas of highest visitation; this also impacts these long-lived plants.

While there is no distinct management plan for this community, management actions and guidance are partially called out in the park's *Fire Management Plan*. Most fires in the park take place in the western third of the park where these communities are located. Park staff are monitoring and actively restoring habitat in burned areas and visitor-impacted areas (i.e., climbing areas, campgrounds). As part of restoration efforts, seeds from most of the park's perennial plants are collected and stored – some of these seeds are grown in the Center for Arid Lands Restoration located at Joshua Tree NP headquarters. Invasive plant inventory and treatment is active and ongoing.

While many questions such as age and population demographics remain unanswered, several studies have been conducted which are beginning to complete the picture of Joshua tree ecology. In 2010, the NPS utilized citizen scientists to map juvenile Joshua trees. This data will increase the park's understanding of recruitment and better inform management in maintaining and protecting these populations. Moreover Joshua trees have been included as one of the focal species for the California Phenology Program at Joshua Tree NP. There has been some active research examining the mutualistic relationship of Joshua trees and Yucca moth *(Tegeticula* spp.*)* (see Godsoe et al., 2008). Smith et al. (2008) have begun to dissect the coevolution of Joshua trees and Yucca moths and have documented a shared history of population expansions.

See also: Status of Knowledge regarding Biological Diversity and Healthy Ecosystem Function: Native Plants; Fire Regimes; Juniper woodlands, mid-elevation mixed desert scrub, north-slope chaparral biotic communities

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B.1.2 Juniper Woodlands, Mixed Desert Scrub, North-Slope Chaparral

The NPS knowledge base for these vegetation communities is limited, reflecting the lack of work on desert plants in general. There are currently no management plans and no monitoring programs specific to these vegetation communities. However, work is commencing through the "*Managing biodiversity along transition zones in the face of climate change*" project (activity # EXP 7 in this document). This project will improve knowledge of plant/animal associations and interactions. Joshua Tree National Park's *Vulnerability Assessment* also provides more insight about threats to these communities as well, and develops a series of models for individual species' adaptations to climate change and range expansion/contraction. While there is no distinct management plan for this community, management actions and guidance are partially called out in the *Fire Management Plan*. Most fires take place in the western third of the park where these communities are located.

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See also: Status of Knowledge regarding Biological Diversity and Healthy Ecosystem Function: Native Plants; Fire Regimes

B.1.3 Colorado Desert Flora

The knowledge base for these communities is limited, reflecting the lack of work on desert plants in general. However, two long-term monitoring projects of Colorado Desert communities documented severe drought-related die-off of adult perennial plants (Miriti et al., 2007, McCauliffe & Hamerlynk, 2010). These studies highlight the reality of living in an extreme environment and point to an uncertain future for Colorado Desert plant species in the face of climate change.

The NPS is actively engaged in developing additional long-term monitoring plots through the ongoing "*Managing biodiversity along transition zones in the face of climate change*" project (activity # EXP 7 in this document). This project will improve knowledge of plant/animal associations and interactions. Joshua Tree National Park's *Vulnerability Assessment* will provides more insight about threats to these communities as well, including the development of models for individual species' adaptations to climate change and range expansion/contraction. There are currently no management plans and no monitoring programs designed specifically for these vegetation communities.

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B.1.4 Native Plants

Joshua Tree National Park is home to a high diversity of desert plants. The latest floristic studies have documented the occurrence of 738 vascular plants species in the park representing 89 families. Joshua Tree NP currently maintains an herbarium and database of herbarium specimens representing 87% of the flora within the park, and is finalizing the *Flora of Joshua Tree National Park* for online and print publication. In addition, vegetation associations and rare plant occurrences have been mapped. Currently, there are two management plans in progress for the two federally listed species located in the park, *Erigeron parishii* and *Astragalus tricarinatus*. These have expected publication dates in 2014. In addition to the vascular plants of Joshua Tree NP, the NPS has funded and is finalizing lichen and bryophyte inventories.

Staff at Joshua Tree NP, in partnership with seven other NPS park units, the USA-National Phenology Network, and the University of California, Santa Barbara have begun to monitor the temporal effects of climate change on seven plant species occurring within the park. Known as the California Phenology Program, this project began in the park in 2011 and monitors a number of perennial plants across various elevation gradients. This program will help gain valuable baseline data in assessing impacts to ecosystem health, including those impacts associated with climate change. Research suggests that monitoring one to two days a week, during the active growing season, is required to capture the effects of climate change. It is anticipated these activities will occur for ten to twenty years. In addition, the MOJN I&M program has instituted the *Integrated Uplands Monitoring Protocol*, with five sites currently monitored in the park. This protocol establishes long-term monitoring plots that will quantify park-wide changes in key plant communities and their associated soils in upland communities.

The NPS recognizes the threat exotic species pose to the park's ecosystems and has worked to develop an exotic species program that is responsible for documenting occurrences of exotic plants, implementing an *Integrated Pest Management* (IPM) control process, and assessing the efficacy of treatment methods. To implement this program, the NPS works with the NPS *Exotic Plant Management Team* (EPMT) and dedicates staff time to exotic plant priorities. The park has been managing exotic species since the 1940s, with the bulk of effort allocated to *Tamarix spp.* management. Other abundant and problematic invasive species include *Brassica tournefortii, Bromus spp., Schismus spp. Penisetum setaceum, Salsola tragus, Erodium circutarium* and *Sisymbrium spp.*

The NPS actively restores disturbed areas within the park. The native plant restoration program utilizes native plants grown in the Center for Arid Lands Restoration (CALR) nursery, located at Joshua Tree NP headquarters in Twentynine Palms, to help reestablish disturbed landscapes. Restoration projects include: off road vehicle disturbances, rehabilitating denuded areas around campgrounds, restoring landscapes after fires, numerous road projects, and other heavily impacted sites. The Center for Arid Lands Restoration was started in the mid-1980s due to the lack of commercially available native plants. Central to the mission of CALR is partnership. CALR has partnered with the Bureau of Land Management, Department of Defense, California State Parks, and other NPS units to grow plants for a range of restoration projects. Additionally, the program strives to publish propagation protocols for native species to make information available to a broader audience.

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B.1.5 Fire Regimes

Fire is a natural process and Joshua Tree NP has endured centuries of lightning-caused fires. Fire in deserts has been historically less common than in forests because shrubs and trees are widely spaced in deserts and grasses are not as abundant as in wetter areas. The NPS maintains records of fires dating back to 1945. Most of these fires occurred between May 18 and September 20 when desert vegetation was very dry. Seventy-four percent of the fires were ignited by lightning. The remaining 26 percent were human caused.

The number and intensity of lightning fires has increased over the past 50 years. Before 1965, most lightning fires burned less than one-quarter acre. After 1965 more large fires and more frequent fires have been recorded. In 1979 the Quail Mountain fire burned 6,000 acres; in 1995 the Covington fire burned 5,158 acres. And in 1999, the largest fire in Joshua Tree NP's history, the Juniper Complex fire burned 13,894 acres of slow-growing California junipers, pinyon pines, and Joshua trees.

Desert plants do not need fire to reproduce and many are highly susceptible to fire. The desert does grow back, but recovery after a fire is slow. Joshua trees frequently re-sprout after a fire, but because they are more susceptible to drought and rodents eating their bark, they often die. Even small shrubs like blackbrush may require 50 years to return to pre-fire densities. Also, non-native grasses are quick to invade burned areas and usurp the habitat from native vegetation.

The key to managing fire in Joshua Tree NP is in understanding how wildfires affect vegetation and wildlife in a desert environment. Biologists are monitoring the long-term consequences of fire in desert ecosystems, as well as the effectiveness of treatments designed to hasten recovery.

The NPS began to study the effects of fire on native vegetation at Joshua Tree NP in 1979 following the Quail Mountain fire. Leary demonstrated that fire caused a decline in the perennial vegetation and provided an opportunity for non-native grasses to expand into the vacated spaces (Leary, 1979). Work completed by Minnich in 2003 addressed how exotic invasive plant species versus native plant species contribute to cumulative fuel build-up in the park. In the past decade, Vamstad and Rotenberry (2010) studied the effects of fire on small mammal and vegetation communities, and showed altered rodent diversity and vegetation assemblages post-fire.

Joshua Tree National Park is subject to anthropogenic nitrogen deposition from air pollution that originates mainly from urban coastal areas to the west (Edinger, 1972; Tonnesen et al., 2003). Increased soil nitrogen has been shown to increase the productivity of exotic annual grasses across the Mojave Desert (Brooks, 1999; Brooks, 2003). In Joshua Tree NP, elevated soil nitrogen is decreasing the diversity and cover of native forb species in the park, and at the same time increasing the cover of exotic annual grasses (Allen et al., 2009). At present, cover of exotic grasses in Joshua Tree NP is higher in the western side of the park where nitrogen deposition is the greatest. Because of this, native species that occur at the higher-concentration end of the gradient are dealing simultaneously with two disturbance factors, competition from non-native species and increasing soil nitrogen (Rao et al., 2010).

Fire effects on vegetation communities have been documented and should be continued, but additional research is needed to identify management actions which can break fire cycles and promote fire-resilient ecosystems. Recently, the NPS in conjunction with re-

searchers from the University of California have begun to examine colonization patterns in the post fire landscapes of Joshua Tree NP which we hope will provide guidance for restoring these impacted landscape.

Currently, the Joshua Tree NP *Fire Management Plan* calls for full suppression of fires when possible to protect life and property, and to minimize the size of fires at the park. Internal policy calls on the NPS to deploy resource advisors to fires within the park to keep fire personnel informed of resource issues that occur during suppression activities. As a practice, the NPS assigns interdisciplinary personal as a Burned Area Rehabilitation team assesses resource damage from the fire and requests funding for restoration when feasible. The current *Fire Management Plan* will be updated in 2014.

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B.1.6 Desert Tortoise

The desert tortoise *(Gopherus agassizii)* was given *threatened* status under the Endangered Species Act due to population declines throughout its natural range. Habitat loss, disease (upper respiratory tract disease), and predation continue to impact tortoise populations.

The vast majority of all free ranging tortoises exist on public lands. Most of these public lands are designated as federal lands subject to multiple uses. As more public lands are identified as potential land for energy development, Joshua Tree NP contains some of the largest protected land area containing tortoise habitat. This fact alone places a significant responsibility on management to provide an aggressive program that ensures that park managers know as much as possible about park populations, and play an active role in the recovery of this species. The NPS works closely with the United States Fish and Wildlife Service to monitor the population of tortoises in the park. Recovery and delisting of the desert tortoise are the goals of the revised desert tortoise recovery plan.

Park biologists complete pre-construction surveys and monitor for tortoises during construction projects inside the park. In addition, select tortoises are monitored year-round using radio telemetry, in an ongoing study assessing the effects of curbing on park roads on their movement. Although this program was originally designed to monitor any increased mortality events on roads with the constructed curbs, the project was expanded to gather habitat use profiles for tortoises living near roads with and without curbing. Tortoise telemetry data is used to compare home range size and road crossing events of tortoises near curbed and uncurbed roads.

These transmittered tortoises also serve as focal animals for annual US Fish and Wildlife Service line distance sampling G_0 calculation. Park biologists tracked 17 tortoises with transmitters for 14 days in 2012 in conjunction with line distance sampling transects being completed in the park and the nearby Chocolate Mountain range.

The park wildlife branch also participates in interagency groups such as the Desert Tortoise Recovery Implementation Team and the Raven Management Workgroup. Continuing the relationships and discussions with other agencies is paramount to guiding management activities related to maintaining and improving desert tortoise habitat and populations.

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B.1.7 Desert Bighorn Sheep

Desert bighorn sheep (*Ovis canadensis nelsoni)* have state protected status due to habitat loss, disease, and interest by the general public. Desert bighorn are popular as viewable wildlife and are hunted outside of park boundaries. For decades, this species has received attention by wildlife managers. Manipulative techniques such as transplanting, artificial water sources, disease control, and hunting have been used by biologists throughout the species' range. These efforts have dramatically helped the once dwindling populations. Though bighorn sheep populations in Joshua Tree NP are relatively undisturbed when compared to populations centered outside park boundaries, maintaining genetic linkages between park populations and outside populations is important. Bighorn sheep populations in the desert have been described as exhibiting a meta-population dynamic: the overall population can remain stable and healthy even though extirpation may occur at local levels. For the park's bighorn populations to remain healthy according to meta-population dynamics, corridors where migration and emigration can occur between smaller (meta-populations) groups must remain open and unblocked.

Threats to bighorn sheep populations in the park include visitor impact to sensitive watering locations, pneumonia, invasive plant species that deplete forage quantity and quality, and encroaching human development.

See also: Status of Knowledge regarding Interconnectivity of California Desert Lands.

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B.1.8 California Treefrog

The California treefrog *(Pseudacris cadaverina)* has no special legal status in California; however, populations of this species in Joshua Tree National Park are under special management status. The California treefrog in Joshua Tree NP inhabit small, isolated riparian areas such as oases and drainages. Observational records have shown that these isolated populations are disappearing. The California treefrog of Joshua Tree NP may be genetically distinct from the rest of California, with the closest relatives found in Whitewater, CA.

In the 1960s, the species was found in approximately seven drainages, but currently they are only found in three. In addition, one of the remaining sites has only a few frogs and another site has tested positive for Chytrid fungus. It has been suggested that the California treefrogs are at risk of extirpation from the park altogether in only a few years.

Because of the frog's high site fidelity, small home range, and highly aquatic nature, reintroduction has been perceived as the best course of action. A couple of historical sites have been identified as having suitable habitat for reintroduction, and preliminary steps have been taken to begin a reintroduction program in the park. However, more data is needed to assess population demography and health, habitat health and suitability, factors which are putting existing populations at risk, and potential reintroduction sites. The wildlife branch at the park has already begun a reintroduction program utilizing tadpoles from desiccating pools which have been tested for disease.

Threats to the California treefrog include disease, direct human impact to habitat, and drought.

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B.1.9 Bat Species

Bats in North America are currently threatened with the *Geomyces destructans* (Gd) fungus, which is the causal agent of white-nosed syndrome that has already killed over a million bats in the eastern United States. Since Gd is a cold temperature-loving fungus, it mostly affects bats during the winter, rousing them prematurely out of their hibernating state. In response, many agencies have been enacting several steps to prevent the spread of white-nosed syndrome, from providing decontamination stations to visitors of caves and mines, to closing off bat habitat to human activities altogether.

Joshua Tree NP hosts twelve bat species, most of which use abandoned mines as habitat. Many of these mines pose hazards to humans; some have either already been closed or have been identified as candidates for closure in the near future. As of 2013, over 720 mine openings have been identified within the park, a number of which provide suitable bat and other wildlife habitat and have been modified with bat gates. Others have been completely closed for safety concerns.

The 45 sites that have already been closed represent a small percentage of sites in the park, and many of these were closed prior to the use of bat-compatible gates. Populations outside of these particular mine openings are unknown. Surveys of more remote mine openings, oases, and rock shelters should be completed to better understand species' presence and numbers due to threats of human recreation in bat habitat and possible maternity roosts.

With the current rate of spread, it can be expected that white-nosed syndrome may hit the park within the next two to three years. Joshua Tree NP has a number of mines that are accessible to visitors who may have been in areas with Gd and may unintentionally introduce the fungus to the park. In addition to white-nosed syndrome, other threats include nearby solar and wind energy projects adjacent to the park, and human disturbance in bat habitat.

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B.1.10 Golden Eagles and Raptors

Joshua Tree National Park is world-renowned for its numerous trails, climbing routes and its over 8,000 bouldering problems. However, many raptor species often use cliff faces and ledges near these activities during breeding periods, nesting stages, and fledging of young. Recreational activities during this timeframe that are within the vicinity of nesting areas can negatively impact nesting and fledgling success. Peak visitation coincides with the breeding season and impacts raptor nesting sites. Golden eagle *(Aquila chrysaetos)* nesting sites are primarily found in the eastern half of the park, in the Coxcomb Mountain range.

Biologists currently survey high visitor use areas and recommend closures to mitigate any negative impacts to these apex predators that are extremely important to a healthy ecosystem. There is a need to maintain and expand the monitoring program, as well as understand impacts, including habitat loss, due to development near park boundaries (specifically renewable energy developments including solar and wind developments), and collaborate with partners and agencies to protect raptors.

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B.1.11 Wildlife Assemblages

Joshua Tree National Park serves as a refuge for a high diversity of wildlife species, providing high quality habitat over two major ecosystems: the Mojave and the Colorado Deserts. Park lists of resident and migrant species include over 250 bird species, 52 mammal species, and 46 reptile and amphibian species. Wildlife observation cards, currently numbering over 15,000 individual records, have provided the park with essential information on wildlife occurrence and give observational "snapshots" of species over time. An electronic database has been established to house the information from the cards and to easily access information.

Other ongoing monitoring programs include the Great Backyard Bird Count and the Christmas Bird Count, which occur annually. New to the park, BioDiversity Hunts bring taxon specialists from a variety of institutions into the park to identify as many species as possible. These events are generally held one to two times per year, each within a specified location and timeframe within the park.

These programs helped to establish certified species lists for herpetofauna, mammals, and birds that were completed by the Mojave Network Inventory and Monitoring Program in the spring of 2012. These lists, now available through the Park Service's IRMA website, contain all species that can be verified as present or historically present in the park, either through reliable observation or voucher specimen.

Threats to park wildlife include climate change, invasive species, disease, pollution, poaching, and encroachment of human development surrounding the park. Smaller systems within the park, such as oases, dunes, and riparian areas, may be especially sensitive to these stressors.

While the above monitoring and documentation programs produce much needed information on species' presence/occurrence, the park is lacking knowledge on population trends and abundances. Surveys need to be done to establish baseline datasets to help assess impacts from the above threats to species and habitat.

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B.2 Interconnectivity of California Desert Lands

The NPS at Joshua Tree NP has a history of collaboration regarding desert land connectivity with various groups and communities to the north of the park boundary, while there is a strong need to engage the communities of the Coachella Valley (south of the park boundary). The Morongo Basin Open Space Group has been working with the park and various community stakeholders identifying corridors most beneficial to wildlife in the Morongo Basin. More recently, the conversation has included Mojave National Preserve and Death Valley National Park to identify linkages between the three large desert parks. Connectivity surrounding the entire park is already compromised due to transportation corridors (major highways: I-10, CA-62 and CA-177) and urban and industrial developments such as mining operations, subdivisions, military facilities, and utility corridors.

The NPS has begun a project to collect data on boundary incursions, but this project needs continued funding to complete data collection and implement management actions including increased protection, infrastructure, education and outreach to protect park boundaries.
Threats to interconnectivity include illegal boundary incursions, development adjacent to the park, urban sprawl and transportation corridors with increased traffic, and effects to landscapes due to climate change. Lack of connectivity may result in low gene flow for a variety of species (especially desert bighorn due to their current status and long-range movements), and therefore contribute to an "island effect" for the park's resources.

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B.3 Oases and Other Riparian Areas

B.3.1 Human Connections With Springs, Oases and Riparian areas

Many oases have a connection to the past. Not much is known about human activity prior to 8,000-10,000 years ago. Both early European settlers and several Native American tribes from the early Holocene on have utilized the areas and left evidence of their occupancy. Today, tribes are still very connected to these sites and there is a need to involve them in management decisions. Additionally, interpretive materials should be updated and enhanced at popular oases to tell the story of the people who have previously occupied and utilized these sites.

See also: Status of Knowledge regarding Archeology, History, Cultural Anthropology, Cultural Landscapes

B.3.2 Spring, Oasis, and Riparian Habitat

Current knowledge includes an inventory/current status of springs completed by the MOJN I&M program with some account of visitor impacts and species sensitivity. Guzzlers have been installed at a few areas where water was historically present in order to offset variable water availability. Monitoring and treatment of areas of known invasive species infestation has occurred on a regular basis. Many treatment areas are unnamed, including treatment for tamarisk at springs in the Cottonwood complex and south of the complex, as well as springs and other wet areas in the Coxcomb Mountains. Recent BioDiversity Hunts at Oasis of Mara and 49 Palms Oasis have added data on the presence of species at these biologically rich areas.

Ecologically critical areas associated with the park's oases and riparian areas are threatened for many reasons. In multiple areas, the groundwater table has been lowered. Loss of surface water has led to loss of the hydric vegetation zone essential for recruitment of palm trees. The most conspicuous example of this can be found at the Oasis of Mara where the lack of palm seedlings and an increase in mesquite indicate that water table has lowered or changed. Ecologically, changes in the water table at the oasis are apparent in that mesquite *(Prosopis glandulosa)* is thriving because it is a phreatophyte and has a tap root capable of reaching the water table. Additional changes include encroaching salt bush and a decline in palms.

Many riparian areas in the park have seen the presence of exotic species, such as fountain grass *(Pennisetum setaceum)*, date palm *(Phoenix dactylifera*) and tamarisk *(Tamarix ramosissima),* which are currently being monitored and treated throughout the park. Fountain grass has been treated at 49 Palms Oasis, while date palms have been removed from Lost Palms Oasis and a nearby spring southwest of this oasis. Tamarisk has been found in virtually all riparian areas at Joshua Tree NP.

Knowledge of local and regional groundwater hydrology is incomplete, and specific causes of lowering groundwater tables are not entirely known. Accurate baseline data and understanding of hydrogeology, information quantifying spatial and temporal variation in physicochemical and biological elements of springs, and surface water expression availability data will enhance the NPS's ability to manage for surface and groundwater protection.

Other needed research includes trends in fan palm recruitment, palm demographics, potential hybridization between native and non-native palm species and demographic and abundance information on other high-priority oasis plant species.

See also: Status of Knowledge regarding Hydrological Resources

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B.3.3 Oasis of Mara

Many oases are very popular visitor attractions while others remain comparatively unspoiled. One of the more highly visited oases in the park, the Oasis of Mara, is affected by both natural and unnatural factors. A lowered groundwater table caused, in part, by drawdown from local use has instigated supplemental watering to sustain the oasis. Hydrogeologic changes associated with the shifting fault line could also block or reduce spring groundwater levels.

In addition, the Oasis has significant prehistoric, ethnographic, and historic value as the ancestral home to the Serrano village of Mara, which took in a group of Chemehuevi in the 1870s. Historic use included homesteading and milling activities, as well as early park infrastructure development.

