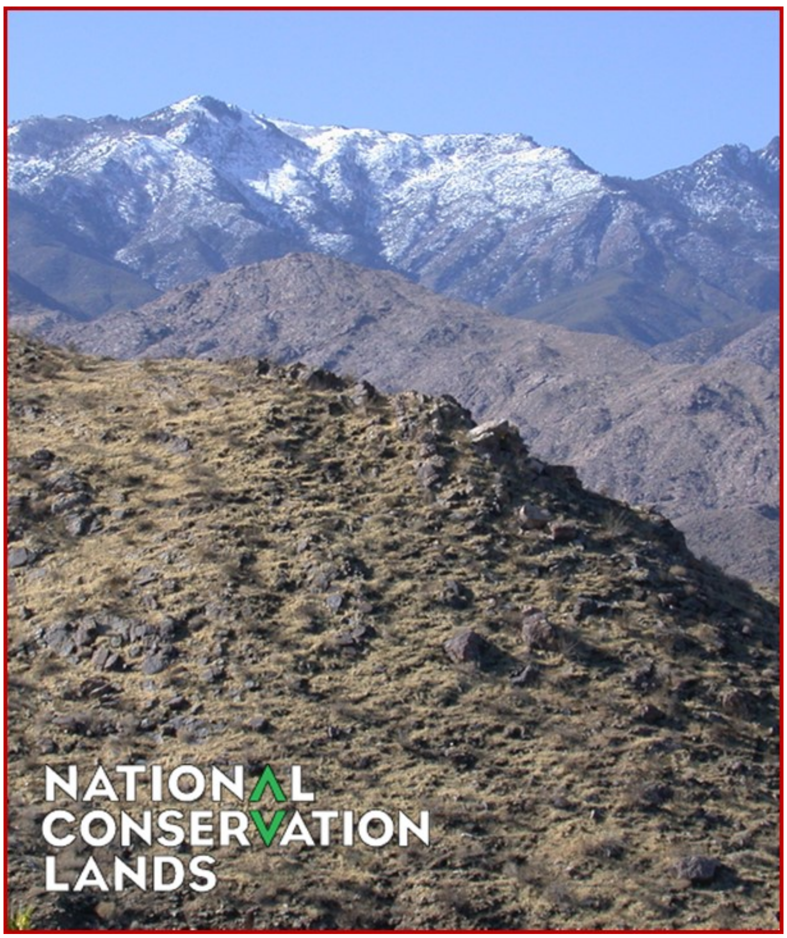
National Conservation Lands Science Plan

for the

Santa Rosa and San Jacinto Mountains National Monument

April 2016



U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Agriculture
Forest Service

U.S. Department of the Interior
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California State Office
California Desert District
Palm Springs-South Coast Field Office
Santa Rosa and San Jacinto Mountains National Monument

U.S. Department of Agriculture
Forest Service
Pacific Southwest Region (Region 5)
San Bernardino National Forest
San Jacinto Ranger District
Santa Rosa and San Jacinto Mountains National Monument

For purposes of this science plan, administrative direction established by the Bureau of Land Management as it relates to fostering science for the National Landscape Conservation System/National Conservation Lands is considered applicable to National Forest System lands within the Santa Rosa and San Jacinto Mountains National Monument to the extent it is consistent with U.S. Department of Agriculture and Forest Service policies, land use plans, and other applicable management direction.

National Conservation Lands Science Plan

for the

Santa Rosa and San Jacinto Mountains National Monument

April 2016

prepared by

University of California Riverside
Center for Conservation Biology

with funding from

Bureau of Land Management
National Conservation Lands Research Support Program

Barrel cactus and palm oases along the Art Smith Trail

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Science Plan

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Santa Rosa and San Jacinto Mountains
National Monument

APPROVED:

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EXECUTIVE SUMMARY

Background

The Santa Rosa and San Jacinto Mountains National Monument (hereafter "the Monument") is embedded in a diverse landscape with unique topographic diversity that then supports a rich assemblage of plants and animals. This biological richness lies adjacent to densely populated and growing Coachella Valley communities. Suburban neighborhoods and agriculture on the valley floor potentially threaten the Monument's biological assemblage by providing habitat for numerous invasive non-indigenous plants and feral animals. Anthropogenic landscapes also isolate the Monument from protected natural areas to the east and north. Additional threats come from beyond the immediate region. Air pollution from the Los Angeles Basin deposits nutrients in the form of nitrogen that promotes growth of non-indigenous grasses that in turn promote the spread and increased frequency of wildfires. Climate change presents an overarching global threat, one with unpredictable outcomes. Agency managers must consider, for example, whether climate change will lead to extensive species extinctions, or how species might redistribute themselves along the complex elevational gradients of the Monument.