The Serrano Indians were the first known inhabitants of the Oasis, although it has probably been utilized by humans for thousands of years. Warfare with the Mohave Indians forced the Chemehuevi Indians from the Colorado River area and they settled at the oasis in 1867. The Serrano and Chemehuevi bands coexisted peacefully. As the Euro-Americans arrived, the Serrano and Chemehuevi drifted away and abandoned the area by 1913. Prospectors looking for gold arrived by 1870 and mining claims took hold in the nearby area. Changes to the Oasis from homesteading and milling, such as the construction of structures, and the removal of palm trees and siphoning of water away from the Oasis, altered the traditional environment the Oasis provided the Native Americans. Thousands of visitors take the opportunity to walk the Oasis of Mara trail and appreciate the ongoing story.

Fire management has been variable at the Oasis, where NPS management called for prescribed burns which were halted due to lack of success in reducing mesquites and increasing palm recruitment. Vegetation is now being selectively thinned to enhance natural breaks in the vegetation to provide fuel breaks in the event of a fire at the Oasis of Mara. See also: Status of Knowledge regarding Archeology, History, Cultural Anthropology, Cultural Landscape, Biological Diversity and Healthy Ecosystem Function: Fire Regimes

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B.3.4 Species Dependent on Riparian Habitat

Desert oases provide food and water to a variety of animals where these resources are scarce elsewhere. There are several factors, however, that deplete the availability of these resources. Because of their scarcity and uniqueness in the desert, riparian areas are a popular attraction for visitors.

California fan palms *(Washingtonia filifera)* are present at many riparian areas within Joshua Tree NP, however at the Oasis of Mara fan palms appear to be recruiting at a lower rate than at other oases. Factors such as full suppression of fire at the oasis, soil compaction, trampling of young plants, lowered water table, and possible hybridization with Mexican fan palm *(Washingtonia robusta)* are probable reasons. Other sensitive plant species may succumb to being trampled by visitors, and may recruit less due to compacted soils and lowered groundwater levels.

The western yellow bat *(Lasiurus xanthinus)* and elf owl *(Micrathene whitneyi)* only roost in palms and the giant palm-boring beetle *(Dinapate wrightii)* lives exclusively in palm oases. Coyotes help distribute palms by eating palm fruit at one location and depositing the undigested seeds at another. One natural process that increases seed production is fire. Hardy vascular bundles are scattered throughout the palm trunk and provide insulation from the heat of a fire.

Bighorn sheep are extremely sensitive to human presence and have been observed abandoning high quality water sources to avoid humans. Guzzlers have been installed historically (1950 to 1970s) to offset variable water availability and to mitigate for the loss of open water availability from historic human activities. These are regularly monitored by park wildlife biologists using motion-activated cameras to assess bighorn sheep use. 49 Palms Oasis was monitored for bighorn sheep activity to assess visitor impacts through use of motion-activated cameras.

Oases located at near urban areas face challenges of feral animals, such as cats and black rats, and many invasive and/or exotic bird species. Assessing visitor impacts to springs and wildlife that depend on the water source will help guide management decisions on visitation and future research needs. Currently, there is no regular monitoring program in place.

See also: Status of Knowledge of Biological Diversity and Healthy Ecosystem Function; desert bighorn and California treefrog

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B.4 Recreational Opportunities and Values

The NPS collects entry fees and campground fees at Joshua Tree NP every day of the year. These numbers go into a database that tracks visitor use statistics. This information allows managers to understand and identify time periods and physical locations of high and low use. The type of information provided, associated with recreation, is the use of campgrounds and backcountry nights. There are no trail counters at Joshua Tree NP, so the number of day hikers is largely unknown.

The majority of detailed information known on recreational opportunities and values comes from the 2010 *Joshua Tree National Park visitor study*. This document reports on

how the visitor evaluates different aspects of their visitor experience and ranges from questions about facilities to recreational opportunities. Among the visitor respondents, the visitors emphasized quality of trails and campgrounds as very important and sightseeing and walking as two of the most popular activities.

The park's *Backcountry and Wilderness Management Plan* (2000) protects natural and cultural resources by permitting visitor enjoyment in ways that reduce resource damage. A climbing management plan is needed and will be initiated within the next several years.

The resource management division does not directly monitor recreation use, but does monitor sites associated with impacts from recreation. The cultural resource branch monitors sensitive cultural sites that are susceptible to impacts associated with climbing. Likewise, the vegetative branch restores social trails that trample vegetation around climbing sites and installs signage to encourage visitors to stay on the main trail.

The NPS seeks to fill gaps in knowledge regarding recreation in the coming years. Understanding the breadth of impacts from recreation on cultural and natural resources will focus management actions. The level of climbing in the park is only understood in estimates. An ecological carrying capacity study will inform managers on how to better manage and regulate this popular recreational pursuit, in the interest of resource protection. The study could also include how the number of climbers affects the visitor experience. Visitor perceptions on impacts to resources are also poorly understood.

There are multiple threats to resources that are caused by visitor recreation. Social trails are often formed as a result of recreationalists seeking a new path to a destination. These social trails cause compaction of the soils and denude areas of vegetation. Books continue to publish new climbing routes leading to an increase in social trails

Rock climbing and bolting deteriorate rock faces, trample vegetation, and impact cultural resources. The climbing aid that generates the most controversy is bolting. Climbers place bolts for protection when no natural method of protection exists. This type of climbing generally takes place on rock faces devoid of cracks (called face climbing). The placement of permanent expansion bolts in the rocks to facilitate climbs has been practiced at Joshua Tree NP and other national parks since technical climbing was introduced. Top roping and clean climbing can provide protection for many climbs. The desire to lead face routes and the recent development of "sport climbing" requires the use of bolts. One bolt displaces approximately 0.4 cubic-inches of rock. The preliminary analysis of the Joshua Tree National Park Fixed Anchor Survey estimates that there are slightly more than 7,100 bolts in the entire park. In recent years, climbers have made a serious effort to camouflage bolt hangers and substitute rock-colored chains and/or webbing for the brightly colored webbing historically found at rappel stations to reduce visual impacts associated with climbing. Since February 1993, the NPS has prohibited new bolts and replacement of existing bolts in wilderness until the completion of Climbing Management Plan. In permitting recreational activities, including rock climbing, the NPS must ensure that no damage to cultural resources occurs and that every effort is made to protect the park's natural resources and wilderness values.

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B.5 Wilderness Values and Wilderness Accessibility

Of the over 792,000 total acres of Joshua Tree National Park, 595,364 acres are congressionally-designated wilderness. A *Backcountry and Wilderness Management Plan* was created in 2000 and identifies management prescriptions for the protection and use of backcountry and wilderness areas, trails, roads, camping, closures, group size limits, artificial, water sources and desert tortoise protection. This plan does not currently meet NPS requirements.

The knowledge base for Joshua Tree National Park Wilderness is limited. Currently, there is a need to increase knowledge regarding backcountry use and to conduct ecological and visitor carrying capacities to understand how visitors impact wilderness character and resources. According to the NPS Visitor Use Statistics Backcountry Overnight Stay data, nearly 10,000 visitors were recorded as using the backcountry overnight. This does not include information about day use, as there is currently no tracking program in place to collect this type of data.

Threats to Joshua Tree National Park Wilderness include park boundary incursions by off-road vehicle use; the NPS has initiated a project to collect data on these boundary incursions. This project needs continued funding to complete data collection and implement management actions. Development adjacent to park wilderness also poses threats to wilderness character, with possible impacts to soundscape, viewshed, air quality, habitat quality and interconnectivity of park wildlife populations. Viewshed analyses have been completed to identify impacts to viewsheds within Joshua Tree National Park Wilderness.

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B.6 Ever-expanding Knowledge Base

NPS staff tracks ongoing research activities in the park through a research permit and reporting system, which all investigators are required to use. Some organizations and institutions with active permits include: the National Park Service, University of California Riverside, San Diego State University, San Bernardino County Museum, and University of California San Diego. The NPS promotes research in the park and carefully considers its implications in management decisions.

Over the past four years, the number of active permits within the park has averaged 31 permits per year with a range between 27 and 39 permits, suggesting a more or less consistent use of the park as a locale for scientific study. Research performed at the park has covered a breadth of topics managed under cultural and natural resources, including geology, paleontology, plant and wildlife ecology, zoology and physiology; and archeological and historical studies. As of 2013, the NPS's highest priority research needs at Joshua Tree NP include ecological effects of invasive, non-native plants, desert fire ecology and impacts of global climate change on natural processes, among others.

The NPS employs a geographic information systems specialist at the park, to maintain databases about the park's resources, including digital elevation models, aerial imagery, geology, fire, vegetation, boundary incursions, cultural resources as well as local and regional datasets pertinent to park resource management. The wildlife branch maintains a natural history observation database that currently has about 15,000 records of wildlife observations made by visitors and park staff since the 1960s.

Park staff continue to establish formal and informal partnerships with research institutions through ongoing presence at professional conferences, engaging students and speaking in graduate and undergraduate conferences, especially in the surrounding region including institutions in southern California and Nevada. The park maintains a list of research needs through the NPS' Research Permitting and Reporting System.

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B.7 Opportunity to Understand, Apply, and Share Knowledge

Joshua Tree NP staff share information about the park's natural and cultural resources through a variety of channels, including displays and in-person contact with staff at visitor centers, educational presentations and activities given at the K through 12 level, roadside kiosks, subject-specific resource briefs and the park's official website. Currently the park's website provides the main portal for visitors to gain information about the park. Many available materials need to be updated more regularly with the latest scientific information, including resource briefs and visitor center displays, requiring close collaboration between the park's Interpretation and Resources Management divisions in the near future. Of special importance for future cross-division collaborations is development and dissemination of information on the possible and observed effects of climate change within the park.

An interpretive prospectus was completed for Joshua Tree NP in 1996. A more comprehensive Long Range Interpretive Plan is currently in draft stage and will become part of a Comprehensive Interpretative Plan.

Resource division staff and affiliated researchers give presentations to local interest groups, visiting college-level groups volunteering on resource stewardship projects, and at academic conferences about topics spanning the breadth of scientific disciplines practiced at the park. Species lists are available online and in the visitor center listing the park's reptile, mammal and bird species. The NPS has also produced an up-to-date, verified web-based flora based on floristic surveys of the park over the last decade.

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B.8 Geological Resources and Desert Landforms

Joshua Tree NP is situated along of one of the world's most active earthquake faults, the San Andreas Fault. Geologic processes, including tectonic activity, have played and continue to play a major role in shaping the mountains, valleys, and basins of the park. The natural fluvial processes of the southwestern United States have also shaped distinct landscapes across a wide variety of geologic and tectonic environments.

Joshua Tree NP is located across two diverse mountain ranges and is adjacent to the highly tectonic plate boundary of the San Andreas Fault. The geomorphic expression ranges from young orogenic mountain blocks and exposed plutonic emplacements, to basin and range topography on the eastern end of the park.

The southwestern portion of the park is within the tectonically active eastern Transverse Ranges. The 105 degree rotated mountain range is the only east-west trending mountain range within California. The eastern Transverse Ranges lie in the heart of the tectonically active regime of the San Andreas Fault. A locally converging segment of the San Andreas Fault, generating uplift from 1 to 3 millimeters per year, drive the deformation processes in the south-southwestern portion of the park. Structurally lower metamorphic rock units of a paleo-subduction zone, lie at the surface juxtaposed to the structurally higher Mesozoic plutonic emplacements. The uplift generated by the locally converging plate boundary over the past seven million years, combined with the wetter climate of the Plio-Pliestocene periods has produced numerous young steeply walled canyons and drainages that continue to rapidly evolve on geologic timescales. The geomorphic landscape of the southwestern portion of the park represents geologic time where regional transtension

gave way to transpression following the abandonment of the continental subduction zone of the coast of California.

The northerly portions of Joshua Tree NP expose Triassic to Cretaceous plutonic emplacements where the older country rock (Pinto gneiss) has been eroded through time. The Mesozoic emplacements represent an era when a subduction zone existed off the coast of California. The highly weathered exposures clearly delineate an iconic viewshed that many visitors associate with Joshua Tree NP.

The eastern portion of the park is more typical Mojave Block basin and range geomorphology with the Coxcomb Mountains as the only northwest-southeast trending range in the park. The playa setting of the eastern Pinto Basin, bounded by the Coxcomb Mountainsm with intervening alluvial fans, define the western boundary of the southern California Basin and Range Province.

Numerous research activities document the geologic and tectonic processes that shape the landscape at Joshua Tree National Park. The age, origin, and distribution of the formations throughout the area are generally well known. However, highly complex tectonic processes that juxtapose differing rock types and ages are constantly evolving.
New research within the Little San Bernardino Mountains (Sabala, 2010; Barth et al., 2008) reveals rapid uplift, tilting and erosion within a Mesozoic block previously described and mapped as Proterozoic in age. This new information constrains the timing during which the San Andreas Fault locally changed from transform margin to a locally convergent margin. The resulting compressional force - within the locally converging margin of the San Andreas Fault - has played an important role in shaping the desert landscape and diverse rock units of Joshua Tree National Park.

Less research is published about the terrace deposit, lacustrine deposits and paleo-braided stream systems of the Pinto Basin. Additional research is needed to understand relationship of volcanic basalts on eastern side of the park, underlain by terrace deposits. Structurally complex, these basalts serve as an age basis for the rotation of the Mojave Block (Carter et al., 1987).

Ongoing research conducted by UNAVCO/Plate Boundary Observatory and the University of Arizona continuously document the movement and the strain partitioning of the San Andreas Fault, centered around the western portion of Joshua Tree National Park. However, continued research both locally and regionally is required in the future if a thorough understanding of seismic hazard is desired.

Until recently, Joshua Tree NP has been a recognized but mostly unexplored region for paleontological remains. The presence of vertebrate fossils in the eastern Pinto Basin was first documented by Campbell and Campbell (1935), who briefly mentioned the presence of mineralized vertebrate bones – mainly remains of camel and horse – from the region. These fossils were initially interpreted to potentially be temporally coincident with local artifacts, including projectile points of the Pinto culture. However, Jefferson (1973, 1986) proposed a depositional hiatus between cultural deposits and older bone-bearing lacustrine sediments [the latter informally designated the “Pinto Formation” by Scharf (1935)]. In this interpretation, sedimentary deflation due to eolian conditions winnowed cultural materials from mid-Holocene alluvium and redeposited these items onto the eroded surface of the “Pinto Formation”.

Ongoing paleontologic field reconnaissance of the eastern Pinto Basin region of Joshua Tree NP, conducted by the San Bernardino County Museum since 2003, has produced

new records of extinct mammoth (*Mammuthus* sp.) and bison (*Bison* sp.), both highly significant finds for the region (Scott et al., 2006, 2009). Based upon these discoveries, a later to latest Pleistocene age for the vertebrate fossils from the "Pinto Formation" can be clearly demonstrated. Additionally, a separate faunal component from the region has been discovered for the first time, from alluvial fan deposits overlying Miocene basalts in the northeastern Eagle Mountains. These remains consist largely of extinct large and small camel (*Camelops* sp., *Hemiauchenia* sp.) and horse (*Equus* sp.), and are likely of Pleistocene age. Further, sediments below the Miocene basalts in the Eagle Mountains have yielded fossil remains of gopher, tentatively assigned to *Thomomys*, from sediments of apparent Miocene Epoch age. The presence of fossils resembling *Thomomys* in a reliable stratigraphic context below Miocene basalts in the Pinto Basin may offer the opportunity to document one of the earliest records of pocket gophers anywhere in North America. Finally, recent field efforts have also documented fossils of ancient green algae and ostracodes from Neogene sediments of the Bouse Formation in the Coxcomb Mountains, which denotes the westernmost occurrence of this formation and confirms for the first time that sediments in this part of Joshua Tree NP have paleontologic sensitivity, as well.

The success of paleontological studies in and around the eastern Pinto Basin indicates that similar efforts throughout Joshua Tree NP will be similarly beneficial for better interpreting, managing, and conserving fossil resources. Future paleontological investigations in Joshua Tree NP should include: 1) Continuing and expanding detailed geologic mapping of the southeastern Pinto Basin region of Joshua Tree NP; 2) sampling of packages of sediment situated between and below basalts in the northeastern Eagle Mountains and the Coxcomb Mountains for vertebrate fossils, especially biostratigraphically-meaningful vertebrate microfossils; 3) radiometric dating of basalts located in the northeastern Eagle Mountains, immediately south of Pinto Wash and the Pinto Basin, as well as the southern Coxcomb Mountains bordering the eastern Pinto Basin; 4) continued and expanded cyclic prospecting for significant fossil resources; and 5) exploration and systematic surveying of potentially fossil-bearing geologic units throughout Joshua Tree NP, enabling determinations of paleontologic sensitivity and avenues for future scientific investigation.

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B.9 Hydrological Resources

Little information is known about the groundwater quality and quantity in the park. Lowering the water table at the Oasis of Mara and other areas within the park is a concern. Adjacent land uses, such as energy development, may impact eastern aquifers and other aquifers near the park boundary. Most interior hydrologic resources are not being directly altered by exterior actions. Groundwater levels throughout the Pinto Basin are poorly understood, including quantity and quality and how to manage for surface and groundwater protection. As park managers gain additional information on quantity and quality, drawdown and recharge, protection measures can be enforced.

Sada and Jacobs (2008) inventoried all known surface water features in the park in 2005-2006. A total of 291 water features were surveyed, of which 73 were flowing springs, 36 were dry springs, 97 were wells, and 85 were other water sources (potholes, reservoirs, and tanks). Most of the springs discharged less than 5 liters/minute (1.2 gallons/minute), and supported spring brooks that were less than 50 m (~150 ft) long. The temperature of all but three springs ranged between 5°C and 20°C, and electrolyte concentrations were generally low (electrical conductance less than 500 microsiemens/cm).

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B.10 Night Sky

Joshua Tree National Park's location east of the heavily populated Los Angeles basin and directly north of the Coachella Valley make for an interesting blend of impacted and unimpacted skies for star gazing. The most severely light polluted skies exist in the northwesterly and southerly areas of the park. Generally the light pollution decreases toward the east, with the most pristine area of the park in the east (Pinto Wells) and northeast area of the Coxcombs.

The most pristine, eastern area of the park, is the currently the most threatened area for potential development and increased light pollution. Numerous large scale solar developments are either in planned or under development, including a proposal for 750-foot power tower that will require permanent Federal Aviation Administration regulated lighting.

The NPS has collected multiple data sets of dark sky images at three locations throughout the park. Numerous data collection points are planned beginning in 2013 and will continue throughout the development of the potential Riverside East Solar Development Zone. Park interpretation staff present a dark night sky program at the Cottonwood amphitheater for visitors to appreciate and learn about the dark sky and how they can help protect this resource.

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B.11 Clean and Breathable Air

Joshua Tree National Park is located within three converging air basins (Mojave, Salton and South Coast). However, two managing air districts, the Mojave and South Coast Air Quality Management Districts, have jurisdiction over the park. 125 miles east of Los Angeles, CA, Joshua Tree National Park has the worst air quality in the National Park Service. A close second is Sequoia Kings National Park with the highest number of days exceed-

ing the 8-hour standard for ozone. Joshua Tree National Park holds the highest value for ozone concentrations of all the parks in the national park system.

Over the past two decades, Joshua Tree National Park has seen a reduction in ozone concentration. This is attributed to higher standards placed on mobile and stationary sources of pollution, set forth by the California Air Resources Board. However, over the past several years, air quality (ozone in particular) has remained status quo. This may be the result of a substantial increase in the numbers of cars on the road and the geographical location of the park.

The NPS Air Resources Division Gaseous Pollutant Monitoring Program began a temporary monitoring program in 1987, with a permanent upgraded station (including standard meteorological monitoring) beginning in September of 1993. The program has undergone several upgrades and changes over the past decade. Some of these changes include: CASTNET stacked ozone filter packs in 1995; National Atmospheric Deposition Program wet deposition for nitrogen in September of 2000; Inter Agency Monitoring for Protected Environments in February of 2000; and visibility monitoring (digital imaging) in November of 2001.

In December of 2005, the NPS added a second air quality station near the Cottonwood Visitor Center. Station parameters include ozone, precipitation, temperature, relative humidity, and occasionally particulate matter 10 microns. The station operates 100% on solar panels and battery backup for nighttime operations. In May of 2006, a third station was added at the Pinto Wells facility on the eastern edge of the park. Similar to Cottonwood, the station is 100% powered by solar panels and battery backup for nighttime operations. Station parameters include ozone, precipitation, temperature, relative humidity, and occasionally particulate matter 10 microns.

University researchers are investigating how soil nutrients, carbon cycling, and nitrogen supply are affected by air pollution in the park. Certain species of native plants are sensitive to ozone, while non-native plants thrive with the additional nutrients fed through nitrates being deposited from polluted air. Native plants will be forced to adapt to these changing conditions or competition by non-natives may reduce their population density. Forage and cover that specific fauna depend on may also be altered by air quality impacts. The park is concerned about the condition of the air for both human visitors and the resident plants and animals.

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B.12 Soundscapes

The soundscape is the total acoustic environment of an area. It can have a wide range of variation from day to night and from season to season. Natural ambient sound level within the wilderness areas of Joshua Tree National Park can be expected to be as low as 35 db, day and night time during periods of low wind levels. Natural soundscapes are an important resource and a vital aspect of the ecological communities preserved at Joshua Tree National Park. Studies suggest that the acoustic environment is important for intra-species communication, territory establishment, finding desirable habitat, courtship and mating, nurturing and protecting young, predation and predator avoidance, and effective use of habitat. Understanding the acoustic environment and the role sound plays in ecosystems is extremely valuable for management and protection of the park.

The NPS has been conducting natural ambient sound inventories in park areas of anticipated or on-going development. Soundscape inventories began in September of 2011 and have been concentrated on the eastern part of the park in anticipation of several potential utility scale solar projects. In conjunction with the soundscape data that is currently being collected, an ongoing research effort needs to correlate impacts of sound pollution to sensitive species. Currently, Joshua Tree National Park lacks this correlative study that can help quantify impacts on wildlife as it relates to sound pollution.

Joshua Tree NP lies beneath airways that facilitate inbound and outbound airline traffic for the Los Angeles area. Military activities ranging from overflights (from Marine Corps Air Station, Miramar) to bombing degrade and infringe upon the park's soundscape. Commercial airlines also dot the sky day and night. Noise pollution generated within the parks boundary does not travel as far and wide as the those generated from outside the park, but still degrades the natural soundscape. These sounds are typically generators in the campground, motorcycles, camping activities, noisy visitor groups, and climbing noises (shouting). Raising the level of awareness to visitors about the values of natural quiet areas may assist in making the park a quieter place.

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B.13 Viewsheds

The National Park Service's Reference Manual #77 identified four Mandatory Class I Area *Integral Vistas* at Joshua Tree National Park: the Coxcomb Mountains (views from 270º to 340º compass bearings), Hi-View Nature Trail (240º to 50º), Inspiration Peak (305º to 140º), and Mastodon Peak (120º to 255º). *Integral Vistas* are views from inside a mandatory Class I area looking outward to specific important panoramas or landmarks beyond the Class I area's boundaries; these views have scenic, scientific, or cultural importance to the Class I area. To date, the NPS has not designated other key scenic vistas, but well-recognized and often-visited scenic vistas include those at Keys View and the summit of Ryan Mountain. Air pollution plays a large role in the quality of viewsheds throughout the park, as views can be obscured on days with high levels of particulate matter. Visibility from the park is monitored from a web-camera placed on top of Belle Mountain; imagery from this camera is accessible online and refreshed every 15 minutes.

A recent visitor survey placed unobstructed viewsheds a high value resource at Joshua Tree NP. Impending energy developments such as solar and wind installations on lands surrounding the park threaten the natural/wilderness qualities of the park's viewsheds. Viewshed analyses have been performed pertaining to the effects of these developments on vistas seen from within the park. In addition photo-points monitoring energy developments are currently being taken as part of the park's Soundscape Monitoring project. These photo-points are taken from two different places in the park that overlook the Chuckwalla Valley to document change in viewshed over time. Comprehensive Digital Elevation Models for all park lands are available to park employees and partners for use in viewshed analyses. In addition to analysis documenting renewable energy influences, cell phone coverage data and maps and radio coverage maps have been produced using viewshed analyses.

Based on increased presence of energy developments on lands surrounding parks, some viewsheds are detiorating.

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B.14 Archeology (Historic and Preshistoric)

Archeological resources in Joshua Tree National Park include prehistoric, ethnographic, and historic-era archeological sites. Prehistoric archeological resources are represented by such things as midden, rock shelters, rock art, milling tools or features, lithic and ceramic scatters, trails, and quarries. Ethnographic sites are represented by the same but may also include the use of historic objects (e.g., projectile points chipped from glass) and petroglyphs may have been chiseled with iron tools or may include modern images (e.g., horse and rider). Historic archeological resources can include the remains of cattle ranching sites including camps, dams, water troughs, and tanks; homesteads, trash dumps, historic inscriptions, roads and trails, mines, mills; and Mission 66 and other park infrastructure over 50 years old.

Archeological work commenced in what would eventually become park lands in the late 1920s by archeologists Elizabeth and William Campbell, working under a permit from the Southwest Museum. Archeological work was infrequent in the early years of the monument but notable reconnaissance level projects were conducted to the east of Geology Tour Road (Sheep Pass District) by W.J. Wallace in 1958, at Indian Cove by George Kritzman in 1965, and below and west of Barker Dam in 1968 by Dennis O'Neil. Many of the inventories conducted have been as a result of compliance for park undertakings and have been completed since the 1966 National Historic Preservation Act and its 36 C.F.R. 800 implementing regulations.

An archeological overview for what was then the monument was completed in 1975 by Thomas F. King. This overview summarized the state of archeological research at the time and offered recommendations for future research. An updated *Archeological Overview and Assessment* for the entire park, written by Michael Newland and Phillip Kaijankoski, was completed in 2013. This report summarizes significant prehistoric archeological work completed since King's overview and attempts to define Campbell's districts and possible site locations and recreate Warren and Schneider's vegetation zones used in the random sampling transects. This report also offers an assessment of where archeological work might be directed in the future.

Other notable research projects are a 1991-1992 random inventory based on vegetation zones (Warren and Schneider 2000), a social trail project in the Wonderland of Rocks and an inventory of dispersed camping areas.

A newer inventory includes three years of boundary surveys in areas most susceptible to the effects of urban encroachment. NPS Cultural Resource specialists have conducted surveys starting in 2007 of areas covered by bouldering problems from Miramonte's book, Joshua Tree Bouldering. Archeological surveys of developed areas including campgrounds, trails, and dirt roads, and studies of dispersed camping sites have also been performed.

As of 2013, less than four percent of the Park has been surveyed. Three of these early surveys that covered large areas were inventoried at a reconnaissance level and are not up to current professional standards. Roughly twelve percent of the total surveyed area of the park, or half a percent of the park total, was surveyed within the last fifteen years and performed to professional NPS standards; however, the State Historic Preservation Office generally requests resurvey after ten years because artifacts can either be exposed or buried, standards change, and what were modern sites become historic.

As of the end of fiscal year 2012 the NPS had recorded a total of 786 archeological sites and entered these records to the Archeological Site Management Information System, or ASMIS, database. Of these archeological sites, 536 are in good condition, 191 are in fair condition, 33 are in poor condition, and 26 were not relocated. Five have been destroyed since being recorded and are therefore not included in the total database count.

It is expected that the park contains about 23,000 archeological sites. This number of predicted sites is based on vegetative zones and is extrapolated from Warren and Schneider's 1991-1992 random stratified archeological survey of 2,595 acres in what was then 560,000 acres of monument land.

Archeological excavations have also taken place across the park. In a many instances, these excavations were performed as a part of National Historic Places Act compliance for specific park projects. Some excavations were completed after large fires as Burned Area Rehabilitation-funded work. However, some excavations have been undertaken for research purposes and to determine eligibility to the National Register of Historic Places. Compliance related excavations include: road excavations on the southwest corner of Geology Tour Loop, Keys Ranch road and the Hidden Valley Campground Road re-route and excavations in 2003 for construction at Oasis of Mara. Excavations undertaken for research purposes include test excavations performed by Loy Neff at approximately 15 sites totaling three years of fieldwork that took place prior to 2007; research in midden sites by Ron Beckwith; two excavations by Mike Newland in response to erosion on Geotour road after the Pushwalla fire; and an excavation at Keys Ranch by Joan Schneider and Claude Rope, which included transects taken out from water sources. Mike Newland also performed test excavations at Hidden Valley Campground and in the Barker Dam area. These excavations will provide a Determination of Eligibility for an archeological district.

Much research is still needed for archeological resources. In particular, catastrophic flooding at Cottonwood Spring Oasis in the fall of 2011 and 2013 caused a two meter cut bank that exposed sterile soil, midden, mill tailings, and overburden. Complete, diagnostic artifacts are falling out of the bank and the area is being disturbed by vandals as evidenced by collected artifact piles. This significant, National-Register-eligible archeological site needs to have data recovery conducted before another flood washes more away.

The cultural resources branch maintains a Geographic Information Systems (GIS) database of recorded, as well as known but unrecorded, archeological sites (plus other cultural resources). NPS cultural resources specialists at the park intend to expand the utility of GIS databases and upgrade these databases to national standards.

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B.15 Cultural Anthropology

Ethnographic resources are landscapes, objects, plants, animals, or sites and structures that are important to a people's sense of purpose or way of life. Managing these resources for these particular values involves facilitating collaborative relationships between the NPS and the peoples whose customary ways of life affect, and are affected by, park resource management. Prior to 2000, ethnographic work at Joshua Tree National Park was limited to compliance with the Native American Graves Protection and Repatriation Act and an ethnobotany study performed by Bean and Vane (1997). Efforts were also made to identify ethnographic resources in the museum collections.

Bean and Vane completed an ethnography overview in 2002; Deur completed a traditional study for Rock Art in 2006. The park's museum collection holds approximately 80 oral histories, in various states of completion, including: homesteading, cattle ranching, mining, Keys Ranch and former park staff.

Traditional Cultural Properties identify those locations that have particular relevance to tribal groups and are a part of ethnographic studies. The NPS keeps these properties in trust for and serves as caretaker on behalf of groups associated with these properties. *Traditional Cultural Property* studies, including oral histories and archival materials, are underway for Queen Mountain and Oasis of Mara as the first step to a determination of eligibility listing with the National Register of Historic Places.

The NPS at Joshua Tree NP is in the process of developing relationships with associated native tribes including bands of the Cahuilla, the Chemehuevi, the Serrano, and the Mojave. These projects recognize Native American cultural connections both in a physical manifestation (as with archeological sites, material gathering areas, ceremonial sties or resources utilized) but also as a part of their cultural identity.

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B.16 History

In 1983, a historic resources study for monument lands concentrating on mining resources but also encompassing homesteads and transportation systems was completed by Linda Greene. This study covers various aspects of mining and milling as well as numerous other topics and has served as a valued reference for historical activities in the old monument lands. This overview gave many preliminary recommendations regarding National Register eligibility based on criterion A, B, and C. It is likely that several National Register nominations generated after this study were a result of recommendations made in Greene's overview. An update of the historic overview is needed particularly with an emphasis on homesteads and in-holdings within the park. Historic information about lands added to what became the park in 1994 was written by Donald Hardesty et al. in 2006. In 2006, Jessica Smith completed a study regarding the use of landscape capital (or re-use of materials from older mining episodes) during the surge in mining activities in the Depression era.

Work is needed to better understand the park's identified historical interpretive themes, which include mineral prospecting, mining, cattle ranching and homesteading; work is also needed to document visitor usage (including the park's place in popular culture), recreation themes (i.e. rock climbing), park management and National Park Service themes like Mission 66.

Joshua Tree National Park is expected to have a completed *Administrative History* of the park by the end of 2014. The California Desert Protection Act and a history of Minerva Hoyt's contributions to desert preservation will be included in the *Administrative History*. A history of William and Elizabeth Campbell (who conducted early archeology in the park and surrounding desert region and contributed a large portion of the park's museum collections) is included in Newland's 2013 *Archeological Overview* (see Archeology references). Additionally, Joan Schneider and Claude Warren are writing a more in-depth history of the Campbells' work. Many oral histories remain untranscribed and without releases.

Historic American Building Survey and Historic American Engineering Record drawings are on record for Keys Ranch, Wall Street Mill, Lost Horse Mill, and Pinto Wye Arrastra. Narratives about the nature of these buildings are included with these drawings.

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B.17 Historic Structures

Historic structures cover a range of eras, events, and cultural groups that existed at Joshua Tree National Park. Most are associated with the history of ranching, mining, milling, homesteading, transportation, and NPS use (e.g., Mission 66 structures). Prior to 2010, work in historic preservation was confined to three significant locations (Keys Ranch, Wall Street Mill, and Lost Horse Mill). Since that time there have been multiple stabilization projects taking place each year at various locations.

In 2013, Eagle Cliff Mine, Paymaster Mine, and structures included in Keys Ranch Cultural Landscape are either undergoing stabilization or being contracted for stabilization. Select projects slated for the 2014 and beyond include Mastodon Mine, Cary's Castle, Chuckwalla Bills Cabin, Lost Horse Mill, Hexahedron Mine, structures associated with Lost Horse Cultural Landscape, and continued work on Keys Ranch structures and Wall Street Mill.

The *List of Classified Structures* (LCS) records and tracks the condition and status of historic and prehistoric structures listed or eligible for listing on the National Register of Historic Places. There are currently 140 structures on the List of Classified Structures, with 26 more in the shadow database. The shadow database contains structures that have no National Register evaluation and are primarily being maintained for interpretive purposes; stabilization work is also being tracked by this method. For the main LCS, 37 structures are in good condition, with 86 structures in fair condition and 17 structures are in poor condition.

Seven districts, structures, or buildings representative of mining and/or ranching opera-

tions are listed on the National Register of Historic Places. These are Ryan House and Lost Horse Well, Barker Dam, Cow Camp, Keys Ranch, Wall Street Mill and Desert Queen Mine, and Lost Horse Mine and Mill. Several other historic districts and sites have been determined, most notable in the four completed Cultural Landscape Inventories.

*Historic Structures Report*s (HSR) provide comprehensive approaches to the treatment of historic structures. HSRs take into account specific park needs based on significance of the structure, the surrounding environmental and interpretive needs. An HSR for Keys Ranch is the first need identified by the park. Further high priority needs are Lost Horse Mill, Wall Street Mill, Silver Bell ore bins, and El Sid Mine structures. In addition to *Historic Structures Reports*, inspection/maintenance/stabilization schedules for structures by type, group and location need to be updated on a yearly basis.

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B.18 Cultural Landscapes

Joshua Tree National Park contains four cultural landscapes that have been identified, evaluated, and determined to be eligible for listing on the National Register of Historic Places: Keys Ranch Historic District, Northern Pinon Mining District, Hexie Mountain Mining Historic District and Lost Horse Mining Historic District. The Oasis of Mara has also been assessed for National Register eligibility and was found not to be eligible as a cultural landscape due to lack of integrity. Lands added in the 1994 transition from monument to park status have yet to be examined for Cultural Landscapes. It is also known that the NPS manages portions of landscapes, the other portions of which are on lands managed by the Bureau of Land Management, that are likely eligible.

Cultural Landscape Inventories (CLIs) provide baseline information about park historic resources. A CLI provides information about the physical development of the landscape; character-defining qualities and features that contribute to its significance; and provide a preliminary assessment of the overall condition and integrity of the landscape. CLIs are

complete and up to date for Keys Ranch Historic District, Hexie Mountain Mining Historic District, Northern Pinon Mining District, and Lost Horse Mining Historic District. Southern Pinon Mining District is in the process of a being inventoried with a completion date set for 2014. In addition to Cultural Landscape Reports, inspection/maintenance/stabilization schedules need to be updated on a yearly basis.

The *Cultural Landscape Report* (CLR) is the primary NPS document for prescribing the comprehensive and integrated treatments for significant park landscapes. A CLR is typically scoped to address specific treatment issues based on the park management objectives and approved planning documents, with interdisciplinary involvement, to guide the long-term management and maintenance of the cultural landscape. A CLR is needed in order to identify appropriate treatments and to ensure a long term approach for comprehensive management. No Cultural Landscape Reports have been initiated at Joshua Tree National Park. The top priority for completion of a CLR is Keys Ranch Historic District.

The Keys Ranch Historic District (CLI 725029) is composed of 1,038 acres in three discontiguous parcels and includes all land that the Keys' family once owned - the Ranch, Cow Camp, and Barker Dam. These three areas are connected by historic roads. The period of significance is 1894 to 1969 and is significant under Criteria A and C for its association with the Keys family and their influence in agriculture and industry (mining) and for its rustic vernacular ranch structures. Forty-seven of the main LCS structures and five shadow database LCS structures are within this district.

The Hexie Mountain Mining Historic district (CLI 975444) has a period of significance from 1934 to 1942 and is significant under Criterion A for Depression Era mining. There are 37 LCS structures within this 3,277 acre landscape. The Northern Piñon Mining District (CLI 725033) is 3,767 acres and contains 42 main LCS structures. The period of significance is 1894 to 1942 and it is significant under Criteria A for events that have contributed to the broad patterns of American History.

The Lost Horse Mining Historic District (CLI 725046) is composed of 2,725 acres that include Lost Horse Mine and Ryan Ranch and some smaller, less successful mines. The period of significance is 1893 to 1936 and the property is significant under Criteria A for its association with the history of mining and ranching in the Mojave Desert. There are 30 eligible LCS structures within the landscape. All four of these landscapes are in fair condition, using the national park service scale of good, fair, poor.

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B.19 Museum Collections of Archives, Natural History Specimens and Archeological Artifacts

The park curation facility, a 3,000 square-foot structure built in 1992, houses the park collections, archives and library and offices. There are currently over 235,000 items in the museum collection. The Joshua Tree NP museum collections are comprised of objects and specimens from the diverse disciplines of archeology, history, natural history and ethnography. Archeological material represents a large percentage of these collections with the William H. Campbell Collection as the major component. The Desert Queen Ranch's historic artifacts comprise the second largest collection.

The collection currently includes:

- The Campbell Collection's 65,000-plus lithic, ceramic, and organic artifacts and archives from across southern California and southern Nevada. Most significant are the notes and artifacts associated with the Pinto Culture dated to 7,000 to 10,000 years ago. The collection also includes an extensive collection of ollas.
- Over 21,000 prehistoric archeological objects exhibiting the material culture of the Cahuilla, Chemehuevi, Serrano and Mojave added to the collections by research investigation including lithic tools, ceramic, basketry, shell, and organic objects.
- The collections both at the park and at other repositories hold representative study specimens from the area's unique diversity of desert flora and fauna. Collections include 78 bird study skins, 1,309 insects, 57 mammals, over 2,000 herbarium specimens, and 25 reptile specimens. There are 550 fossil specimens. With the increased study of climate change these collections will be of invaluable use.
- Over 3,200 objects of historic and cultural value documenting over a hundred years of ranching, homesteading and mining.
- Over 100 linear feet of park legislative history, planning documents, administrative, environmental, and resource management records of the park along with archival collections associated with significant participants in the park history.
- Nearly 70 oral history interviews documenting the ranching, mining, homesteading, recreation, and park management history.
- An extensive collection of historic photographs from the late 1800s to the 1970s and additional images of resource management activities.
- A natural and cultural history reference collection of books, scientific reprints, rare books, park reports, area environmental impact statements, ephemera, and unpublished and published papers from recent scientific research projects.

In 1988, efforts were started to bring to Joshua Tree NP's museum collection up to National Park Service standards. A preliminary inventory was taken in order to assess the full scope of the collections and its needs. These inventories revealed greater numbers of artifacts than were previously thought to have existed and needs that far surpassed NPS expectations. A dedicated

museum storage, office, and research library building was completed in 1992 which meets National Park Service standards.

In fiscal year 2012, park staff made a total of 31 research requests for museum access. In fiscal year 2013, 41 individuals external to the park, including non-park NPS staff researchers working on specific issues, individuals and visiting groups with a general interest in the park, made requests for access to museum materials. Despite these numbers, the museum is not utilized to its full potential.

As of the end of FY 2013, the majority of the collections are cataloged and fully processed. Archives need to be reorganized to higher standard. Finding aids lack good standardized software. Some existing finding aids need to be redone to provide better information. The storage facility is in good condition; exhibit areas are not to standards and do not provide sufficient space. Archival, specimen, and artifact condition is stable and collections are housed in secure facilities with appropriate temperature and light control. Objects at Desert Queen Ranch can't be maintained to museum standards and need to be deaccessioned.

Museum staff attempt to obtain archival documentation materials from project proponents; however, often times permit holders do not submit their information upon project completion, making records for ongoing research in the park incomplete. In addition, the museum has a number of materials on loan to large numbers of repositories, which presents a management challenge. A smaller number of repositories are in the process of being selected for the majority of off-site specimens.

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Appendix C

Section 1

Joshua Tree National Park
Climate Change Scenario Planning Summary Report

September 9, 2013

Climate Change Considerations for Joshua Tree National Park's Resource Stewardship Strategy

National Park Service, Natural Resource Stewardship and Science

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Introduction

The purpose of this summary is to provide some of the core informational needs for considering climate change during the development of Joshua Tree NP's Resource Stewardship Strategy.

This summary captures the important outcomes from the 2007 Joshua Tree NP Climate Change Scenario Planning workshop. A group of fifteen scientists, managers and educators participated in the 2007 workshop to explore and develop a range of plausible climate futures for Joshua Tree NP and identify some of the associated implications. The workshop was funded by the National Park Service Division of Fire and Aviation Management and was facilitated by the National Center for Landscape Fire Analysis at the University of Montana.

In preparing this summary report, we revisited the latest historic and projected climate change trends for the region that includes Joshua Tree NP to validate the scenarios generated during the 2007 workshop. This new information is incorporated into this report.

Historic Climate Change Trends for Joshua Tree National Park

Joshua Tree NP experiences a desert climate, with scarce rainfall and high summer temperatures. Average monthly minimum and maximum temperatures, with average monthly precipitation, (1895-2010) are illustrated in Figure C.1.

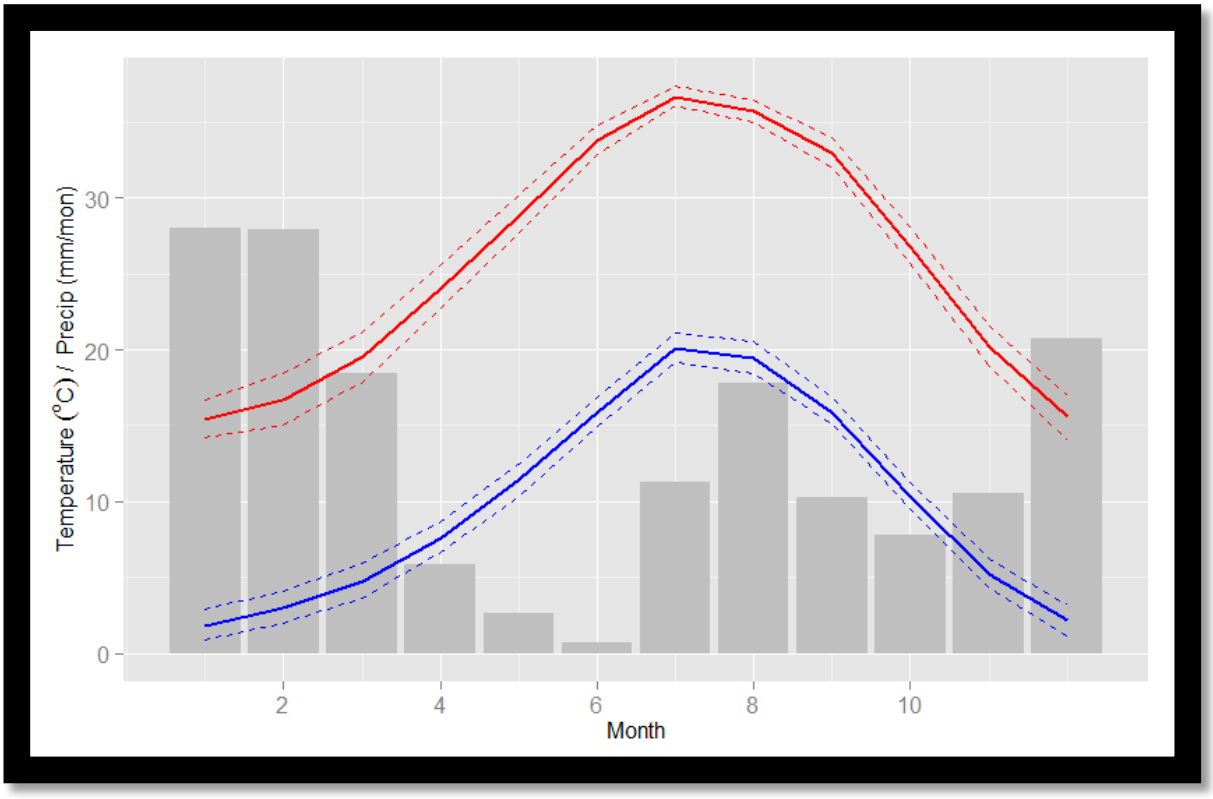

Figure C.1. Average monthly minimum (blue) and maximum (red) temperatures for JOTR estimated from PRISM data for 1895-2010. Bars are precipitation, and dashed lines are 25th and 75th percentiles.