Goals

The science mission for the Monument is to identify, prioritize, and answer questions in a research and monitoring framework that will support management of the natural and cultural resources and recreational opportunities in the Monument and across a larger landscape. A central component of the science plan is to identify the most pressing hypotheses to be tested and to prioritize the research directions that will lead to improved management practices for preserving the natural and cultural resources of the Monument and securing opportunities for recreation.

One core element for the Monument science plan consists of tracking the impacts of climate change on native species. Because many hundreds of floral and faunal species occur within the Monument, an initial step in developing the science plan was to convene a working group comprised of local scientists, naturalists, and other interested and knowledgeable individuals to develop a list of 32 species for management focus and monitoring. This approach is valuable for Monument-wide conservation planning where monitoring the identified species collectively can indicate the status of landscape habitat and ecosystem conditions for the range of species life history traits, elevational distributions, and sensitivity or resilience to potential threats. Understanding the effects of potential environmental stressors and threats to Monument resources overall begins with an understanding of how those stressors impact each of the 32 identified species.

Methods

Two independent tools were used to assess species-level science priorities for monitoring species and objectively assigning species extinction risks in a changing environment. Each tool provides information that should be considered hypotheses, not measured outcomes. One tool is a vulnerability assessment (VA) which uses available scientific literature to identify species sensitivities to environmental changes, and strives to leverage that information to predict species' vulnerability to changing habitat conditions. The VA questionnaire and responses thereto are presented in **Appendix B**. Another tool for assessing species sensitivity to changing conditions is habitat suitability modeling. This approach statistically combines environmental variables at known species locations, such as climate and terrain, to model the complex interaction of factors that constrain the distribution of a species. Habitat suitability models for selected species are presented in **Appendix C**. VAs used here are species-based and use available information about species physiology and habitat needs to identify potential mechanisms that may result in species sensitivity or resilience to shifting conditions, regardless of a particular location or region. In contrast, habitat suitability models are both species- and place-based, using species' location data to construct a spatial model that synthesizes features selected by that species in that area. One or both of these tools were applied to assess the risk that the 32 identified species face with regard specifically to climate change. Availability of sufficient current location data and/or peer-reviewed research determined how assessment tools were employed.

Results from these modeling approaches include the identification of species with the greatest risk to environmental change within the Monument, especially from climate change. Highest ranked at-risk species include single-leaf pinyon pine, red shank, Jeffrey pine, California juniper, bigberry manzanita, Peninsular bighorn sheep, coast horned lizards, and desert tortoises. Species with modeled low risk from climate change include creosote bush, desert agave, brittlebush, and desert spiny lizards.

Adaptive Management

To inform management, this science plan identifies changes in resource conditions that might warrant shifts in management practices. Data needs are at two scales: broad patterns in vegetation composition at a landscape scale, and finer-scale shifts in the distribution of species populations or impacts to cultural resources. Vegetation mapping is the highest value task for creating a critical baseline to measure future landscape-scale changes within the Monument. Its long-term value will be in the repeated mapping efforts at 5- to 8-year intervals.

Finer-scale vegetation mapping that looks at potential changes in species composition, beyond broad vegetation shifts, could become an expansion of the annual data collection surveys of the Deep Canyon Transect now conducted by University of California biologists. However, expanding that survey methodology in a sustainable manner will require more “boots on the ground.” Engaging and training volunteer citizen scientists to monitor a series of transects placed along the extensive non-motorized trail system within the Monument is proposed. This approach could serve multiple objectives such as collecting data on natural resource conditions, monitoring trail use, and fostering citizen stewardship for Monument objects and values. These data would be tied to precise GPS records and photographs, allowing the data to be sorted by accuracy, dates, times, and locations to give the data greater comparability. Citizen scientists could be organized and trained through a local nongovernmental organization. An additional high priority is to continue monitoring water sources within the Monument. These water sources are critical for many wildlife species, and may be impacted by climate change. Resurveys every 5 to 8 years are recommended.

Data Management

Concurrent with any system of collecting data that track conditions of the Monument’s resources is the need for a database system to archive those data and provide for such data to be readily retrieved and evaluated. Such a common natural diversity database should serve all users and potentially be housed in several locations (BLM, USFS, University of California). Any sensitive cultural resource locations would need to be kept separately and housed with the appropriate Native American tribes and federal agencies to ensure the protection of those resources.