Historic climate trends for Joshua Tree NP were evaluated from 800m PRISM (Parameter-elevation Regressions on Independent Slopes Model) data sets (Daly et al., 2002; PRISM Climate Group, 2012) clipped to the park boundary. A summary of the park's climate observations is presented in Table C.1, and Appendix C, Section 2 includes a more detailed evaluation. Annual rainfall in the park is 162 mm (~ 6 inches) with an average annual temperature around 18^{o} C (64^{o} F) (Table C.1).

Table C.1. Historical climate trends in Joshua Tree NP estimated from 800m resolution PRISM climate data (Daly et al., 2002) for the period of 1895-2010. See text for measurement abbreviations. Significance of linear trends indicated by: ns = not significant; * P < 0.05; ** P < 0.01, *** P < 0.001. (T = temperature; Ppt = precipitation)

Measurement	Mean/Trend	SD or SE (slope)	Units
Tavg 1895-2010	17.7 (63.9)	0.59 (1.06)	^{o}C (^{o}F)
Tavg 1895-2010 trend	0.934(1.7)***	0.14 (0.25)	^{o}C (^{o}F) century^{-1}
Tmax 1895-2010	25.5 (77.9)	0.62 (1.12)	^{o}C (^{o}F)
Tmax1895-2010 trend	0.53** (1.0)	0.17 (0.31)	^{o}C (^{o}F) century^{-1}
Tmin 1895-2010	9.8 (49.6)	0.71 (1.28)	^{o}C (^{o}F)
Tmin 1895-2010 trend	1.32*** (2.4)	0.16 (0.29)	^{o}C (^{o}F) century^{-1}
Tmin 1975-2010	10.45 (50.8)	0.52 (0.94)	^{o}C (^{o}F)
Tmin 1975-2010 trend	3.05*** (5.5)	0.66 (1.19)	^{o}C (^{o}F) century^{-1}
Ppt 1895-2010	161.7 (6.4)	72.4 (2.9)	mm (in) year^{-1}
Ppt 1895-2010 trend	-11.0 (-0.4) ns	20.2 (0.8)	mm (in) year^{-1} century^{-1}

Joshua Tree NP has experienced no statistically significant trend in precipitation, but temperatures have risen significantly, especially during the past 40 years (Table C.1). The rate of increase in minimum temperatures is about 50% greater than that of maximum temperatures. Average conditions are currently similar to those experienced during the dust bowl, a period with (what were then) unusually high temperatures and low rainfall. An overall effect of historical climate change is a dryer landscape.

Climate Change Scenarios for Joshua Tree National Park

A key goal of NPS scenario planning is to inform development and implementation of climate change adaptation strategies that best serve the park purpose, resources, and visitors in a rapidly changing environment.

The three climate change futures (scenarios) generated during the 2007 workshop; 1. *When it Rains it Pours*, 2. *Summer Soaker*, and 3. *Dune* (Table C.2), provide a view into the range of plausible future conditions that Joshua Tree NP may experience. We reviewed these climate scenarios in light of more recent findings to determine whether changes to the scenarios were needed (IPCC, 2012; Dominguez et al., 2012; Gonzalez, 2012; Brekke et al., 2013; Kunkel et al., 2013). Newer model projections and analyses are consistent with 2007 results, and we felt the relatively small differences to projections and, in general, increases in the confidence of changes, did not require a redefinition of climate drivers or a change in scenarios.

Table C.2. Three climate change scenarios developed by workshop participants for Joshua Tree NP adaptation planning.

Scenario	Variables and Projections (2050-2100)							
	Average Temperature	**Precipitation (ppt)**	**Relative Humidity**	**Wind Speed**	**Extreme Events: Temperature**	**Extreme Events: Precipitation**	**Extreme Events: Storms**	**Extreme Events: Wind Speed**
Scenario 1 ***Summer Soaker*** **(~ B1 emission scenario)**	About 1.3 °C (2 °F) increase (2050); slightly more in winter. About 2.5 °C (4.5 °F) increase (2100)	No change in annual total. Less ppt in winter and more ppt in spring & summer	Increased in summer	General increase		Increased frequency and intensity in spring and summer		More common
Scenario 2 ***When it Rains it Pours*** **(~ A1B emission scenario)**	About 1.7 °C (3 °F) increase (2050). About 3.4 °C (6 °F) increase (2100)	Average is same, but increased annual variability	Increased			Greatly increased frequency. Flooding & erosion widespread	Increase	
Scenario 3 ***Dune*** **(~ A1F1 emission scenario)**	About 2.5 °C (4.5 °F) increase (2050). About 4.6 °C (8 °F) increase (2100)	Same or less but drier due to higher temperatures and increased period of drought	Decrease	Increased	Much more common			More common. Combined with drought, much more wind erosion.

Scenario 1: *Summer Soaker*

In the ***Summer Soaker*** scenario, annual precipitation does not change but seasonally less rain falls in winter and spring and more during summer monsoons. This scenario was constructed to be consistent with IPCC scenario B1. Because summer rains favor annual native grasses, this could help to curtail invasion by non-native vegetation. Warmer temperatures drive vegetation communities to move upslope, causing the Mojave ecosystem to be reduced and the Sonoran ecosystem to expand. As the transition zone between the two ecosystems is altered, features that occur along the zone would be impacted. For example, a popular feature in the zone is Cholla Garden, a dense growth of cholla cactus. Warmers temperatures and erosion from intense summer rains may threaten the unique nature of the Garden. In addition, as the Mojave ecosystem is reduced, some of the species native to this system, such as the bighorn sheep or the relic, namesake species, the Joshua Tree, would likely become isolated or could be lost altogether from the park. Other species, such as the desert tortoise may improve as their vegetative browse (summer native grasses) increases, although increased summer moisture may exacerbate the upper respiratory tract disorder in tortoises. Some of the impacts that characterize this climate scenario are presented in Table C.3, along with some of the associated implications and opportunities for park management.

Table C.3. Selected Impacts and Implications for *Summer Soaker* Scenario.

Scenario 1: Summer Soaker	
Impacts	▪ Precipitation decreases in the winter and spring while annual precipitation does not change. ▪ Winter temperatures increase. ▪ Summer precipitation increases, mainly in the form of monsoons. ▪ Increase in localized flooding. ▪ Nitrogen fertilization minimized due to CO_2 emissions at a slow rate of increase. ▪ Frequency and intensity of wind increases.
Implications/ Opportunities	▪ Erosion and debris dams from flooding. ▪ Roads damaged or washed out due to flooding. ▪ Native grasses do better than non-native annuals, which slowly decline. ▪ Native annual grasses migrate to higher elevations due to increased temperatures ▪ Movement of vegetation to higher elevations increases fuel loads at those elevations. This fire increase could become a barrier to upslope vegetation migration. ▪ Loss of Joshua trees at lower elevations with warmer temperatures. Winter freeze required for trees to flower. ▪ Higher elevation species and vegetation die off. ▪ Woody vegetation survives in higher elevations. ▪ A minimal increase in nitrogen fertilization of non-native annuals. ▪ Since summer precipitation favors annual grasses, current non-native annuals slowly decline keeping fire spread and size near current levels producing patchy fires creating a mosaic on the landscape. This assists the park in managing invasives. ▪ Loss of some Mojave-ecosystem-dependent species, as Sonoran desert ecosystem expands. ▪ If new suite of invasives enter Joshua Tree NP with the expansion of Sonoran desert ecosystem, fire severity and frequency increase. ▪ Bighorn sheep habitat reduced, migration restricted and populations isolated. ▪ Desert tortoise habitat may improve as native grasses increase. ▪ Mountain quail and other native birds survive as long as a pinyon pine and scrub oak vegetation survives. ▪ Habitat for Sonoran species such as antelope may improve. ▪ Pests and pathogens thrive in warmer temperatures.

Scenario 2: *When it Rains it Pours*

When it Rains it Pours is a scenario in which extreme precipitation events are common, especially during winter, and often follow summers of extreme drought. This scenario was constructed to be consistent with IPCC scenario A1B. Chief concerns are flash flooding events and erosion, causing debris dams in canyons that blow out, increased disruption in traffic and other visitor activities, safety concerns, and higher costs for infrastructure maintenance and emergency response. Flooding and erosion would destroy many easily damaged archaeological sites, although new sites may be uncovered. Conditions would also enhance a positive feedback loop involving drought, invasion by exotic grasses, and fire, effectively converting the system to a grassland ecosystem with a more extreme fire regime (i.e. summer drought kills off native annuals; heavy winter rains follow that promote growth of exotic invasive grasses that act as fuels for fire, which fertilizes the ground for non-native annuals). This shift stresses many native species that occupy small niches and do not thrive on less nutritious non-native grasses. Some of the impacts that characterize this climate

scenario are presented in Table C.4, along with some of the associated implications and opportunities for park management.

Table C.4. Selected Impacts and Implications for the *When it Rains it Pours* Scenario.

Scenario 2: When it Rains it Pours	
Impacts	▪ Wet and dry season variability increases. ▪ Winter precipitation increases during wet years, but average precipitation stays equal to slightly lower than current precipitation. ▪ Frequency and severity of wind events increases. ▪ Extreme flash flooding events due to extreme storms following extreme droughts. ▪ Nitrogen fertilization increases due to CO_2 emissions increase. ▪ Fire incidents occurs in cycles. Rain promotes grass growth, increasing fuel loads and fire, fire fertilizes the non-native annuals, drought kills off annuals, extreme precipitation events stimulate non-native annuals seed bank, non-native annuals thrive during wet years, but decline with sustained drought.
Implications/ Opportunities	▪ Wind damages vegetation (e.g., Joshua trees) which are stressed from drought. ▪ Change to a grassland ecosystem. ▪ Grass forage for animals decrease as drought increases. ▪ Nitrogen fertilization of non-native annuals increases. ▪ Erosion and debris dams from flash flooding. ▪ Oases damaged from flooding and erosion. ▪ Higher infrastructure/maintenance costs due to flooding and erosion. ▪ Decisions to abandon some cultural resources. ▪ Safety concerns for visitors and infrastructure increase due to temperature extremes and flash floods. ▪ Many important species are threatened or lost: cyptobiotic crust; Joshua trees, pinyon pines, scrub oaks, black brush, desert tortoise, mountain quail, horned lizard. ▪ May expand Fringe-toed lizard habitat.

Scenario 3: *Dune*

In the ***Dune*** scenario the park experiences increasing temperature with persistent dryness and drought. This scenario was constructed to be consistent with IPCC scenario A1F1. Wind increases in frequency and intensity. Change in vegetation habitats due to drought and high temperatures leads to a significant loss of woody species. Fire spread increases due to increased non-native vegetation fuel load and increased winds. As more fires occur and consume available vegetation, fire occurrence declines. This was considered to be the most devastating of the three scenarios in that the end result would be near complete loss of vegetative cover due to fire, water mining, wind, and higher temperatures. Resulting wind erosion increases dune formations in the Pinto Basin. Some of the impacts that characterize this climate scenario are presented in Table C.5, along with some of the associated implications and opportunities for park management.

Table C.5. Selected Impacts and Implications for the *Dune* Scenario.

Scenario 2: Dune	
Impacts	▪ Temperature increase overall. ▪ Persistent drying and drought. ▪ Wind increases, with an increase in intensity and frequency in spring and fall. ▪ Fire spread increases until fuel loads are consumed. ▪ Nitrogen fertilization increases due to CO_2 emissions increase..
Implications/ Opportunities	▪ Loss of woody species. ▪ Dune formation increases. ▪ Nitrogen fertilization of non-native annuals increases. ▪ Vegetation transitions from exotic grasses and current vegetation to most vegetation gone except for oases to no vegetation. ▪ Park visitation drops as key species are lost, air quality degrades (dust and smoke), and temperatures increase. ▪ Oases might survive a short time, but they are still impacted by external water demands from local communities.

Recommendations for Using Outcomes from Climate Change Scenario Planning

Wind Tunnel Testing

When considering existing, or developing new management strategies at Joshua Tree NP, managers can use these climate change scenarios to ask, "Does the strategy make sense under the scenarios?" Seen through the context of the scenarios, it may be apparent that continuing some current activities is an unwise expenditure of time/resources, while other activities may warrant additional effort. In some cases, entirely new approaches may also be prudent. Scenarios enable park managers to make better informed decisions regarding what level of risk they are willing to take with future park investments. The term used to describe this process is sometimes referred to as "wind tunnel" testing.

Robust Strategies

Table C.6 describes "robust" or “no regrets” strategies that make sense for all three climate change scenarios. These actions provide good preparation for future events, and represent low risk with respect to influences from the three plausible climate change futures. The climate projections diverge more widely after the next 20-30 years, such that in the near term, a broader array of these “robust” strategies are available. Many of these are activities the park may already have underway, or planned – the scenarios can help to set priorities among them.

Table C.6. Robust Strategies Identified for the Three Scenarios.

Potential Management Considerations, common to *all three scenarios*		**Reference Number**
FRV	**Management Considerations**	
Biological diversity and healthy ecosystem function	Research hybrid species that could survive warming and strengthening seed banks and nurseries to support future restoration.[1]	**1**
	Develop vegetation plan (including riparian vegetation plan). Increase inventory of resources in response to decrease in biodiversity. Prioritize what communities to monitor.[4]	**2***
	Update park Fire Management Plan and develop fuel reduction plan	**3****

Potential Management Considerations, common to *all three scenarios*		Reference Number
FRV	**Management Considerations**	
	and wildland fire interface plan. Incorporate prescribed burning to reduce fuel loads. (Increase employee red card training).[4]	
	Explore different options for fuel breaks on the landscape.[1]	**4****
	Manage park for exotic grasses and non-native plants (existing and potential new invasions associated with climate change)[1]. Develop invasive plant management plan. Set priority areas in park for treating exotics (EPMT).[4]	**5***
Biological diversity and healthy ecosystem function *Interconnectivity of the California desert lands*	Develop area-specific and resource-specific plans to protect resources and values most at risk from climate change and other stresses[2]. For high-priority species such as the Joshua Tree, consider relocating species to higher elevations to assist in survival.[1]	**6****
	Reduce other (non-climate) stressors on priority resources and values[2].	**7***
	Implement restoration efforts to enhance species' ability to cope with stresses and adapt to climatic and environmental changes.[3]	**8***
Interconnectivity of the California desert lands	Restore and conserve connectivity within habitats and develop access corridors to climate change refugia.[3]	**9***
	Work with neighbors (LCC partners) to establish appropriate connectivity and corridors. Evaluate alteration options to maintain species. Nurture partnerships to plan and develop appropriate communities/landuse around the park.[4]	**10****
Interconnectivity of the California desert lands *Opportunity to understand, apply, and share knowledge to benefit the park and beyond*	Engage and enlist collaborator support (e.g., nearby agencies, private land-holders) in climate change discussions, responses, adaptation and mitigation.[3]	**11***
Ever-expanding knowledge base	Encourage climate change research and scientific study in the park.[3]	**12***
Archeology; *Cultural anthropology;* *History;* *Historic structures;* *Cultural landscapes;* *Museum collections* *Oases and other riparian areas*	Need baseline inventory of park cultural resources (cultural landscapes, archeological sites/collections, list of classified structures). Conduct and record oral histories to preserve ethnographies. Compare survey coverage and vulnerability maps for archeology and monitor sites for erosion issues. Incorporate digital media for collections/inventories[3]**.**	**13***
Opportunity to understand, apply, and share knowledge to benefit the park and beyond	Inform public about how climate change impacts threaten park resources and values and the broader ecosystem on which they depend.[2]	**14****
	Educate visitors about prevention of introducing exotics into the park.[4]	**15****
	Inform public of high-risk flash flood areas. [4]	**16**
	Post climate change information in easily accessible locations such as bulletin boards and websites.[3]	**17****
	Provide training for park staff and partners on effects of climate change impacts on resources and values, and on dissemination of climate change knowledge to the public.[3]	**18****
	Incorporate climate change research and information in interpretive an education outreach programming.[3]	**19****
Hydrological resources	Define park water needs/usage and develop park water conservation plan. Update park potable water distribution system, as needed.[4]	**20****
Hydrological resources	Define areas prone to flash flooding. Monitor flash flood events (magnitude and frequency). [4]	**21**
Hydrological resources *Oases and other riparian areas*	Characterize (quality and quantity) and monitor local aquifer system(s). Characterize (quality and quantity) surface waters (springs, impoundments) and monitor.[4]	**22***
Recreation opportunities and values	Study drivers of visitation and how climate change may affect visitation patterns (timing/activities/demographics).[4]	**23**

Potential Management Considerations, common to *all three scenarios*		Reference Number
FRV	**Management Considerations**	
Other	Monitoring climate variables (temperature; precipitation; extreme events: precipitation, temperature, and wind; wind speed; relative humidity) to validate and update the range of plausible climate futures.[4]	**24***
	Convert to renewable energy sources such as solar or wind generated power.[3]	**25**
	Specify "green" designs for construction of new or remodeled buildings.[3]	**26**
	Conduct emissions inventory and set goals for park CO_2 reduction.[3]	**27**
	Provide alternative transportation options (employee bicycles, shuttles for within-unit commuting, hybrid electric or propane-fueled vehicles for official use.[3]	**28**
	Provide recycling options for solid waste and trash generated within the park.[3]	**29**
	Selected indicators of climate-driven effect to monitor. [4]	**30***

[1] Identified during 2007 JOTR Climate Change Scenario Planning workshop; [2] Sanders et al. (2010); [3] Loehman (2010); [4] Robust strategies identified from other NPS climate change scenario planning projects that apply to JOTR.

* Denotes potential management considerations addressed by high priority RSS activities designated as "R" strategies for adaptation

** Denotes potential management considerations addressed by low and medium priority RSS activities, as well as high-priority activities not falling within an "R" adaptation strategy

Monitoring

Lastly, "Monitoring" is another critical element in scenario planning. Climate change scenario planning is a *living process* that requires review of new information and understanding to further develop, validate, or potentially invalidate a given scenario(s). Park managers monitor climate drivers and/or indicators of effects to "calibrate" the three scenarios (*Summer Soaker*, *When it Rains it Pours*, and *Dune*) against reality, possibly adjusting or developing new scenarios as warranted, and revising strategies accordingly. This enables park staff to recognize what climate future is unfolding or what new scenarios may be evolving.

Monitoring selected indicators of climate-driven effects in the park will also be necessary to evaluate the response of the park's priority resources and values to climate change, and to understand the evolving relationships between the climate drivers and ecosystem response.

As stated previously, in developing this summary report, the three climate change scenarios created in 2007 were revisited to validate and update the climate projections. Continuous monitoring of climate variables (temperature, precipitation, storm events, drought, extreme temperature events) as well as the effects that form the climate change scenarios allow park staff to track how the future is unfolding relative to the scenario projections, so that decisions use the most current information possible.

Monitoring
▪ Temperature ▪ Precipitation ▪ Wind speed ▪ Extreme events: Temperature ▪ Extreme events: Precipitation ▪ Drought ▪ Selected indicators of climate-driven effects

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Appendix C
Section 2

Historical Climate Patterns for Joshua Tree NP

Prepared by John Gross, NPS Inventory and Monitoring Division

Climate trends from 1895-2010 were examined to provide a context for evaluating past and projected changes in the park's communities and processes. When compared to climate projections, historical views of climate trends provide a context to illustrate and evaluate potential impacts of rapid climate change. Our analyses are based on a temporally-complete, gridded climate data set obtained from the PRISM (Parameter elevation Regressions on Independent Slopes Model) climate group at Oregon State University (Daly et al. 2002; http://prism.oregonstate.edu). These data consist of monthly averages, interpolated to a spatial scale of 800 m, and they are complete for the United States from 1985-2010 (data at 4 km resolution are available with a 1-2 month lag). PRISM data used for historical analyses are at a monthly time step, and the variables are:

- mean monthly minimum temperature (Tmin; °C, °F)
- mean monthly maximum temperature (Tmax; °C, °F)
- mean monthly temperature (°C) (Tavg[1])
- total monthly precipitation (precip; mm/month, in/month)

To examine seasonal and long-term variation, these climate variables were averaged by season, year, and for 10-year periods. Periods of analysis are:

Winter = December, January, and February
Spring = March, April, and May
Summer = June, July, and August
Fall = September, October, and November

For 10-year rolling means, the 10-year mean is plotted as a point at the final year of the period (e.g., the mean of 1895-1904 is plotted as the point for 1904). The R statistical language version 3.1 (R Development Core Team 2013) was used for all analyses. Analyses reported here used PRISM data clipped to the boundary of Joshua Tree NP.

Climate Trends

Over the period of 1895-2010 PRISM data exhibited a trend towards warming for annual Tavg, Tmax and Tmin (Table C.7; Figures C.2-C.4). The linear warming trends are 0.5^{o} C (0.9^{o} F) per century for Tmax and 1.3^{o} C (2.3^{o} F) per century for Tmin estimated over the entire period of record (1895-2010). The rate of increase in annual Tmin is much more rapid in the period since 1975 (Table C.7, Figure C.2, C.3) with a rate of increase of 3.1 ^{o}C (5.6 ^{o} F) century^{-1}. There has been no statistically significant trend in precipitation over this period (Table C.7; Figures C.2 & C.3).

Box plots of decadal average temperatures and precipitation by season (Figures C.4-C.6) clearly illustrate the high variability characteristic of the park's climate. The increasing trend in Tmin is most apparent in spring and summer (Figures C.5, C.8). Seasonal data highlight the importance of winter rains (Figure C.6), which are normally responsible for about half of the annual precipitation. Figure C.6 shows that large (but rare) rainfall events can result in substantial precipitation during any season.

[1] In this report, Tavg = (Tmin + Tmax)/2. Tavg estimated from hourly (or finer) data will be slightly different because more frequent measurements better account for rates of cooling and heating.

Trends in anomolies (departures) from the long-term record are most apparent for Tmin (Figure C.7). Figure C.7 further emphasizes the variability characteristic of the park's climate.

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Table C.7. Historical climate trends in JOTR estimated from 800m resolution PRISM climate data (Daly et al. 2002) for the period of 1895-2010. See text for measurement abbreviations. Significance of linear trends indicated by: ns = not significant; * $P < 0.05$; ** $P < 0.01$, *** $P < 0.001$.

Measurement	Mean/Trend	SD or SE (slope)	Units
Tavg 1895-2010	17.7	0.59	^{o}C
Tavg 1895-2010 trend	0.93***	0.14	^{o}C century^{-1}
Tmax 1895-2010	25.5	0.62	^{o}C
Tmax1895-2010 trend	0.53**	0.17	^{o}C century^{-1}
Tmin 1895-2010	9.8	0.71	^{o}C
Tmin 1895-2010 trend	1.32***	0.16	^{o}C century^{-1}
Tmin 1975-2010	10.45	0.52	^{o}C
Tmin 1975-2010 trend	3.05***	0.66	^{o}C century^{-1}
Ppt 1895-2010	161.7	72.4	mm year^{-1}
Ppt 1895-2010 trend	-11.0 ns	20.2	mm year^{-1} century^{-1}

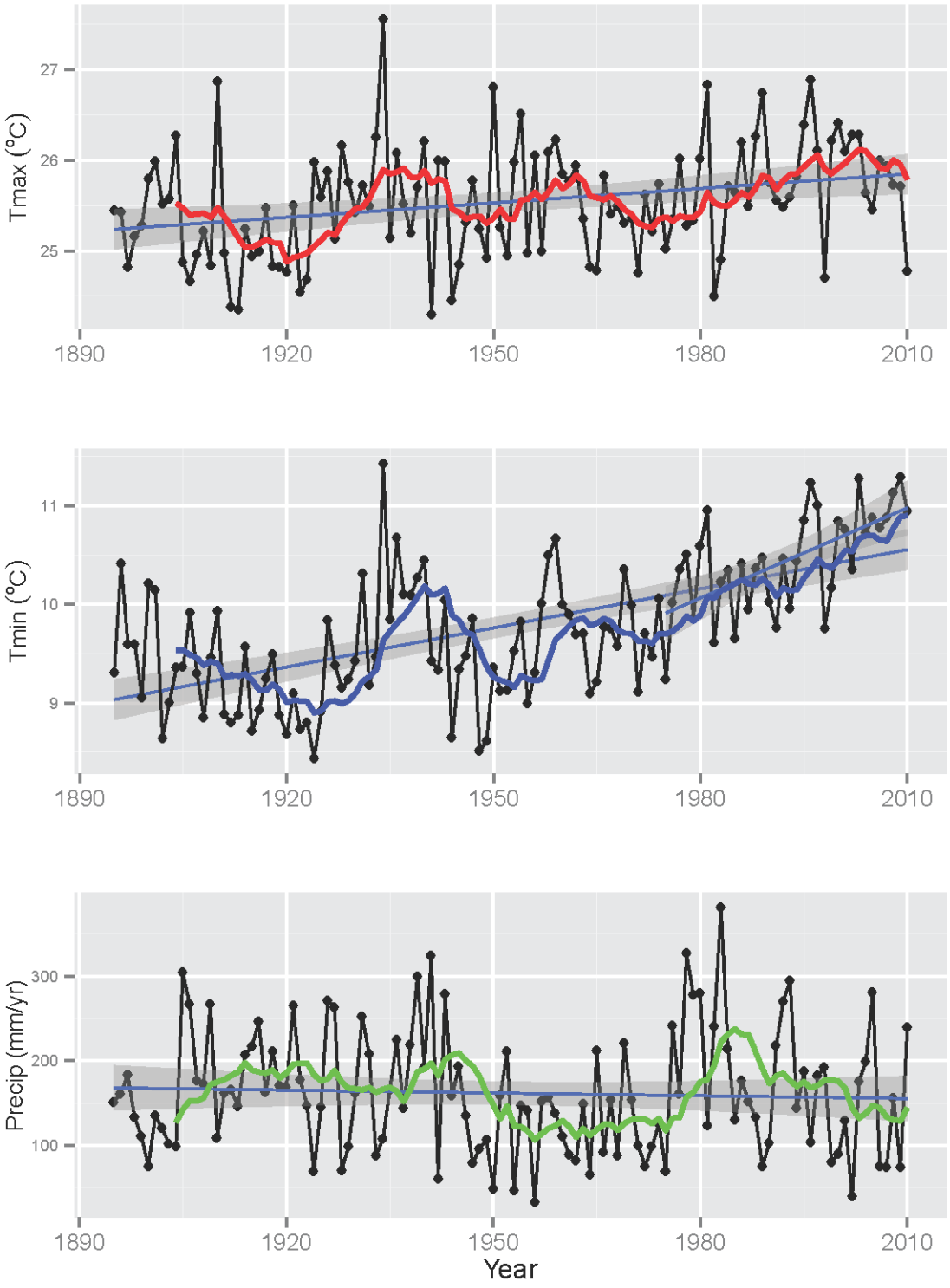

Figure C.2. Annual average maximum temperature (Tmax), minimum temperature (Tmin), and precipitation (Precip) estimated from 800m PRISM data for JOTR. Filled circles and black lines are annual means. Red, blue, and green lines are 10-year running means, and straight lines are linear regressions. For Tmin, the linear trend 1975-2010 is also shown.

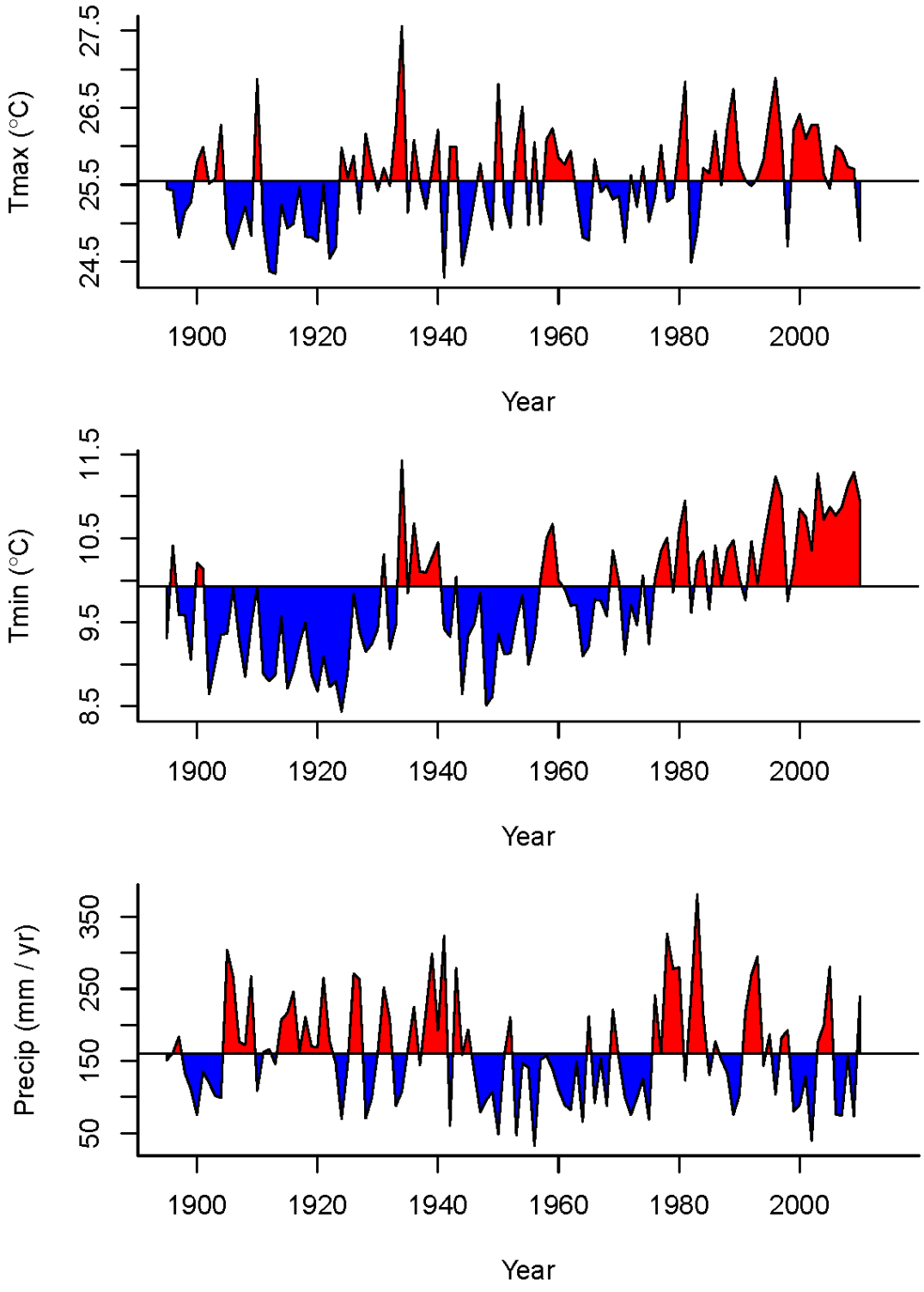

Figure C.3. Annual average maximum temperature (Tmax), minimum temperature (Tmin), and precipitation (Precip) estimated from 800m PRISM data for JOTR, showing departures from the 1960-1989 30-yr normals. Red-filled area illustrates periods of above-average observations, and blue periods of below-average observations.

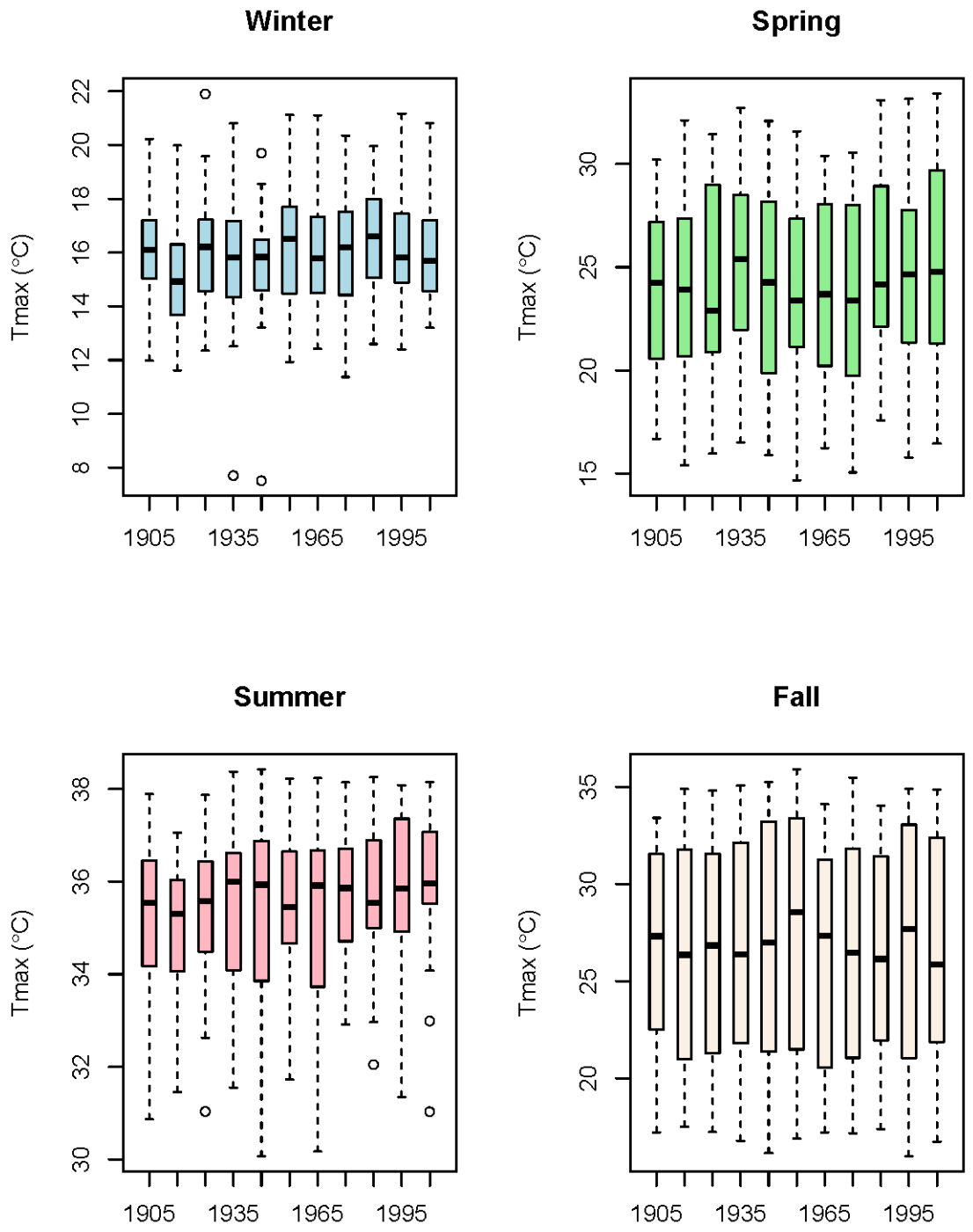

Figure C.4. Trends in decadal average maximum temperature for JOTR by season. Filled boxed bracket 25th and 75th percentiles; horizontal line shows the median, and dashed lines extend to 5th/95th percentiles. Note different scales on vertical axis.

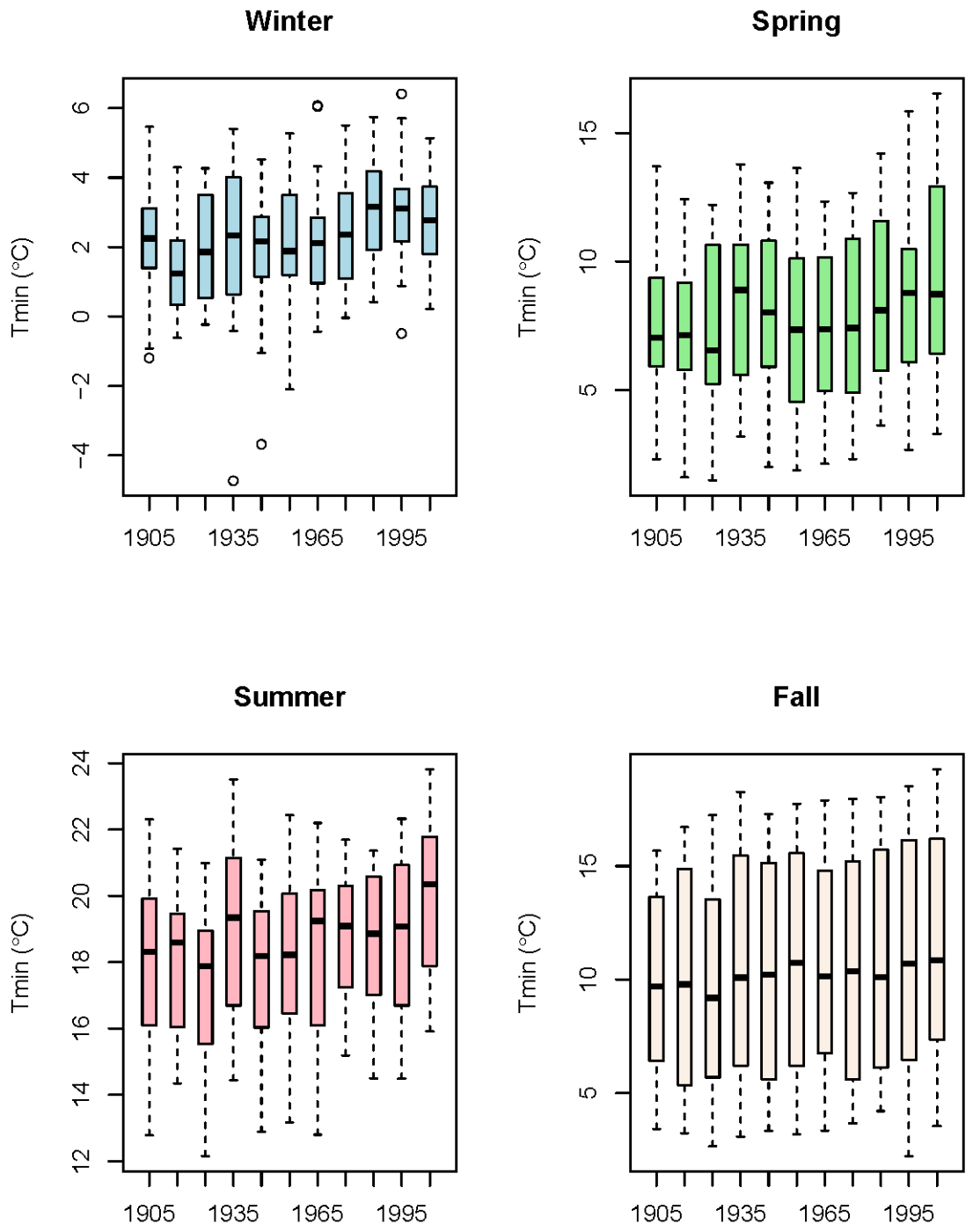

Figure C.5. Trends in decadal average minimum temperature for JOTR by season. Filled boxes bracket 25th and 75th percentiles; horizontal line shows the median, and dashed lines extend to 5th/95th percentiles. Note different scales on vertical axis.

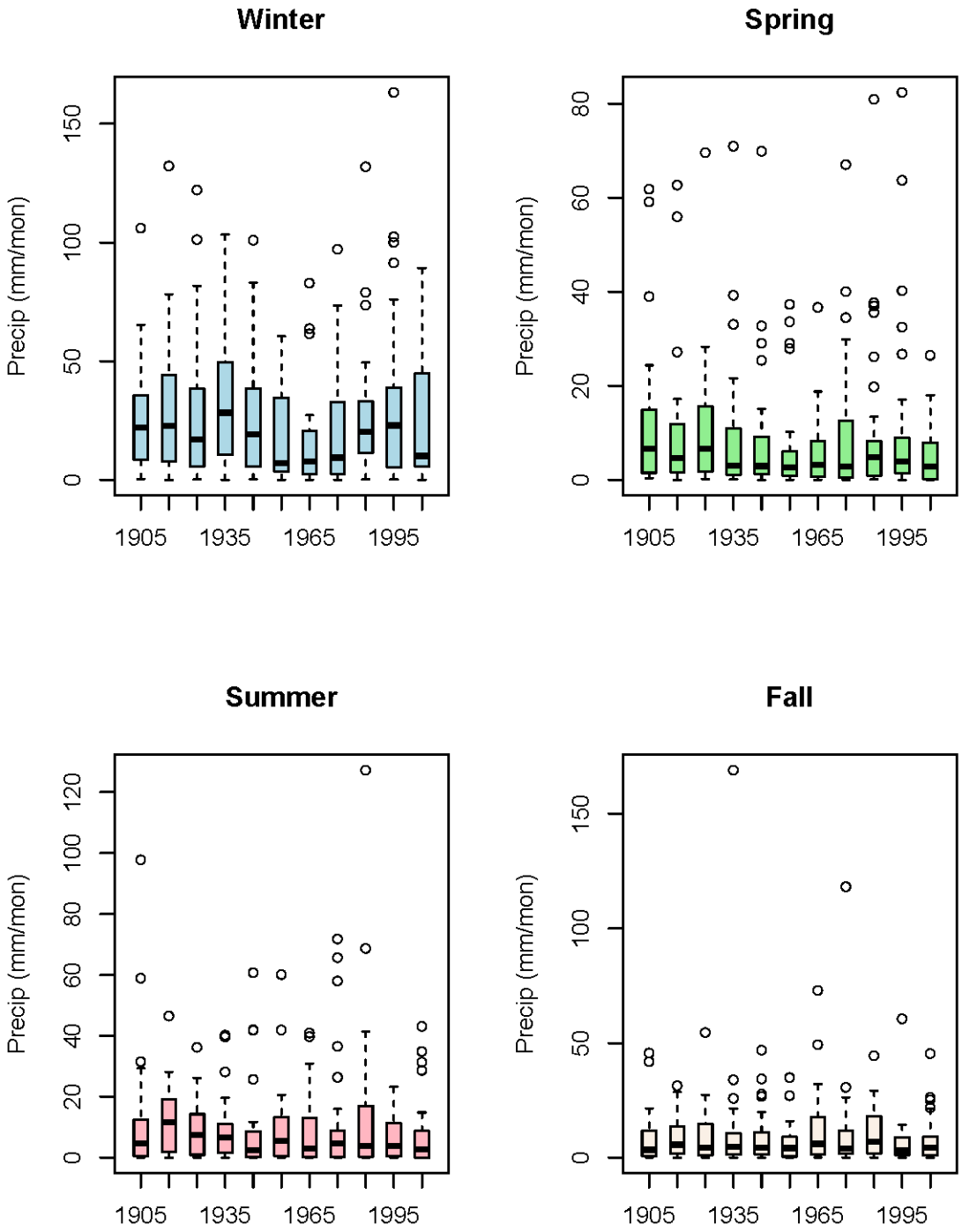

Figure C.6. Trends in decadal average precipitation for JOTR by season. Filled boxes bracket 25th and 75th percentiles; horizontal line shows the median, and dashed lines extend to 5th/95th percentiles. Circles are outlying values. Note different scales on vertical axis.