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VERTEBRATES

Coast horned lizard (Phrynosoma blainvillii)
Banded rock lizard (Petrosaurus mearnsi)
Desert spiny lizard (Sceloporus magister)
Southern sagebrush lizard (Sceloporus vandenburgianus)
Mojave desert tortoise (Gopherus agassizzi)
Peninsular bighorn sheep (Ovis Canadensis nelsoni)
Gray vireo (Vireo vicinior)
Pinyon jay (Gymnorhinus cyanocephalus)
White-headed woodpecker (Picoides albolarvatus)
Ladder-backed woodpecker (Picoides scalaris)

VEGETATION

Red shank (Adenostoma sparsifolium)
Desert agave (Agave deserti)
Bigberry manzanita (*Arctostaphylos glauca*)
Acton encelia (*Encelia actoni*)
California juniper (*Juniperus californica*)
Jeffrey pine (*Pinus jeffreyi*)
Single-leaf pinyon pine (*Pinus monophylla*)
California fan palm (*Washingtonia filifera*)
Catclaw acacia (*Senegalia greggii*)
Fountain grass (*Pennisetum setaceum*)

Appendix C: Habitat Suitability Models

REPTILES

Coast horned lizard (Phrynosoma blainvillii)
Desert horned lizard (*Phyrnosoma platyrhinos*)
Banded rock lizard (Petrosaurus mearnsi)
Chuckwalla (*Sauromalus ater*)
Granite spiny lizard (*Sceloporus orcuttii*)
Western fence lizard (*Sceloporus occidentalis)*
Desert spiny lizard (Sceloporus magister)
Southern sagebrush lizard (*Sceloporus vandenburgianus*)
Desert night lizard species complex (*Xantusia* spp.)
Mojave desert tortoise (Gopherus agassizzi)

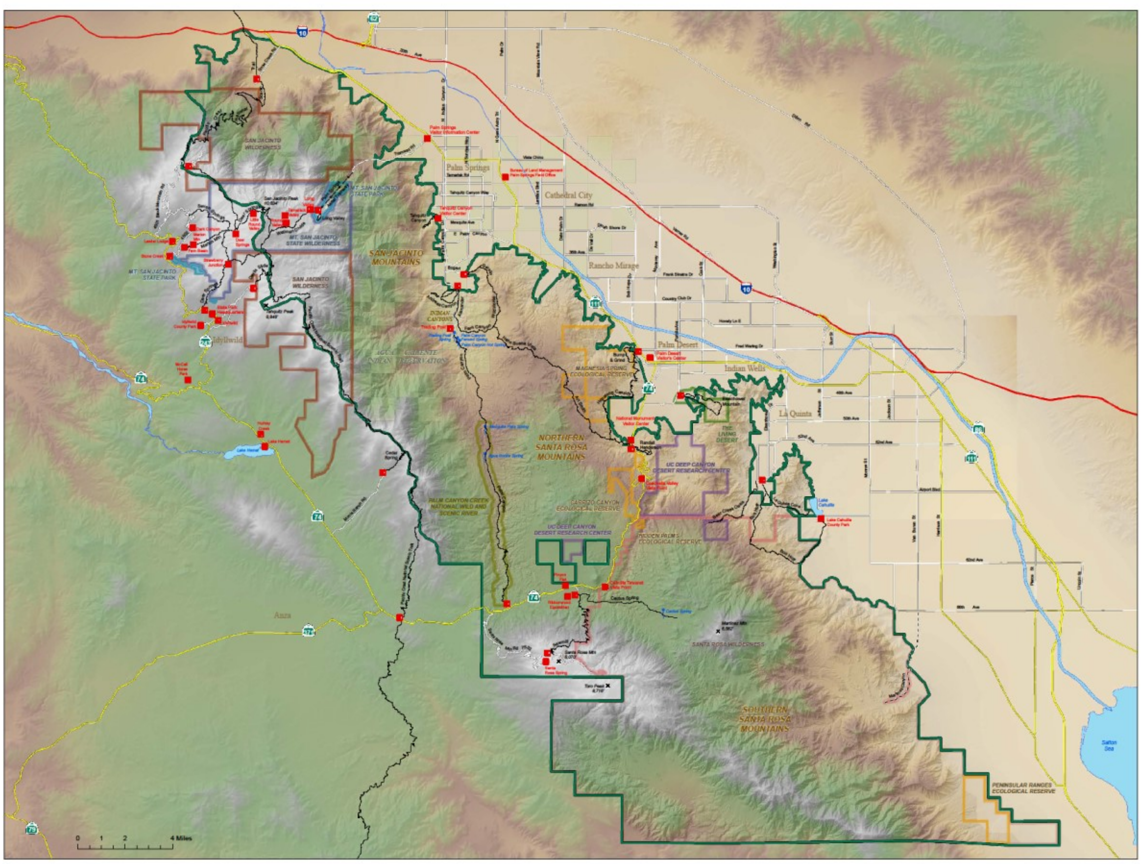
PERENNIAL/WOODY VEGETATION

Creosote bush (*Larrea tridentate*)
Jojoba (*Simmondsia chinensis)*
Muller's oak (*Quercus Cornelius-mulleri)*
California juniper (*Juniperus californica*)
California barrel cactus (*Ferocactus cylindraceus*)
Single-leaf pinyon pine (*Pinus monophylla*)
Ocotillo (*Fouquieria spendens*)
Desert agave (Agave deserti)
Red shank (Adenostoma sparsifolium)
Jeffrey pine (*Pinus jeffreyi*)
Catclaw acacia (*Senegalia greggii*)
White bursage (*Ambrosia dumosa*)
Acton encelia (*Encelia actoni*)
Brittlebush (*Encelia farinosa*)

SECTION 1: INTRODUCTION

The Santa Rosa and San Jacinto Mountains National Monument was established on October 24, 2000, by Act of Congress (Public Law 106-351) "[i]n order to preserve the nationally significant biological, cultural, recreational, geological, educational, and scientific values found in the Santa Rosa and San Jacinto Mountains and to secure now and for future generations the opportunity to experience and enjoy the magnificent vistas, wildlife, land forms, and natural and cultural resources in these mountains and to recreate therein …" This bipartisan legislation established the first Congressionally-designated national monument to be jointly managed by the Bureau of Land Management (BLM) and USDA Forest Service (USFS).

The Monument is located in Riverside County, California, approximately 100 miles east of the City of Los Angeles, and within what the U.S. Census Bureau defines as the "Los Angeles-Long Beach-Riverside combined Statistical Area" comprised of the Counties of Los Angeles, Ventura, Orange, San Bernardino, and Riverside with a combined population of more than18 million people comprising the second largest metropolitan region in the United States behind the New York metropolitan area. Including nearby San Diego and Imperial Counties, the Monument is a three-hour drive or less for 21 million people. As increasing numbers of this resident population "discover" the Monument, along with visitors from outside the region, ensuring that the objects and values found within the Monument are conserved may concomitantly be increasingly challenging.



Visit www.palmspringslife.com/santarosa for an interactive version of this map.

Establishment of the NLCS

The National Landscape Conservation System (NLCS), also referred to as the National Conservation Lands, was created in 2000, but its roots go back further. The beginnings of the NLCS may be traced to 1970 when Congress created the King Range National Conservation Area on the northern California coast and gave the BLM responsibility for its management. BLM's authority to protect natural and cultural resources was fortified by passage of the Federal Land Policy and Management Act of 1976 (FLPMA) which set the BLM on an interdisciplinary course of multiple-use and sustained-yield management "… in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource and archaeological values."

Former Secretary of the Interior Bruce Babbitt became a believer in BLM's ability to manage land with outstanding values during a trip to Southern California's Mojave Desert in 1993. Over the next several years, Secretary Babbitt continued to work with the President, Congress, and local communities to designate additional areas through legislation or presidential proclamation, with one important change. Instead of transferring these special places to another agency, the BLM was to retain stewardship over the designated areas and be given the chance to demonstrate its capability to manage, in concert with the public, the stunning landscapes of the West.

The concept of a special BLM system of lands with a dominant conservation mission began to take shape, culminating in a Secretarial Order signed in 2000. In that Order, Secretary Babbitt created the NLCS within BLM to include lands, rivers, and trails designated by Acts of Congress or Presidential Proclamations under authority of the 1906 Antiquities Act.