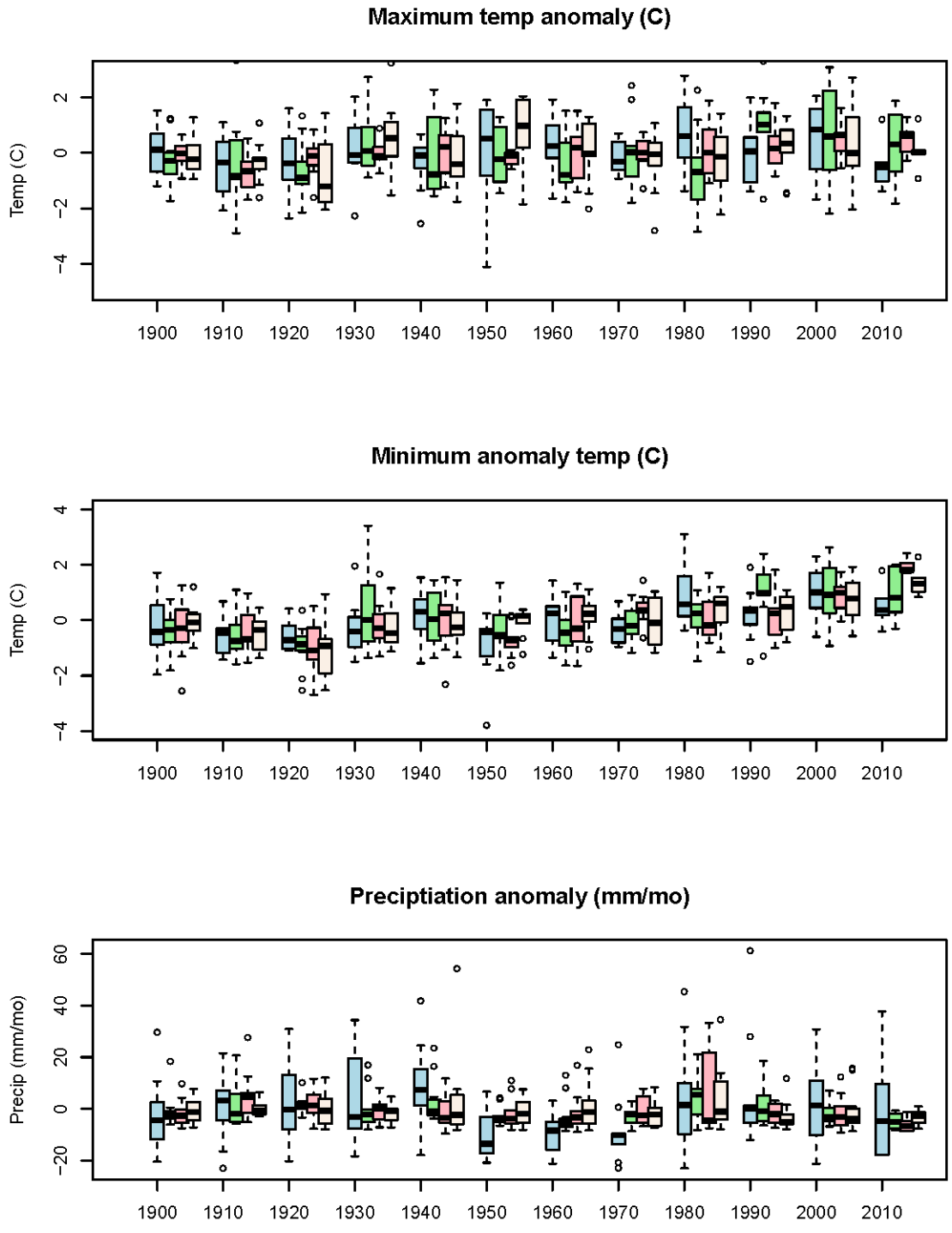

Figure C.7. Anomolies (departures) from the in decadal average maximum temperature, minimum temperature, and preciptiation for JOTR by season from the period-of-record means. Colors are winter (blue), spring (green), summer (red), and fall (linen). Filled boxed bracket 25th and 75th percentiles; horizontal line shows the median, and dashed lines extend to 5th/95th percentiles.

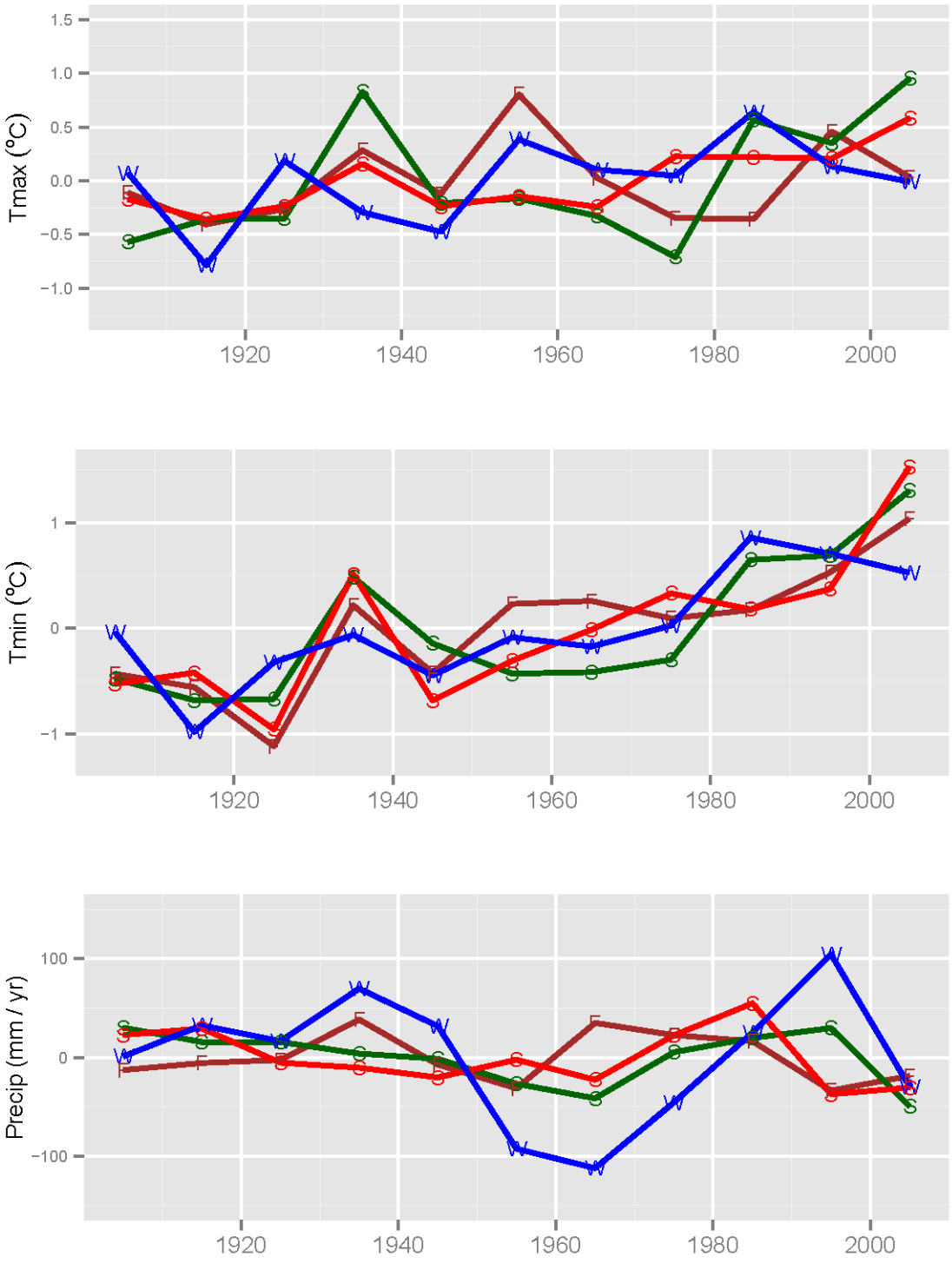

Figure C.8. Trends in anomolies (depatures) in decadal averages for JOTR temperature and precipitation by season. Anomolies computed as differences from the full-record average.. Symbols/lines are: W (blue) = winter; S (green) = spring; S (red) = summer; F (brown) = fall.

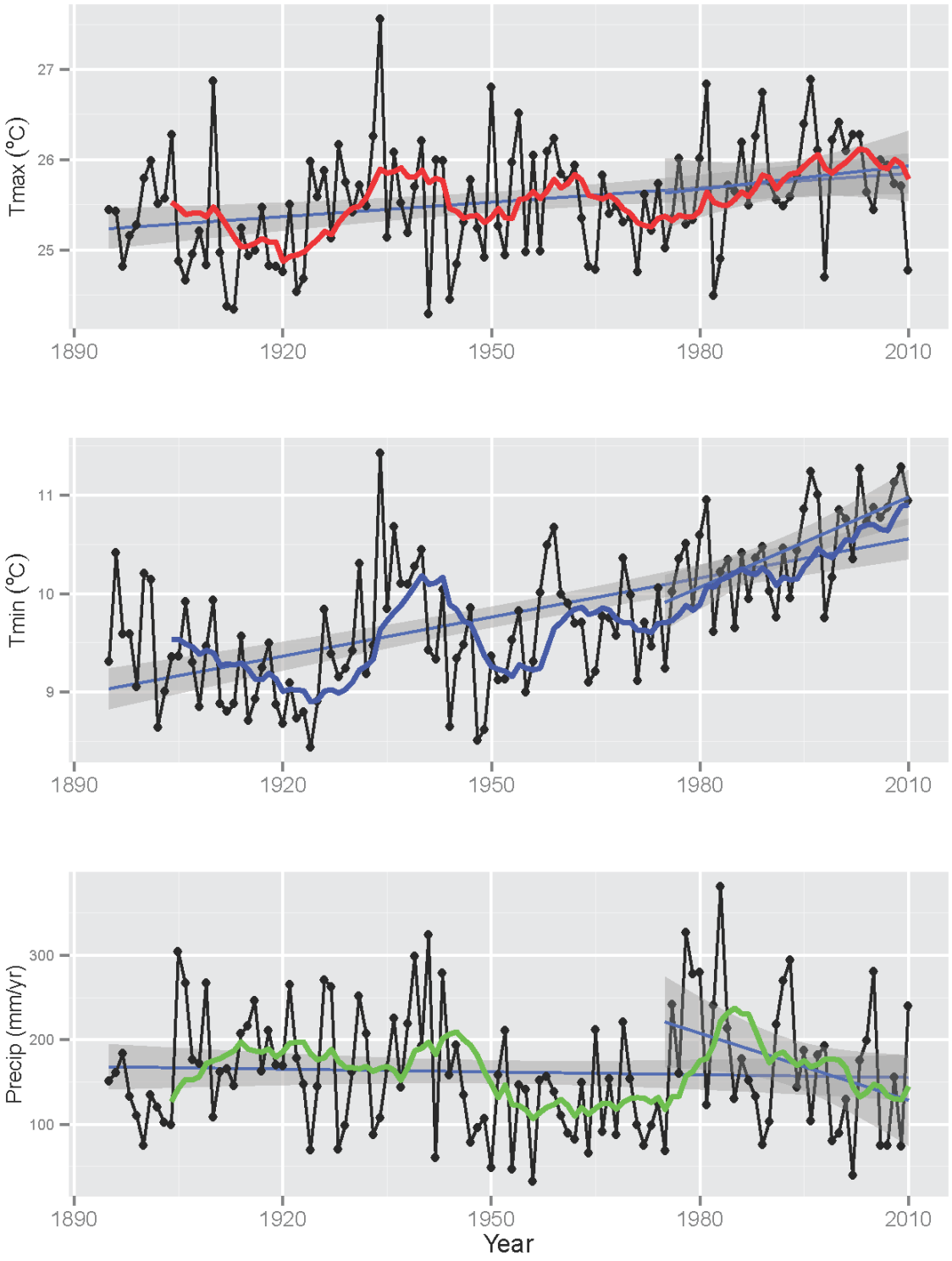

Figure C.9. Annual average maximum temperature (Tmax), minimum temperature (Tmin), and precipitation (Precip) estimated from 800m PRISM data for JOTR. Filled circles and black lines are annual means. Red, blue, and green lines are 10-year running means, and straight blue lines are linear regressions for the 1895-2010 and for 1975-2010. Tmax trend for 1975-2010 does not differ from long-term trend. Increase in Tmin from 1975-2010 is more rapid than for 1895-2010. Decreasing rate of precipitation for 1975-2010 is marginally significant ($P < 0.05$), but the observed variation in suggests the trend is not ecologically meaningful.

Appendix D: Wilderness Character Monitoring and Narratives

D.1 Monitoring

Wilderness character monitoring allows managers to assess the condition and trend of wilderness character over time. It prompts managers in all divisions to evaluate the consequences of decisions and proposed actions inside wilderness for environmental compliance, scientific studies, minimum requirements analyses, and most other wilderness stewardship activities.

There are thirteen standard indicators for wilderness character monitoring. The RSS Development Team identified at least one measure, as required, for the 13 standard indicators found in the wilderness character integration user guide (NPS, 2012), with an intent of capitalizing on existing datasets to meet multiple objectives. Some RSS indicators and measures from the resource summary table (Table 5) and potential activities within RSS strategies are also relevant to wilderness character. The team did not establish targets for wilderness character; these will be incorporated into the upcoming *Wilderness Stewardship Plan*, and further refined and vetted through a public participation process.

The RSS Development Team did not incorporate indicators and standards specific to wilderness character monitoring tables in Chapters 3 and 4 of this document, but rather developed a standalone table for wilderness character monitoring (Table D.1, below). The structure of this table will need little modification for incorporation into the future *Wilderness Stewardship Plan* for the park. In addition to the wilderness character monitoring table, the RSS Development Team created narratives to describe wilderness character at the park. The wilderness character narratives were written to provide context for Joshua Tree National Park Wilderness, based on the information gathered from the RSS Indicators workshop. These narratives and measures are a component of the wilderness building blocks for a wilderness stewardship plan.

The wilderness character monitoring table, D1, will be further refined during the initation and development of Joshua Tree National Park's *Wilderness Stewardship Plan* and will more accurately represent Joshua Tree NP measures and data sources. NPS staff will determine whether or not to implement any of the wilderness character monitoring efforts now or wait until the completion of the *Wilderness Stewardship Plan*.

Table D.1. Wilderness Character Monitoring Indicators

Indicators	Possible Measures	Data Sources
Natural Quality		
Plant and animal species and communities	Abundance, distribution, or number of indigenous species that are listed as threatened and endangered, sensitive, or of concern	• NPS Integration of Resource Management Applications (IRMA) NPSpecies database (http://science.nature.nps.gov/im/datamgmt/IRMA.cfm) • State agencies and other partners (*e.g.*, Nature Serve datasets) • US Fish and Wildlife recovery records for listed species
	Number of extirpated indigenous species	• NPS IRMA NPSpecies database • State agencies and other partners (*e.g.*, Nature Serve datasets) • US Fish and Wildlife recovery records for listed species
	Number of non-indigenous species	• Vegetation map inventory • NPS Inventory and Monitoring Program monitoring data; NPS IRMA NPSpecies Database • National Forest Service Inventory and Analysis • Fire Monitoring Handbook plot records or FEAT/FIREMON Integration data (http://www.frames.gov/portal/server.pt/community/feat_firemon_integrated_(ffi)/483) • Non-indigenous Aquatic Species database (http://nas.er.usgs.gov/)
	Abundance, distribution, impact to native species or number of invasive non-indigenous species (e.g., *Tamarix* spp.)	• Alien Plant Control and Monitoring database for gross infested acres • Nonindigenous Aquatic Species database • LANDFIRE Uncharacteristic Vegetation data
	Change in demography or composition of communities	• LANDFIRE data • NPS Inventory and Monitoring Program Vegetation Monitoring datasets

Indicators	Possible Measures	Data Sources
Physical resources	Visibility based on average deciview and sum of anthropogenic fine nitrate and sulfate	• National IMPROVE data (http://views.cira.colostate.edu/web/) • Transmissiometer datasets
	Ozone air pollution based on concentration of N100 episodic and W126 chronic ozone exposure affecting sensitive plants	• National EPA AIRS data (http://epa.gov/airdata/aqsdb.html) • National CASTNET data (http://epa.gov/castnet/javaweb/index.html)
	Extent and magnitude of change in water quality (springs and oases)	• NPS Inventory and Monitoring Program datasets
	Extent and magnitude of disturbance or loss of soil or soil crusts	• NPS Inventory and Monitoring Program datasets • Trail/campsite monitoring datasets
	Departure from natural fire regimes averaged over Joshua Tree National Park Wilderness	• LANDFIRE Ecosystem Alteration Departure Index (http://www.landfire.gov/) • Local Fire Regime Condition Class maps available from local Fire Management Office
	Extent and magnitude of effects of global climate change	• LANDFIRE Uncharacteristic Vegetation Map (http://www.landfire.gov/) • Species shift data from local or regional sources (check with DOI Regional Climate Science Center to see what is available at http://nccwsc.usgs.gov/csc.shtml)
	Area and magnitude of pathways for movement of non-indigenous species into Joshua Tree National Park Wilderness	• Geographic analysis of pathways and vectors adjacent to wilderness (roads, trails, waterways) • NPScape datasets • Examples: road and river corridors, solar energy collection fields
	Area and magnitude of loss of connectivity with the surrounding landscape	• NPS Inventory And Monitoring Program • Geographic analysis using landscape ecology tools (*e.g.,* FragStats at http://www.treesearch.fs.fed.us/pubs/3064) • NPScape datasets

Indicators	Possible Measures	Data Sources
Untrammeled Quality		
Actions authorized by the Federal land manager that manipulate the biophysical environment	Number of actions taken to manage plants, animals, pathogens, soil, water, or fire (*e.g.,* invasive species control, animal reintroduction, guzzlers, Minimum Requirements Decision Guides for # of actions)	• Minimum requirements analyses • Wildland Fire Management Information records and/or fire narratives (DI-1202 or ICS209 forms) for fire incidents • National Fire Plan Operating and Reporting System for prescribed fire and fuel treatments • Alien Plant Control and Monitoring Database for exotic plant treatments
	Percent of natural fire starts that received a suppression response	• Wildland Fire Management Information records for fire incidents (check with fire management officer for access to database at http://www.nifc.blm.gov/) and/or fire narratives (DI-1202 or ICS209 forms)
Actions not authorized by the Federal land manager that manipulate the biophysical environment	Number of unauthorized actions by agencies, citizen groups, or individuals that manipulate plants, animals, pathogens, soil, water, or fire	• Law enforcement data systems (*e.g.,* case incident databases)
Solitude or Primitive and Unconfined Recreation Quality		
Remoteness from sights and sounds of people inside the wilderness	Amount of visitor use	• Permit records, including number of permits, issuing agency, type of use, number of people in party, trip itinerary
	Number of trail contacts	• Trail counters • Staff reports • Climbing permits
	Area of wilderness affected by access or travel routes that are inside the wilderness	• Facility Management System Software data • Trails maps and datasets
	Area of wilderness affected by access or travel routes that are adjacent to the wilderness	• Agency Geographic Information Systems datasets • Aerial photography • Geographic analysis using landscape ecology tools (*e.g.,* FragStats at http://www.treesearch.fs.fed.us/pubs/3064) • NPScape datasets • Highway maps
	Night sky visibility averaged over the wilderness	• National night sky visibility maps • NPS Night Sky Program
	Extent and magnitude of intrusions on the natural soundscape	• NPS Natural Sounds Program

Indicators	Possible Measures	Data Sources
Facilities that decrease self-reliant recreation	Type and number of agency-provided recreation facilities	• Facility Management System Software
	Type and number of user-created recreation facilities (*e.g.*, social trails, unauthorized bolting routes, illegal camping structures)	• Local knowledge • Law enforcement data systems (*e.g.*, case incident databases) • Aerial photography for some types of facilities
Management restrictions on visitor behavior	Type and extent of management restrictions	• Superintendent's Compendium • Backcountry/Wilderness Permit terms and conditions (*e.g.*, geospatial, bolting permits, waste disposal, fires, length of stay)
Undeveloped Quality		
Non-recreational structures, installations, and developments	Index of authorized physical development	• Local spatial datasets for locations of communication installations, utilities, other rights-of-way, grazing infrastructure, research installations (*e.g.*, air quality monitoring stations, weather stations, other research installations, guzzlers)
	Index of unauthorized physical development (*e.g.*, research installations)	• Law enforcement data systems
Inholdings	Area and existing or potential impact of inholdings (including mining claims, parcels with and without road access, state and privately-owned)	• NPS Regional Lands Office records
Use of motor vehicles, motorized equipment, or mechanical transport	Type and amount of administrative and non-emergency use of motor vehicles, motorized equipment, or mechanical transport	• Extract from minimum requirements analyses
	Type and amount of emergency use of motor vehicles, motorized equipment, or mechanical transport	• Minimum requirements analyses • Case incident reports for law enforcement and search and rescue operations • Fire incident narratives (DI-1202 and/or ICS 209 reports)
	Type and amount of motor vehicle, motorized equipment, or mechanical transport use not authorized by the Federal land manager	• Case incident reports for law enforcement and search and rescue operations • Unauthorized boundary incursions map

Indicators	Possible Measures	Data Sources
Other Features Quality		
Deterioration or loss of cultural resources integral to wilderness character	Number of unauthorized actions that result in disturbances to cultural resources (*e.g.,* looting, trespass activities, non-compliance with NHPA, graffiti, vandalism)	• Citations, Archeological Resources Protection Act violations, Secretary's Annual Report to Congress, site condition reporting datasets
	Number of authorized actions that result in disturbances to cultural resources (*e.g.,* visitor and commercial use, cat-holes, trampling, social trails, hearths, aircraft landings findings of adverse effect for projects and operations)	• Citations, Archeological Resources Protection Act violations, Secretary's Annual Report to Congress, site condition reporting datasets
	Number of naturally caused disturbances (*e.g.,* erosion, animal digging, floods, fires)	• Inventory and Monitoring Program data • National fire datasets • Local datasets
Loss of paleontological resources	Number and severity of disturbances to paleontological resources	• NPS Geologic Resources Division's literature based paleontology resource inventory • Inventory and Monitoring Program data • Local datasets

D.2 Narratives

This section provides a positive and wilderness affirming qualitative description to communicate wilderness values, organized by each quality of wilderness character.

On October 20, 1976, Public Law (PL) 94-567 designated 429,690 acres as wilderness and 37,550 acres as potential wilderness additions within Joshua Tree National Monument. On October 31, 1994, the California Desert Protection Act, PL 103-433, added 234,000 acres to the monument and re-described it as a national park; in addition, the California Desert Protection Act also designated an additional 131,780 acres of park land as wilderness. The Omnibus Public Land Management Act of 2009 (PL 111-11), designated another 36,700 acres as wilderness. The same 2009 act designated 43,300 acres as potential wilderness. Joshua Tree National Park Wilderness now totals over 595,000 acres as designated wilderness, over 70,000 acres as potential wilderness, and over 400 acres as proposed wilderness, or about 84% of the park.

In 1994 Congress passed the California Desert Protection Act (CDPA) to:

> . . .preserve unrivaled scenic, geologic, and wildlife values associated with these unique natural landscapes. . . perpetuate in their natural state significant and diverse ecosystems of the California desert. . . [and] protect and preserve historical and cultural values of the California desert associated with ancient Indian cultures, patterns of western exploration and settlement, and sites exemplifying the mining, ranching and railroading history of the Old West.

Areas in the park currently not managed as wilderness include: developed zones, special use zones, backcountry transition subzone, private inholding parcels not within the aforementioned zones and access areas associated with the inholdings.

D.2.1 Natural Quality

Natural processes within Joshua Tree NP shape the desert landscape. Flash floods, wind, and erosion events assist in soil formation, structure the landscape over time, and expose the paleontological resources found in the park. The park's biodiversity is generated in part by a rich geological history that has created varied soil types and elevation gradients. Soil nutrients and gas-exchange processes of desert vegetation go unnoticed, but are a vital process, especially for vegetation communities. Species distribute themselves across q landscape, while evolutionary adaptation to change is generally unrestrained by management intervention.