Bipartisan passage of the Omnibus Public Land Management Act of 2009 permanently established the NLCS "… to conserve, protect and restore nationally significant landscapes that have outstanding cultural, ecological, and scientific values for the benefit of current and future generations." The NLCS fulfills part of the multiple-use and sustained-yield principles under FLPMA. The authors of FLPMA included an astute qualification for public lands: management activities must abide by those principles, except "… where a tract of such public land has been dedicated to specific uses according to any other provisions of law it shall be managed in accordance with such law." That qualification means that in some places, conservation may be elevated over development or production if a law identifies conservation as the primary use for which the public land is designated. On the protection end of the multiple-use spectrum, NLCS areas are designated by Act of Congress or Presidential Proclamation to conserve, protect, and restore specified natural and cultural values. Valid existing rights are honored, and the NLCS-designating legislation or proclamation may specify allowable uses such as grazing, oil and gas development, and recreation, or specify uses that are not allowed. Beyond that, the BLM may consider other uses within the NLCS to the extent that they are in harmony with the conservation and protection of NLCS objects and values.

While establishment of the NLCS focused on conserving, protecting, and restoring BLM-managed public lands that possess outstanding cultural, ecological, and scientific values, the USFS manages National Forest System lands with a similar approach. In amending the Forest and Rangeland Renewable Resources Planning Act of 1974 upon passage of the National Forest Management Act of 1976, Congress found that "… the public interest is served by the Forest Service, Department of Agriculture, in cooperation with other agencies, assessing the Nation's renewable resources, and developing and preparing a national renewable resource and program, which is periodically reviewed and updated; … the new knowledge derived from coordinated public and private research programs will promote a sound technical and ecological base for effective management, use, and protection of the Nation's renewable resources; … [and] the Forest Service, by virtue of its statutory authority for management of the National Forest System, research and cooperative programs, and its role as an agency in the Department of

Agriculture, has both a responsibility and an opportunity to be a leader in assuring that the Nation maintains a natural resource conservation posture that will meet the requirements of our people in perpetuity."

SECTION 2: LEGISLATIVE AND ADMINISTRATIVE DIRECTION

As part of the NLCS or National Conservation Lands, the Monument is required to create a science plan that encourages science within the Monument, effects positive change in managing landscapes, and promotes cooperative conservation and communications about science. The administrative foundation for this direction has many layers as described below.

- ***from*** **Santa Rosa and San Jacinto Mountains National Monument Act of 2000 (Public Law-106-351, October 24, 2000)**

  Section 2(b) ESTABLISHMENT AND PURPOSES.—In order to preserve the nationally significant biological, cultural, recreational, geological, educational, and scientific values found in the Santa Rosa and San Jacinto Mountains and to secure now and for future generations the opportunity to experience and enjoy the magnificent vistas, wildlife, land forms, and natural and cultural resources in these mountains and to recreate therein, there is hereby designated the Santa Rosa and San Jacinto Mountains National Monument.

- ***from*** **BLM's National Landscape Conservation System 15-Year Strategy, 2010-2025:**

  The BLM's vision for the NLCS is to be a world leader in conservation by protecting landscapes, applying evolving knowledge, and bringing people together to share stewardship of the land.

  Theme 1: Ensuring the Conservation, Protection, and Restoration of NLCS Values

  This theme focuses on ensuring that BLM management of NLCS lands aligns with the purposes for which the lands were designated and uses science to further conservation, protection, and restoration of these landscapes, while providing opportunities for compatible public use and enjoyment.

  Goal 1C: Provide a scientific foundation for decision-making.

  1. In concert with the BLM National Science Strategy, develop and implement science strategies for NLCS areas (with emphasis on Monuments, National Conservation Areas, and areas of special scientific importance), as well as for the system as a whole, to identify research needs and incorporate physical, biological, and social science into management, decision-making, and outreach.
  2. Promote the NLCS to universities and research institutions as a major research resource consistent with the protection of NLCS values. Emphasize projects that meet identified NLCS research needs.
  3. Participate and more effectively utilize existing national networks such as the Cooperative Ecosystem Studies Unit (CESU) to support research and share scientific information that can be applied to NLCS management.
  4. Promote a better understanding of the importance and value of science in decision-making and ensure that research results are readily available to BLM managers, staff, and the public.
  5. Establish an NLCS Science Team to facilitate interagency and cross-directorate scientific collaboration, promote science, disseminate research results, and integrate science into NLCS and BLM management. Utilize the sound science and peer-reviewed scientific research

developed by the U.S. Forest Service, Fish and Wildlife Service, National Park Service, and other federal agencies, and integrate this research information into the NLCS where appropriate.

Goal 1D: Use the NLCS as an outdoor laboratory and demonstration center for new and innovative management and business processes that aid in the conservation, protection, and restoration of NLCS areas.

1. Enhance the role of science partnerships in resource management and the engagement of the public to assist with scientific work (citizen science).
2. Promote use of the NLCS as an outdoor laboratory for enhancing conservation of natural and cultural resources, consistent with the designating legislation or presidential proclamation. Promote opportunities to share these practices (for example, online forums, publications, training, workshops, conferences) for application on NLCS and other BLM lands.
3. Use the NLCS to showcase emerging technology and innovative management practices.

- ***from* BLM-California's National Conservation Lands Five-Year Strategy, 2013-2018:**

This BLM-California Five-Year Strategy provides a starting point for discussions with partners, stakeholders, and members of the public to elicit their views on needed knowledge to ensure best management of public resources on National Conservation Lands, and the role and actions that all people can take to support and contribute to the management of these special places.

Theme 1:
Ensuring the Conservation, Protection, and Restoration of National Conservation Lands Values

Enact conservation measures within the National Conservation Lands, use science to further conservation, and provide uses compatible with the National Conservation Lands resources and values.

Goal 1B:
Expand understanding of the National Conservation Lands values through assessment, inventory, and monitoring.

State Level Actions:

1. Continue baseline inventories of natural and cultural resources on National Conservation Lands.
    b. Inventory the resources, objects, and values for which national monuments, national conservation areas, and similar designations were established.
5. Develop citizen science partnerships to involve California's young people and local residents in National Conservation Lands gateway communities.

Goal 1C: Provide a scientific foundation for decision-making.

State Level Actions:

1. Establish a Science Team consisting of BLM staff, university researchers, and other scientists to develop a California science strategy that includes assessments of ecosystem vulnerabilities and research needs.

  a. Complete inventories of National Conservation Lands natural and cultural resources.
  b. Prioritize applied research for basing mitigation and adaptation actions under changing climate conditions and monitoring that determines effectiveness of management actions.
  c. Support data needs for ecosystem-process models used to forecast environmental changes.
  d. Collaborate with National Conservation Land units from the same ecoregion in adjacent states and with similarly protected areas in Baja California and Sonora, Mexico to enhance understanding of ecological and sociological processes of National Conservation Lands in each California ecoregion.
2. Make research results readily available to BLM staff, partners, and the public.
  a. Distribute significant research findings that meet the Department of the Interior's and the BLM's science standards through state and unit webpages.
3. Strengthen and expand existing partnerships with U.S. Geological Survey, Natural Resource Conservation Service, U.S. Forest Service Research Stations, Landscape Conservation Collaboratives, Cooperative Ecosystem Study Units, Joint Ventures, and others.
4. Expand opportunities for volunteers and youth corps teams to work with scientists conducting research and monitoring on National Conservation Lands.

- ***from* BLM Manual 6220—National Monuments, National Conservation Areas, and Similar Designations (July 2012):**

The purpose of this manual is to provide guidance to BLM personnel about managing BLM public lands that are components of the BLM NLCS and that have been designated by Congress or the President as National Monuments, National Conservation Areas (NCAs), and similar designations. National program policies that are generally applicable to BLM public lands apply to NLCS components to the extent that they are consistent with the designating proclamation or legislation, other applicable law, and BLM policy.

The BLM's objectives in implementing this policy are, in part, to utilize science, local knowledge, partnerships, and volunteers to effectively manage Monuments and NCAs.

<u>Section 1.6 Policy—M. Science</u>

1. Science and the scientific process will inform and guide management decisions concerning Monuments and NCAs in order to enhance the conservation, protection, and restoration of the values for which these lands were designated.
2. The BLM will promote Monuments and NCAs as sites for scientific research, including research incorporating youth and citizen scientists, so long as such research does not conflict with the conservation, protection, and restoration of these lands.
3. Each Monument and NCA must develop and regularly update a science plan in coordination with the Washington Office NLCS Science Program. Science plans must include sections on:
  a. the scientific mission of the unit;
  b. the scientific background of the unit;
  c. the identification and prioritization of management questions and science needs, including:
    1. investigations of the values for which the Monuments and NCAs were designated;
    2. assessment, inventory, and monitoring needs;
    3. science that addresses restoration needs; and
    4. landscape-level issues;

d. the unit's plan to meet science needs, often in coordination with partners;
e. the development and application of scientific protocols for the unit, including authorizing and tracking research projects;
f. the organization of scientific reports in order to facilitate communication of scientific findings throughout the BLM, with partners, and with the public; this section of the plan must include:
    1. a bibliographic list of completed reports from science on the unit; and
    2. any syntheses of relevant scientific information;
g. the plan for integrating science into management.