The geographic location, climate, and variation in elevation sustain ecological conditions that foster populations of the plants and animals characteristic of the Mojave and Colorado deserts. Renowned for its plant diversity, Joshua Tree NP supports over 750 native plant species. The namesake for the park, the Joshua tree, is the aesthetic signature of the Mojave Desert, in contrast with the tall spindly, stiff stemmed Ocotillo that epitomizes the Colorado Desert. From afar, some desert plants appear lush and green, but closer investigation reveals the defenses of the cactus family, whose spines serve as protection from herbivores and prevention of water loss. Intact soil and expanses of microbiotic soil crust, formed by ecosystems of tiny living organisms, aid in essential desert functions: soil stability and erosion, atmospheric nitrogen fixation, nutrient for plants, soil-plant-water relations, infiltration, germination, and plant growth (Belnap, 2001). Without these important expanses of microbiotic soils, the plants would struggle to survive.

The natural springs, oases, and riparian areas of the park attract wildlife and host a variety of plant species unique to those areas. A number of species depend on these areas for water resources or for year-round habitat: reptiles, roosting yellow bats, elf owls, burrowing palm beetles, migratory and resident birds, big horn sheep, and many invertebrates. Guzzlers provide wildlife with another water source, albeit an artificial one.

The desert tortoise is a species that relies on smaller forbs and grasses in the lower elevation areas of the park while desert bighorn roam the steep cliffs and higher elevation woodlands. Granivorous insects and rodents are an important dispersal agent of seeds of desert flora, which provides for resilience after disturbance and results in the clumped distribution of many desert plant species. Humans and wildlife alike both benefit from the pockets of clean air found in the interior of the wilderness, as well as dark skies blanketing the eastern side of the park.

Although many of the natural qualities at Joshua Tree National Park Wilderness are intact, a number of internal and external threats compromise these resources. The natural quality is degraded by the occurrence of non-native species, such as annual brome grasses, Sahara mustard, and salt-cedar trees. Some invasions have become established after fires in places like Joshua tree woodlands and increase fire frequency. Other invasions come from outside the park from residential landscaping and take root in hospitable canyons and drainages within Joshua Tree NP.

Anthropogenic climate change may lead to reduced precipitation/soil water, drying of springs, fewer flowers, tree mortality, a separation of otherwise mutualistic species and an overall loss of biodiversity. The combination of drought, nitrogen deposition and projected increased temperatures can degrade multiple components of the natural environment.

There are potential impacts from groundwater withdrawal within the park and beyond, but the extent and effects are largely unknown.

Regionally, air pollution from distant urban sources in the greater Los Angeles area severely degrade air quality within the park's Class I airshed.

Developments adjacent to park boundaries fragment connectivity of the landscape and obstruct historic wildlife corridors. Over time, fragmentation could isolate wildlife populations and threaten species diversity.

Social trails also degrade the natural quality of park wilderness by trampling the vegetation and soil resources. The recovery time for these resources is slow and may take decades in the desert environment.

D.2.2 Untrammeled Quality

The ever changing complexity of desert areas form patterns of beauty generally free from modern human control or manipulation. Tectonics and erosion shape the vast expanses of geologic formations and mountain ranges at a pace undetectable to the human eye and uninterrupted by humans. Phenological processes continue among plants and animals and follow climatic conditions and seasonal weather patterns. Unaltered water sources at oases and springs create dependencies among vegetation and animal communities. These processes represent the untrammeled quality of the park's wilderness.

Perpetuating this untrammeled quality requires managers to restrain themselves, leaving the wilderness uncontrolled and unmanipulated. Most of the park's infrastructure and concentrated administrative uses occur outside of wilderness. Some actions in wilderness degrade the untrammeled quality, often with the intent of improving the natural quality. Chukar, a Eurasian gamebird in the pheasant family, was likely introduced as a product of state game management in the 1960s. Joshua Tree NP staff remove non-native plants and restore other areas with native plants. Suppression response to fire and retardant lines manipulate the wilderness. Guzzlers provide unnatural drinking water sources for wildlife, as well as historic resources such as Barker Dam. Rock manipulation from climbers alters their natural position.

D.2.3 Solitude or Primitive and Unconfined Recreation Quality

Wilderness is a destination for many and offers opportunities for people to explore rugged, wild lands. Joshua Tree National Park Wilderness facilitates rare recreational experiences with abundant opportunities for self-directed exploration as well as mental and physical challenge. The park's extensive trail network allows visitor use to be spread out over roughly 288 miles of trail, providing ample opportunity for solitude in all but the busiest times of the spring wildflower season and year-round on the remote trails. The open landscape and dispersed vegetation provide for extensive views and wide panoramas along many trails, enhancing the feeling of solitude that Joshua Tree National Park Wilderness provides.

The extensive trail system provides not only solitude but also offers the chance to take cross-country excursions. The rugged landscape presents vast challenges to the cross-country traveler, especially considering the lack of any drinking water sources. Backcountry camping is an option for the experienced visitor; a backcountry permit is required. The flexibility for the visitor to design their own itinerary, route, and experience increase the opportunity for self-reliant, primitive and unconfined recreation and solitude. In the depths of the wilderness, away from urban centers, the night sky quality is good. Limited cell phone coverage also serves to enhance a sense of solitude and self-reliance. The park's desert terrain accommodates a wide variety of recreational pursuits, such as hiking, birding, rock climbing, and nature study.

There are some impacts to the primitive and unconfined quality of the park's wilderness as well. Opportunity for solitude is degraded by seasonally high visitor use where encounters with other climbing and/or hiking parties are common. In addition, signs of camping/waste, user-built stone fire rings, and signs (wayfinding and interpretive) also degrade the wilderness's primitive and unconfined quality. Social trails and shortcuts are present in many areas associated with climbing. These diminish the sense of remoteness from inside the wilderness. In regard to the remoteness from occupied and modified areas outside the wilderness, surrounding urban areas and developments interrupt the viewshed from some key locations and air pollution and particulates from regional and distant urban sources impact viewsheds.

In addition, the proximity to large airport and military facilities produces sounds from overflight activities and bombings that degrade the natural soundscape in the park.

Energy developments and urban areas on the park boundary, and also more distant urban areas, illuminate the once dark sky with unwanted light pollution. The west, south, and north boundaries are particularly impacted by the sky glow.

Primitive and unconfined recreation is degraded by the prevalence of designated trails, bolting on climbing routes, requirement of a permit, and regulatory signs. It is also degraded by restrictions for stock use on certain trails, restrictions on dogs, raptor advisories, closures for cultural resources, and other park visitor-use regulations. Such restrictions were put into effect primarily for the protection of other qualities of wilderness character or to meet other agency mandates, but they do serve to confine the recreational opportunities offered in the wilderness.

D.2.4 Undeveloped Quality

The vast open areas of Joshua Tree National Park Wilderness exemplify an undeveloped quality. While there are some improvements for administrative or scientific purposes found in the wilderness, most of the landscape retains its primeval character.

The absence of communications towers and grazing infrastructure (*e.g.*, fences, troughs) enhance the undeveloped quality of Joshua Tree National Park Wilderness. The desert

ecosystem has continued uninterrupted for thousands of years and continues now and in the future with no immediate need for human designed improvement or oversight. This quality continues to improve with the lack of structures and prohibited uses by the agency or for administrative purposes.

The undeveloped quality is degraded by the number of inholdings; however, only a portion of these have structures present. Fortunately, many inholdings are not often accessed and increase the opportunity for solitude. Some installations are also present for scientific research and other purposes. A number of structures and relics from the mining and homesteading days also dot the landscape. Although these features are an important piece of the cultural history of the park, the developments stand in great contrast to their wild surroundings and remain high profile sites in an otherwise undeveloped horizon. These installations and structures degrade the undeveloped quality.

Overall, the majority of the wilderness is unspoiled from permanent improvements or human habitation. To preserve this desert wilderness, Joshua Tree National Park staff limits administrative motorized equipment use to helicopter use for mine closures (approximately 6 times in 2012). For responding to emergencies, the county may be responsible for non-compliance with wilderness policies by using motorized equipment in the wilderness. The staff at Joshua Tree NP rarely use any motorized equipment, motorized vehicles, or mechanical transport for emergency response in wilderness. Any proposals for planned use of motorized equipment or mechanical transport, as well as administrative installations in the wilderness are subject to a minimum requirement analysis process.

D.2.5 Other Features

Other qualities of the Joshua Tree National Park Wilderness are not captured by the above four qualities. The NPS has defined the fifth quality, other features, based on the last clause of Section 2(c) of the Wilderness Act which states that a wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value (Wilderness Act of 1964)."

Unlike the preceding four qualities that apply throughout every wilderness, this fifth quality is particular to an individual wilderness based on the features that are inside that wilderness. These features typically occur only in specific locations within a wilderness and include cultural resources, paleontological localities, or any feature generally not under the other four qualities. While many different types of features could be included, the intent is to include those that are significant or integral to the park and wilderness. This quality is preserved or improved by preservation or restoration of such features, even when such management actions degrade other qualities of wilderness character. Loss or impacts to such features degrade this quality of wilderness character.

Joshua Tree NP staff identified c*ultural resources* as a component of this quality of wilderness character. Human influence has left a range of historic structures in what is now wilderness at Joshua Tree NP. Cultural resources connect the story between people and nature. Visitors to wilderness can appreciate and understand these relationships by observing examples of cultural resources, such as at Eagle Cliff Mine, Piñon Well, or Carys Castle. Joshua Tree National Park Wilderness contains cultural resources including archeological sites, ethnographic sites, ethnobotanical resources, historic structures, prehistoric and historic roads and trails, and cultural landscapes.

Historic uses of the land included: processing of gold ore, cattle ranching, rustling, and homesteading of the southwestern deserts.

The park contains 122 structures included on the main *List of Classified Structures*. The park contains at least four cultural landscapes: Keys Ranch Historic District, Hexie Mountains Mining Historic District, Lost Horse Mining Historic District, and Northern Piñon Mining District. These historic districts exemplify the California Desert Protection Act mandate to:

> . . .protect and preserve historical and

> cultural values of the California desert associated with ancient Indian cultures, patterns of western exploration and settlement, and sites exemplifying the mining, ranching and railroading history of the Old West… (CDPA, 1994).

Visitor activities can degrade features of cultural resource quality in wilderness. Social trails, bolts in rocks near cultural resources, vandalism, and looting all impact the condition of these important sites. Natural processes, such as erosion and weathering, may also degrade or result in the loss of cultural features that contribute to wilderness character.

APPENDIX E: Restructuring of Foundation Statement FRVs for the RSS

Park staff developed twenty-three *fundamental resources and values* during a *Foundation for Planning* workshop in 2010, following a thorough review of the park's enabling legislation and legislative documents that direct National Park Service management activities at Joshua Tree National Park. The list of *fundamental resources and values* has been revised for purposes of the RSS. FRVs were removed that were not directly related to natural and cultural resource management. Others were modified or nested under appropriate FRVs for purposes of clarity and logic. Figure F.1 below lists the restructuring of FRVs from the *Foundation Statement* to the RSS: FRVs retained from the *Foundation Statement* to the RSS are listed in the left column of the figure; the middle column represents modified or new FRVs (or attributes in some cases) in the RSS; and the right column represents *Foundation Statement* FRVs that were either removed or modified and nested under other FRVs for the RSS (arrows point to the modification in the middle column).

The RSS team redefined the original cultural resource *fundamental resources and values* to align with the specific disciplines outlined in NPS Director's Order 28A: *Archeology, Cultural Landscapes, Historic Structures, History, Museum Collections,* and *Cultural Anthropology*. The team adopted this approach in order to allow NPS managers to plan for protection of these resources by disciplines familiar to technical experts and to correspond to NPS tools for data management, resource condition reporting, funding, and research. The FRV narratives for cultural resource are thus written by discipline rather than the thematic context represented in the *Foundation Statement.*

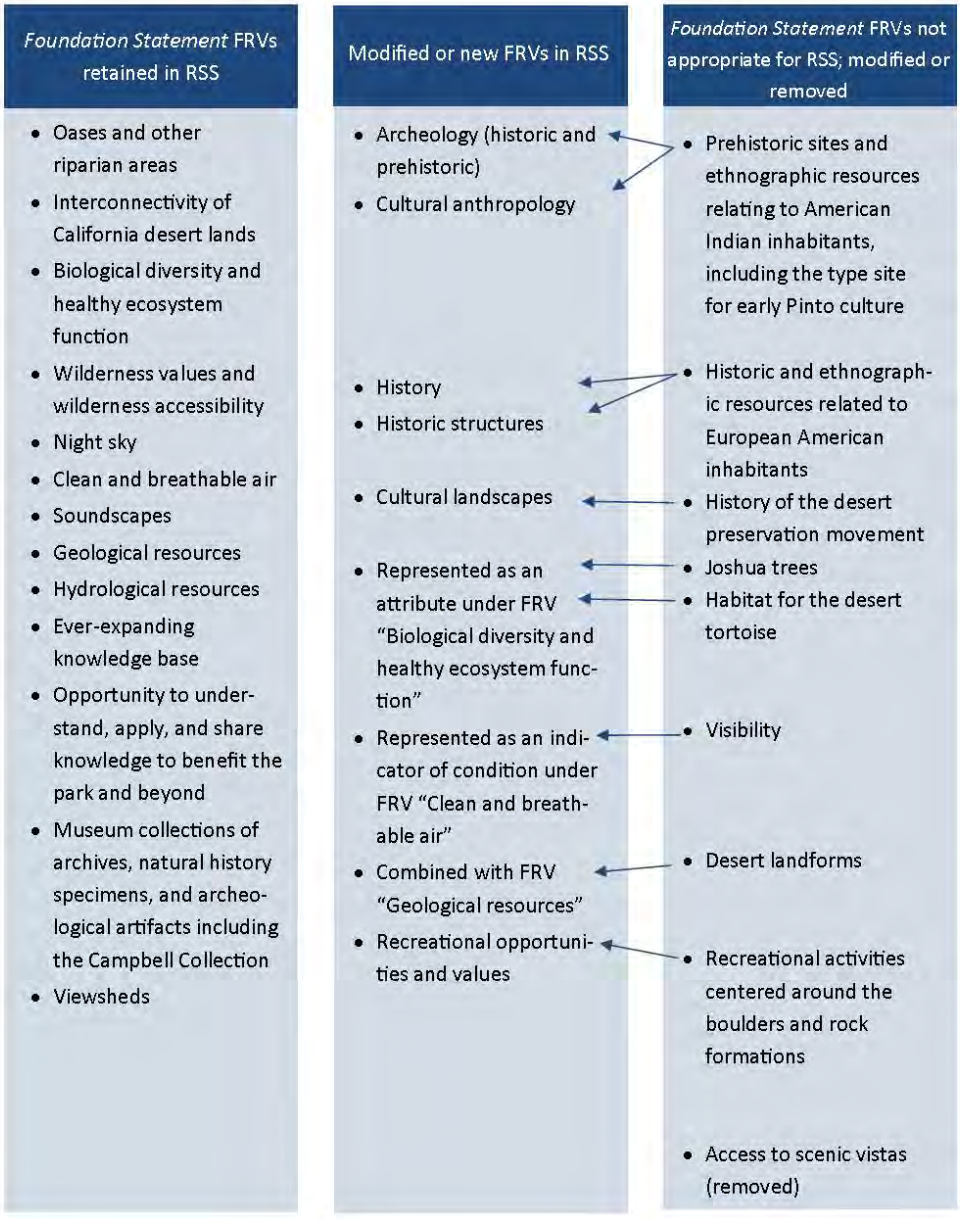

Figure F.1. Restructuring of *Foundation Statement* FRVs for the RSS

Appendix F: The Changing Environment

There are several changing conditions within and beyond park boundaries. Park staff identified a subset of these stressors including land use intensification, air pollution, and climate change. The following graphs correspond with the text presented in Chapter 2, section 2.6.3.

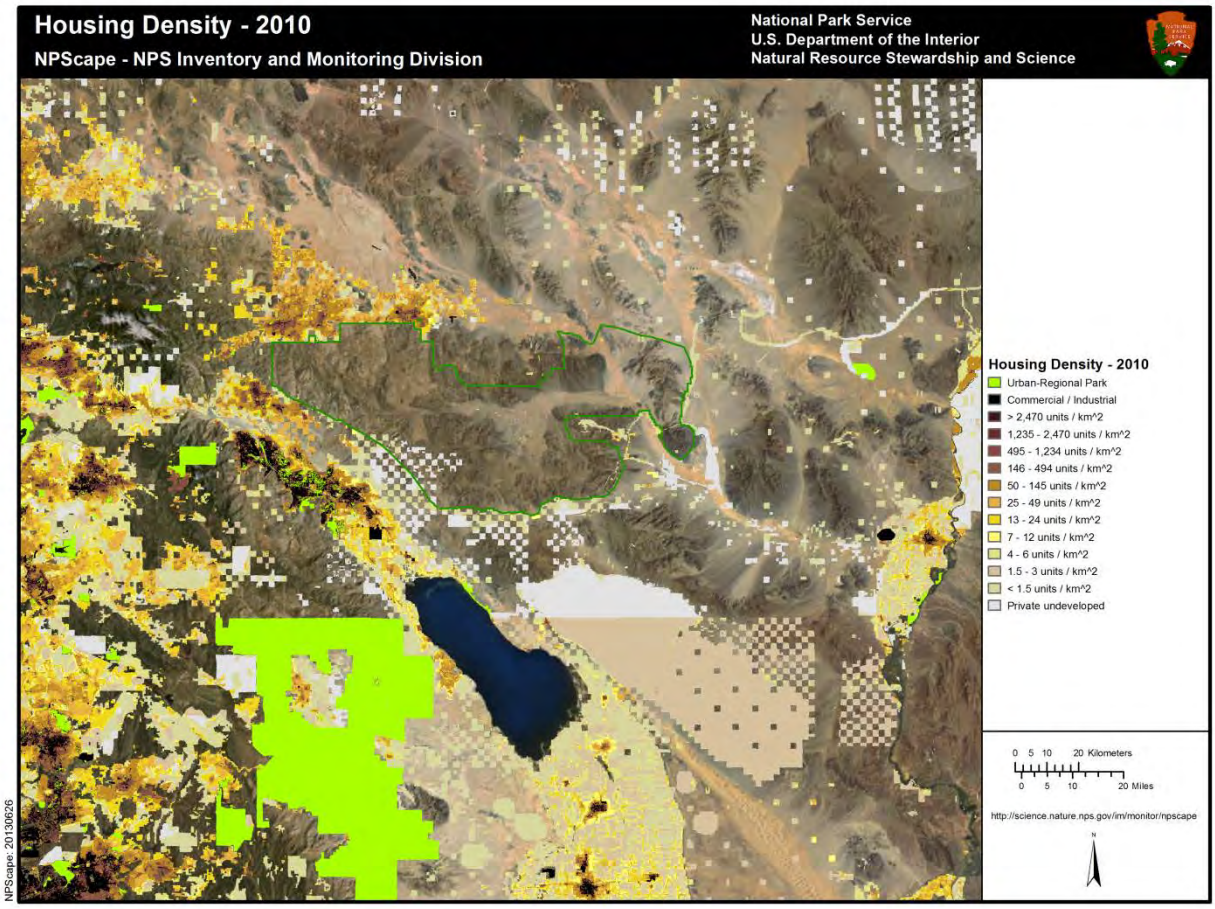

Figure F.1. Housing density (data for 2010) in the area surrounding Joshua Tree NP (park boundary in green). Extensive development centered on Hwy 62 (northwest of Joshua Tree NP) and I-10 (south and southwest of Joshua Tree NP) is apparent in this map.

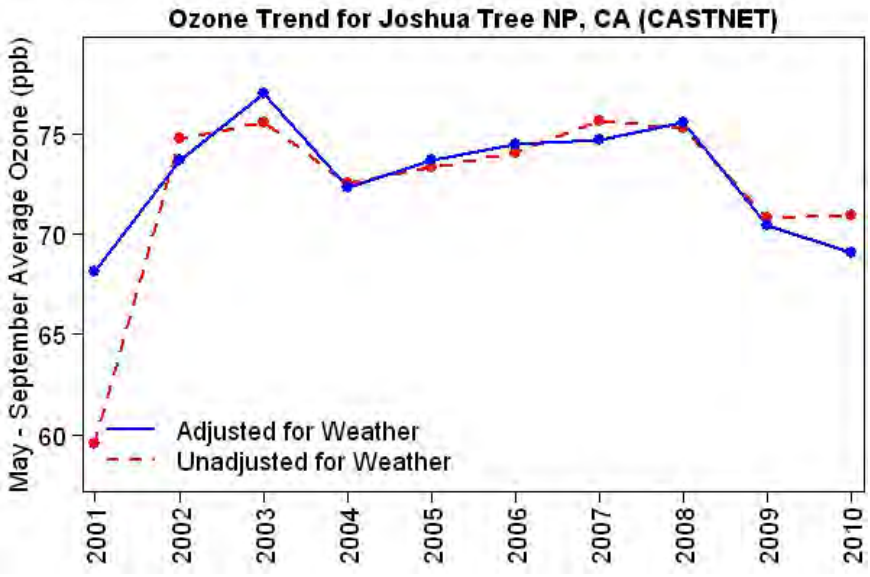

Figure F.2. Weather-adjusted ozone levels from rural monitoring stations at Joshua Tree NP (from http://www.epa.gov/airtrends/weather.html).

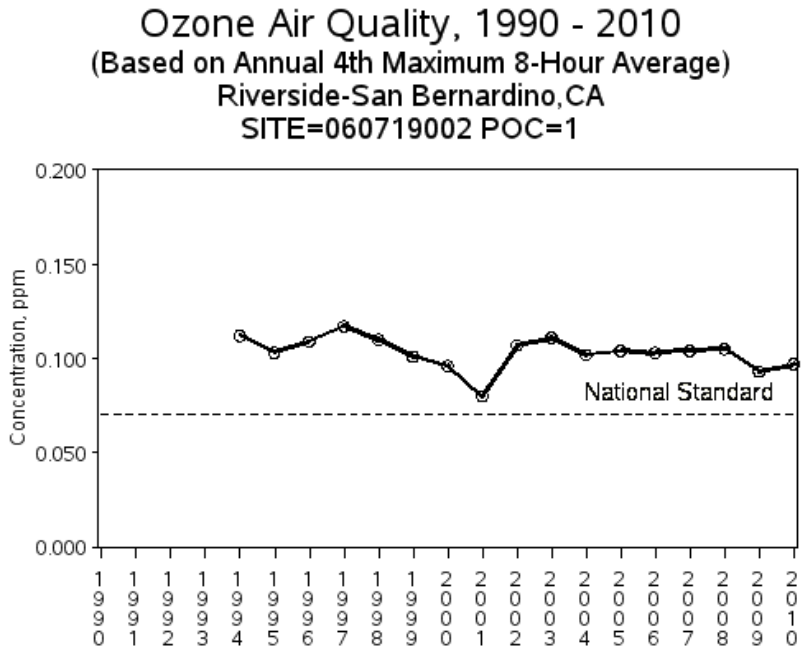

Figure F.3. Ozone trends from a single monitoring site in western Joshua Tree NP (from http://www.epa.gov/airtrends/ozone.html).