- ***from* BLM Manual 6340—Management of Designated Wilderness Areas (July 2012):**

The purpose of this manual is to provide guidance to BLM personnel on managing BLM lands that have been designated by Congress as part of the National Wilderness Preservation System. These lands are also managed as part of the BLM's NLCS. The BLM's objectives in implementing this policy are, in part, to manage wilderness for the public purposes of recreational, scenic, scientific, education, conservation, and historic use while preserving wilderness character.

Section 2(a) of the Wilderness Act includes "… gathering and dissemination of information regarding their use and enjoyment …" as part of the necessary administration of wilderness areas. In addition, Section 2(c) lists "scientific" as one of the supplemental values that may be found as Unique or Other Features of wilderness character. Section 4(d)(2) provides that "nothing in this Act shall prevent … gathering information about … resources, if such activity is carried on in a manner compatible with the preservation of the wilderness."

The public purpose of scientific use recognizes the value of research activities that are necessary for wilderness management or can best be accomplished in wilderness. The public purpose of scientific use includes gathering information about the effects of external stressors on wilderness. The BLM may approve an otherwise prohibited use for the purposes of scientific research only if a suitable location outside wilderness cannot be found, the prohibited use is the minimum necessary to successfully complete research, and the information to be gathered through the research is necessary for the management of the area as wilderness or is essential to protect human health and safety.

<u>Section 1.6 Policy—C. Managing Resources and Resource Uses in Wilderness—14. Research</u>

Wilderness offers important and unique opportunities for biophysical and social science research in areas that are relatively unmodified by modern people; these studies may improve wilderness stewardship and benefit both science and society. Educational benefits derived from such research can be significant. All research in wilderness will be managed to minimize impairment of wilderness character through the use of the MRDG [Minimum Requirements Decision Guide] and applicable NEPA analysis. Though its use is not required for BLM managers, *A Framework to Evaluate Proposals for Scientific Activities in Wilderness* (U.S. Forest Service General Technical Report RMRS-GTR-234WWW) may be of assistance to both managers and researchers in developing and analyzing research proposals.

- ***from* Forest Service Strategic Plan FY2015-2020:**

The USFS is the Nation's foremost federal forestry organization, providing leadership in the management, protection, use, research, and stewardship of natural and cultural resources on our country's vast forests and grasslands.

<u>Strategic Goal: Sustain Our Nation's Forests and Grasslands</u>

Outcome: Forest and grassland ecosystems are resilient and adaptive in a changing environment.

> As forests and grasslands continue to change, so does the agency's understanding of complex ecological processes and the effects of USFS management actions on natural resources. New information and knowledge are constantly acquired through scientific inquiry and through the agency's experience in managing natural resources. When this knowledge is applied, land management practices become more effective, helping to make ecosystems more resilient. Long-term conservation across landownership boundaries, through collaborative partnerships, and via knowledge transfer can enhance the natural functions of the land. It can also contribute to sustainability—the ability of forests and grasslands to produce goods and services that people want and need, both now and in the future. The agency's commitment to long-term sustainability will help maintain healthy, resilient, and productive forests and grasslands for future generations.
>
> *Strategic Objective A:* Foster resilient, adaptive ecosystems to mitigate climate change.
>
> > Many land areas are particularly susceptible to insects, disease, and wildfire. Climate change is exacerbating these challenges. Coordinated inventory, monitoring, and assessments support Forest Service's prioritization of the areas of greatest concern and need for investment. Forest Service managers use the best available science and information to understand and respond to integrated ecological, social, cultural, and economic dynamics.
> >
> > Means and Strategies for Accomplishing Strategic Objective A (in part):
> >
> > a. Use information from climate change vulnerability assessments to inform adaptive management strategies.
> > b. Develop and apply detection, prediction, prevention, mitigation, treatment, restoration, and climate change adaptation methods, technologies, and strategies for addressing disturbances such as wildfire, human uses, invasive species, insects, extreme weather events, and changing climatic conditions.
> > c. Coordinate inventory, monitoring, and assessment activities across all lands to improve adaptive management of natural resources.

<u>Strategic Goal: Apply Knowledge Globally</u>

Outcome: Natural resource decision-making is improved through the use of reliable information and applications.

> Through intellectual inquiry and knowledge transfer, the Forest Service provides land managers and others with better information, applications, and tools for improved resource management and decision-making. By advancing the agency's fundamental understanding of forests and grasslands, better informed decisions can be made that better achieve USFS goals. To increase understanding of forests and grasslands, the agency's knowledge of complex environmental processes, biological and physical conditions, resource uses, human and social dimensions, the

economic value of resources, and the interconnections among all these elements is constantly improving.