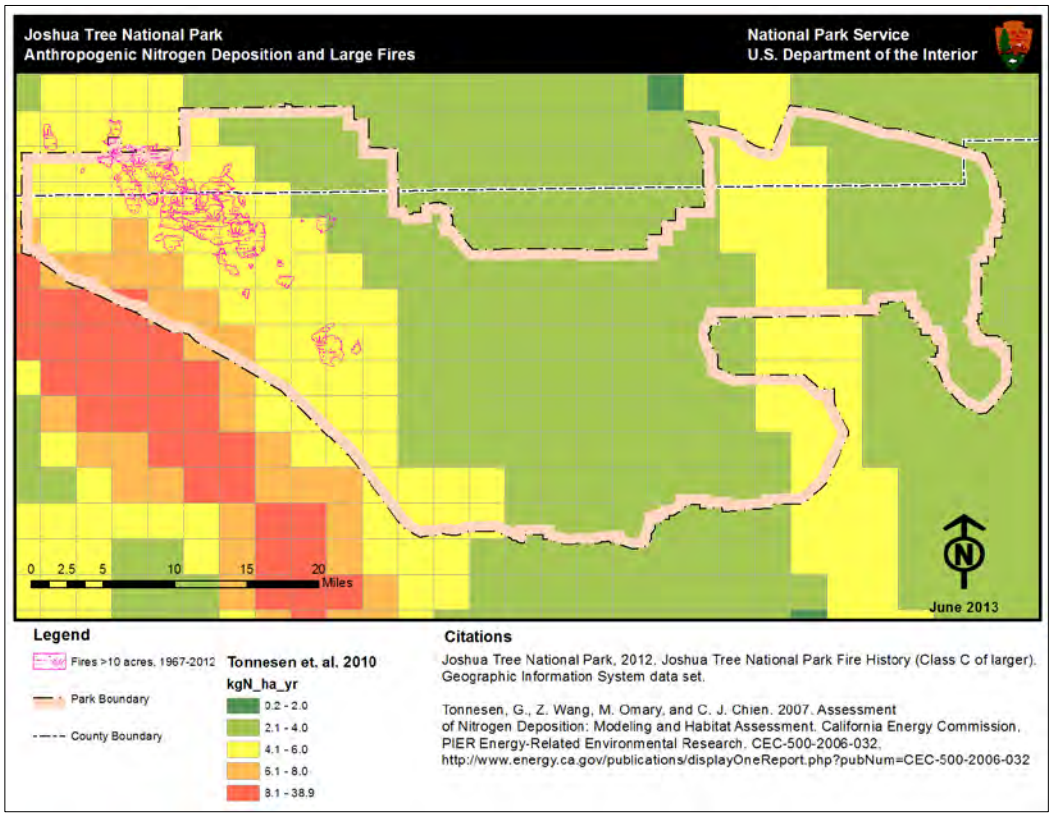

Figure F.4. Visualization of anthropogenic nitrogen deposition and large fires at Joshua Tree NP. All fires greater than ten acres occur in locations which receive more than 4kg nitrogen/hectare/year.

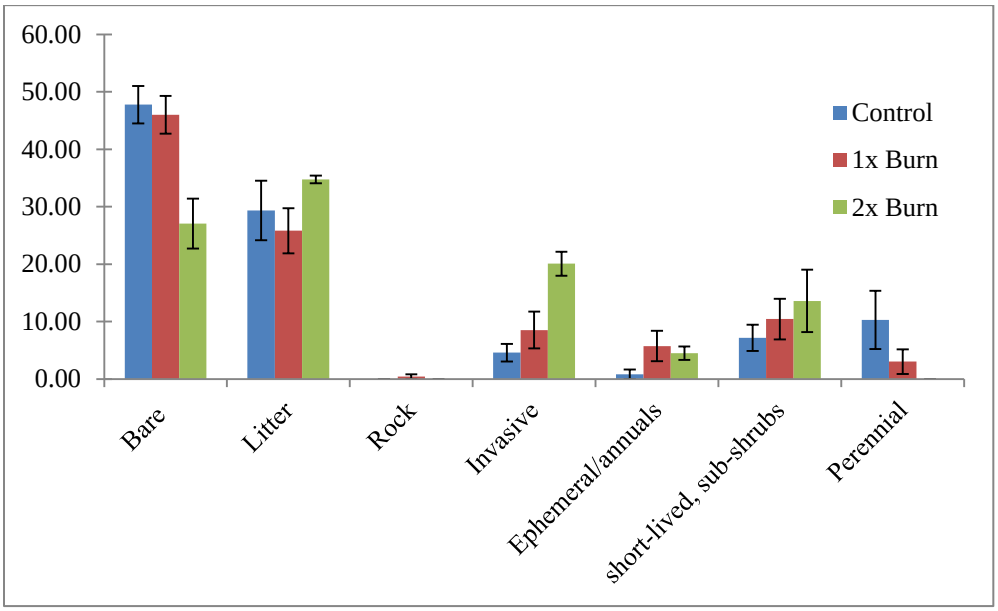

Figure F.5. Unpublished data from Joshua Tree NP showing changes in percent cover between areas that have not burned, burned once, and locations that have burned two times. This preliminary data set shows a significant increase in invasive cover between all three treatments. Perennial plants were not observed by sampling in the areas twice burned.

Appendix G: Potential Activities Organized by Climate Change Response Type

The following seven tables represent the climate change adaptation Rs discussed in Chapter 4, followed by the potential activities that the park hopes to accomplish as a climate change adaptation strategy. These strategies provide good preparation for future events, and represent low risk with respect to influences from the three plausible climate futures (Appendix C). The number in parentheses corresponds with the robust strategies, results of the 2007 Climate Change Scenario Planning workshop, listed in the right hand column of Table 6, Appendix C: Climate Change Scenario Planning Summary Report. This list provides a comprehensive summary of the potential activities Joshua Tree National Park plans on implementing to prepare for or adapt to climate change.

Table G.1 *Reduce*

BIO4: Direct Management: Control non-native annual grasses associated with Joshua tree stands in order to minimize threats from fire **(5,7,8)**
BIO18: Monitoring: Continue active early detection program to inventory and control noxious novel weeds and track changes in behavior of existing invasive plant populations (in conjunction with Mojave Network Inventory & Monitoring work) **(5)**
BIO30: Direct management: Continue to minimize areal extent and frequency of fires through control of non-native plants (particularly in areas where these species carry fire unnaturally- Joshua tree stands, blackbrush) **(5,7,8)**
BIO47: Direct management: Maintain closures to human visitation at Cow Camp and Keys Ranch. Implement measures to protect sheep populations from visitor impacts at 49 Palms Oasis, Barker Dam, and other water sources **(7)**
OAS9: Direct management: Continue monitor and control of invasive plant species in riparian habitat (e.g., Tamarisk, fountain grass, pepperweed) **(2,5,7,8)**
OAS11: Direct management: Evaluate impacts on a seasonal basis to riparian habitat from human trampling, implement seasonal exclusions as needed **(7,8)**
REC9: Direct management: Restore areas that have received resource damage due to high use, specifically social trails, in non-wilderness and implement measures to prevent reoccurring damage **(7,8)**
REC12: Direct management: Restore areas of illegal off road use or closed roads **(7,8)**

Table G.2 *Resilience*

BIO4: Direct Management: Control non-native annual grasses associated with Joshua tree stands in order to minimize threats from fire **(5,7,8)**
BIO30: Direct Management: Continue to minimize areal extent and frequency of fires through control of non-native plants (particularly in areas where these species carry fire unnaturally-Joshua tree stands, blackbrush) **(5,7,8)**
OAS9: Direct management: Continue monitor and control of invasive plant species in riparian habitat (e.g., Tamarisk, fountain grass, pepperweed) **(2,5,7,8)**
OAS11: Direct management: Evaluate impacts on a seasonal basis to riparian habitat from human trampling, implement seasonal exclusions as needed **(7,8)**
REC9: Direct management: Restore areas that have received resource damage due to high use, specifically social trails, in non-wilderness and implement measures to prevent reoccurring damage **(7,8)**
REC12: Direct management: Restore areas of illegal off road use or closed roads **(7,8)**

Table G.3 *Representation*

BIO4: Direct Management: Control non-native annual grasses associated with Joshua tree stands in order to minimize threats from fire **(5,7,8)**
HSTRU2: Direct management: Stabilize historic structures through ongoing cyclic maintenance program (e.g., Keys Ranch structures) **(13)**
CL4: Direct management: Improve and maintain the condition of cultural landscapes (e.g., through vegetation management, maintaining structures and landscape features) at Keys Ranch, Northern Pinyon, Lost Horse Mining Historic District, Hexie Mountain, Southern Pinyon **(5,7,13)**
MUS9: Direct Management: Perform conservation and preservation of objects, specimens, archives, and library materials, including natural history collection (e.g., rehouse objects, scan photographs, migrate oral history tapes) **(13)**

Table G.4 *Restoration*

BIO4: Direct Management: Control non-native annual grasses associated with Joshua tree stands in order to minimize threats from fire **(5,7,8)**
BIO30: Continue to minimize areal extent and frequency of fires through control of non-native plants (particularly in areas where these species carry fire unnaturally- Joshua tree stands, blackbrush) **(5,7,8)**
OAS9: Direct management: Continue monitor and control of invasive plant species in riparian habitat (e.g., Tamarisk, fountain grass, pepperweed) **(2,5,7,8)**
OAS11: Direct management: Evaluate impacts on a seasonal basis to riparian habitat from human trampling, implement seasonal exclusions as needed **(7,8)**
REC9: Direct management: Restore areas that have received resource damage due to high use, specifically social trails, in non-wilderness and implement measures to prevent reoccurring damage **(7,8)**
REC12: Direct management: Restore areas of illegal off road use or closed roads **(7,8)**
HSTRU2: Direct management: Stabilize historic structures through ongoing cyclic maintenance program (e.g., Keys Ranch structures) **(13)**
CL4: Direct management: Improve and maintain the condition of cultural landscapes (e.g., through vegetation management, maintaining structures and landscape features) at Keys Ranch, Northern Pinyon, Lost Horse Mining Historic District, Hexie Mountain, Southern Pinyon **(5,7,13)**
MUS9: Direct Management: Perform conservation and preservation of objects, specimens, archives, and library materials, including natural history collection (e.g., rehouse objects, scan photographs, migrate oral history tapes) **(13)**

Table G.5 *Refugia*

INC5: Research: Investigate and map migration corridors, including habitat for genetic linkages, for mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), desert bighorn sheep (*Ovis canadensis*), tortoise (*Gopherus agasizii*), chuckwalla (*Sauromalus ater*) **(9)**
OAS6: Monitoring: Track trends in oasis palm recruitment (*Washingtonia filifera*), palm demographics, and other high-priority oasis plant species **(30)**

Table G.6 *Reconnaissance*

BIO1: Monitoring: Joshua tree abundance and reproductive success, associated temperature regimes, fire extent, and invasive species in Joshua tree woodlands **(30)**
BIO6: Research: Investigate sources and timing of N deposition and other airborne pollutants and impacts on native flora, including Joshua trees **(30)**
BIO8: Monitoring: Track trends in abundance and reproductive success of pinyon/manzanita/oak communities, and associated temperature regimes, fire extent, invasive species **(30)**
BIO12: Monitoring: Track trends in the distribution and species composition of plants/animals/microbial communities in the Mojave/Colorado Deserts transition zone **(30)**
BIO13: Monitoring: Track trends in Ocotillo abundance (as representative of a larger plant community) and migration **(30)**

BIO15: Research: Improve knowledge of two federally-listed plant species, including mapping populations, identifying genetic markers, establishing baseline seed germination and ecology studies **(30)**
BIO17: Monitoring: Document continued presence of 44 state-listed plant species (continue mapping and inventory) **(30)**
BIO18: Monitoring: Continue active early detection program to inventory and control noxious novel weeds and track changes in behavior of existing invasive plant populations (in conjunction with Mojave Network Inventory & Monitoring work) **(5)**
BIO25: Monitoring: Track trends in phenology of key plant and pollinator species (in conjunction with University of California, University of California at Santa Barbara and the National Phenology Network through the NPS California Phenology Project) **(11,30)**
BIO35: Monitoring: Continue to assist USFWS with range-wide monitoring of desert tortoise (medium ranking activity) **(11,30)**
BIO45: Inventory: Evaluate existing water sources for desert bighorn sheep **(7,8,22)**
BIO60: Monitoring: Track trends in bat species richness at open water habitat and palm oases **(30)**
BIO63: Monitoring: Track trends in reptile and amphibian distributions, ranges, and abundances across the transition zone (community trends and response to climate change monitoring) **(30)**
INC3: Inventory: Map illegal roads and trails within park boundaries and evaluate OHV incursions into the park, update map as needed **(7,30)**
INC5: Research: Investigate and map migration corridors, including habitat for genetic linkages, for mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), desert bighorn sheep (*Ovis canadensis*), tortoise (*Gopherus agasizii*), chuckwalla (*Sauromalus ater*) **(9)**
OAS6: Monitoring: Track trends in oasis palm recruitment (*Washingtonia filifera*), palm demographics, and other high-priority oasis plant species **(30)**
OAS9: Direct management: Continue monitor and control of invasive plant species in riparian habitat (e.g., Tamarisk, fountain grass, pepperweed) **(2,5,7,8)**
OAS12: Monitoring: Track trends in surface water area extent in selected oases (potentially 49 Palms, Smithwater, Johnson Spring) (Concurrent with OAS13) **(22)**
OAS13: Monitoring: Track gross-scale changes in spring, oasis, and riparian habitat qualities (e.g., via photomonitoring) **(22)**
REC1: Research: Research impacts of recreation on archeological resources, vegetation, soil, wildlife (e.g., climbing, bouldering, , horseback riding, off-road vehicles, backcountry camping) **(7)**
REC6: Research: Investigate visitor and ecological carrying capacity studies to understand how the number of climbers affects visitor experiences and resources **(7)**
EXP7: Monitoring: Monitor the effects of climate change through pitfall traps; expand if necessary. Project Title: "Managing biodiversity along transition zones in the face of climate change" **(12)**
EXP8: Administrative Management: Complete vulnerability assessment **(12)**
GEO5: Direct management: Work with research partners to protect paleontological resources through cyclic prospecting, correlate cyclic prospecting with rain events (bi-annual basis) **(7)**
HYD2: Monitoring: Track trends in water quality and quantity at a random sample of springs through the Mojave Desert Network Inventory & Monitoring Program **(22)**
HYD3: Monitoring: Repeat inventories of locations and hydrology characteristics of springs (Citizen Science: "Wet Hands" survey) **(22)**
HYD4: Research: Comparison of present day locations and conditions of springs with historical surveys **(22)**
HYD7: Research: Characterize Cottonwood aquifer (water balance, faulting system, withdrawal rate, life of well, ecological impacts of human water use) **(22)**

AIR1: Monitoring: Inventory, monitor, and document the condition of air quality related values for Joshua Tree NP **(24, 30)**
AIR2: Monitoring: Expand air quality monitoring throughout the park by adding more stations **(24, 30)**
VIEW1: Research: Complete visual resource inventory **(30)**
VIEW7: Monitoring: Expand coverage of visibility monitoring stations and continue monitoring (including web camera and photo-points) **(30)**
ARCH4: Documentation: Data recovery and update of National Register Determination of Eligibility for Cottonwood Spring Oasis **(13)**
ARCH5: Inventory: Inventory springs and other water sources for archeological resources **(13,22)**
ARCH9: Documentation: Collect baseline documentation on known but unrecorded archeological sites **(13)**
ARCH10: Inventory: Inventory of park developed area cultural resources **(13)**
ARCH11: Inventory: Conduct archeological surveys in areas subject to increased wildland fires (e.g. pinyon/juniper areas) **(13)**
ARCH17: Inventory: Inventory boundary lands **(13)**
ANTH1: Collaboration and Documentation: Complete Queen Mountain and Oasis of Mara traditional cultural properties (oral histories and archival material) **(13)**
HIST3: Research: Continue to conduct archival research and oral histories (including identifying people) that pertain to homesteads mines, park management user groups and popular culture **(13)**
CL2: Documentation: Complete Cultural Landscape Inventories (e.g., Southern Pinyon) **(13)**
CL8: Documentation: Initiate Cultural Landscape Reports (e.g., Keys Ranch- FLREA project) **(13)**

Table G.7 *Relationships*

BIO36: Collaboration: Work with USFWS Desert Tortoise Recovery Implementation Team to promote goals of the plan (Low ranking activity) **(11)**
INC4: Collaboration: With neighboring governments and agencies, work to minimize impacts to biota from developments near park boundaries **(7,11)**
SHARE5: Collaboration: Continue to integrate MOJN I&M program with park programs and external partners (interpretation, research partnerships, education partnerships, NR and CR programs) **(11,30)**
GEO5: Direct management: Work with research partners to protect paleontological resources through cyclic prospecting, correlate cyclic prospecting with rain events (bi-annual basis) **(7)**
GEO11: Research: Work with research partners to initiate more scientific studies about geologic processes within the park **(30)**
AIR6: Collaborate: Work with air quality management districts, CARB and EPA to strengthen air quality protections **(11)**
VIEW9: Collaboration: With municipalities, developers and agencies, maintain natural viewsheds as much as possible **(11)**
ANTH7: Collaboration: Continue and enhance tribal communications, including conducting oral histories **(13)**

Appendix H: Terms and Abbreviations

H.1 Terms

Air quality related value (AQRV):
: A resource that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource.

Archeological resources:
: The remains of past human activity and records documenting the scientific analysis of these remains. Archeological resources include stratified layers of household debris and the weathered pages of a field notebook, laboratory records of pollen analysis and museum cases of polychrome pottery. Archeological features are typically buried but may extend above ground; they are commonly associated with prehistoric peoples but may be products of more contemporary society.

Best management practices (BMPs):
: Practices that apply to the most current means and technologies available to not only comply with mandatory regulations, but also maintain a superior level of environmentally and culturally sensitive performance.

Comprehensive strategy:
: A logically organized, science/scholarship-based sequence of potential management activities with a consistent focus on understanding park resources in order to detect and adapt to changing conditions.

Cultural landscapes:
: Settings that humans have influenced in the natural world. They reveal fundamental ties between people and the land–ties based on our need to grow food, give form to our settlements, meet requirements for recreation, and find suitable places to bury our dead. Landscapes are intertwined patterns of things both natural and constructed: plants and fences, watercourses and buildings. They include diverse settings such as formal gardens, cattle ranches, cemeteries, and pilgrimage routes to village squares.

Cultural anthropology:
: The branch of anthropology dealing with the origins, history, and development of human culture, especially its social forms and institutions.

Documentation:
: The degree to which records pertaining to cultural resources have been completed and data have been collected relevant to eligibility of the resource to be included on the National Register of Historic Places.

Ethnographic resources:
: Basic expressions of human culture and the basis for continuity of cultural systems. A cultural system encompasses both the tangible and the intangible. It includes traditional arts and native languages, religious beliefs and subsistence activities. Some of these traditions are supported by ethnographic resources: special places in the natural world, structures with historic associations, and natural materials.

Fundamental resources and values (FRV):
: Qualities (features, systems, processes, experiences, stories, scenes, *etc.*) that are critical to achieving a park's purpose and maintaining its significance.

Foundation Document:
: A analysis that begins a park unit's planning process and sets the stage for all future planning and decision-making by identifying the park's purpose and significance, special mandates and the broad, park-wide mission goals. The *Foundation Document* identifies the park's *fundamental resources and values* and *other important resources and values*.

General management plan (GMP):
An environmental assessment or environmental impact statement and planning document that clearly defines direction for resource preservation and visitor use in a park, and serves as the basic foundation for decision making. GMPs are developed with broad public involvement.

Indicator of condition:
Quantitative standards describing the condition that a resource should be managed toward. Assessment of the current status of the resource compared with the desired condition allow for communication about the state of park resources with managers, partners, and the general public.

Management objective:
A goal statement that provides more specific management direction to attributes. Objectives are based on park policy, federal and state law, and current knowledge of natural and cultural resources.

Museum objects:
Manifestations and records of behavior and ideas that span the breadth of human experience and depth of natural history. They are evidence of technical development and scientific observation, of personal expression and curiosity about the past, of common enterprise and daily habits.

Potential activity:
A specific project or action that the NPS may implement to promote management objectives if appropriate compliance and/or contracting has been completed, funding is secured, and staff are available.

Resource stewardship strategy (RSS):
A program planning document that serves as a resource management work-plan based on analysis of laws and policies, best available science and scholarship, current conditions, and park planning and priorities.

Stewardship:
The responsible cultural and natural resource protection ethic of employing the most effective concepts, techniques, equipment, and technology to prevent, avoid, or mitigate unacceptable impacts to resources.

Structures (including historic structures):
Material assemblies that extend the limits of human capability. Without them, humans are restricted to temperate climates, walkable distances, and limited transportation of goods.

Traditionally associated peoples:
Traditionally associated peoples may include park neighbors, traditional residents, and former residents who remain attached to lands included within a unit of the national park system. These peoples regard the resources of the park as essential to its continued identity as a culturally distinct people, or the association has endured at least two generations, or the association began prior to park establishment.

Wilderness (designated):
Federal land that has been designated by the U.S. Congress as a component of the national wilderness preservation system.

H.2 Abbreviations

AQRV
: Air quality related value

ASMIS
: Archeological Sites Management System

BMP
: Best management practices

CARB
: California Air Resources Board

CLI
: Cultural Landscape Inventory

CLR
: Cultural Landscape Report

EPA
: Environmental Protection Agency

FRV
: Fundamental resource and value

FTE
: Full time equivalent (i.e., the work of one full time employee for one year)

GMP
: General Management Plan

RM Division
: Resources Management Division

I and M
: Inventory and monitoring

IRMA database
: Integration of Resource Management Applications database

ICMS
: Interior Collection Management System

LCS
: List of Classified Structures

NEPA
: National Environmental Policy Act

NHPA
: National Historic Preservation Act

NP
: National Park

NPS
: National Park Service

NRCA
: Natural Resource Condition Assessment

PMIS
: Project Management Information System

RSS
: Resource Stewardship Strategy

SOP
: Standard Operating Procedure

USFWS
: United States Fish and Wildlife Service

USGS
: United States Geologic Service

WC
: Wilderness character