To continue the agency's advancement, there is a need to improve knowledge-sharing globally across disciplines and jurisdictional boundaries. By exchanging scientific results, natural resource assessments, management trends, innovations, and best practices across natural resource management disciplines and jurisdictional boundaries, the agency will gain the information needed to sustain and improve the Nation's forests and grasslands. The transfer of knowledge, technology, and applications will help the global natural resource community make better management decisions in a collective effort to care for all lands and deliver sustainable benefits to people.

Strategic Objective G: Advance knowledge.

The USFS conducts highly integrated research at various geographic scales to address issues of environmental and social concern. The agency's products and services provide for timely analyses of scientifically sound information and lead to better informed management decisions. Although uncertainty is inherent, resource management decisions and outcomes can be improved by using the best available information. Cutting-edge research, monitoring, and assessment activities will continue to enable the agency to reduce uncertainty by interpreting emerging results and translating them into practical knowledge. As land managers, policymakers, and other users incorporate the scientific discoveries and new knowledge into their decision frameworks, more effective operational guidelines, forest and grassland management, land management plans, natural resource policymaking, and other constructive improvements can be expected.

Means and Strategies for Accomplishing Strategic Objective G (in part):

a. Regularly review research and development needs and set priorities.
b. Continue information collection and sharing through the forest inventory and analysis program and implementation of the national inventory, monitoring, and assessment strategy.
c. Identify priority resource management requirements and core social, economic, and ecological information needs for the agency.
d. Find effective ways of communicating resource data and new knowledge and making it widely available.

The Monument's designating legislation (Santa Rosa and San Jacinto Mountains National Monument Act of 2000) and subsequent legislation directly affecting the Monument (Omnibus Public Land Management Act of 2009) are provided in **Appendix A**. Legislative and administrative direction resources are identified in **Section 10**.

Monument Management Plan

In 1976, Congress passed the Federal Land Policy and Management Act (FLPMA), a law to direct the management of BLM-administered public lands of the United States. In that law, Section 601 established the California Desert Conservation Area (CDCA) "to provide for the immediate and future protection and administration of the public lands in the California desert within the framework of a program of multiple use and sustained yield, and the maintenance of environmental quality." The CDCA boundary encompasses about 25 million acres, of which approximately 12 million acres are public lands administered by the BLM. FLPMA also directed the Secretary of the Interior to prepare and implement a comprehensive, long-range plan for the management, use, development, and protection of the public lands within the CDCA. Congress mandated that such plan “shall take into account the principles of multiple use and sustained yield in providing for resource use and development, including, but not limited to, maintenance of environmental quality, rights-of-way, and mineral development,” and that such plan shall be completed and implementation thereof initiated on or before September 30, 1980. Since then, the CDCA Plan has been amended on many occasions to reflect changed conditions and circumstances, and provide for more effective and efficient management of public lands.

The San Bernardino Forest Reserve was established on February 25, 1893; the San Jacinto Forest Reserve was subsequently established on February 22, 1897. On March 4, 1907, all Forest Reserves were renamed National Forests, but shortly thereafter on July 1, 1908, the San Jacinto National Forest became part of the Cleveland National Forest. The San Bernardino National Forest was reestablished on September 30, 1925, combining National Forest System lands in San Bernardino County from the Angeles National Forest with those in the San Jacinto Mountains from the Cleveland National Forest. The San Bernardino National Forest now encompasses the San Bernardino Mountains, San Jacinto Mountains, and San Gabriel Mountains (within San Bernardino County).

The current San Bernardino National Forest Land Management Plan (LMP 2005) describes the strategic direction at the broad program level for managing National Forest System lands and resources within the San Bernardino National Forest. This LMP was prepared under authority of the Forest and Rangeland Renewable Resources Planning Act of 1974, the National Forest Management Act of 1976, and approved planning regulations at 39 CFR 219 (2005) which allowed plan revisions started under the 1982 planning regulations to finish under the 1982 regulations. The LMP was amended in 2014 with a Supplemental Environmental Impact Statement (SEIS) addressing land use zone changes for 37 Inventoried Roadless Areas (IRAs) across the Southern California USFS province. The SEIS included the Pyramid Peak IRA, which overlaps with portions of the Monument, for which wilderness management was recommended. Management of roads and trails by the USFS within this area is consistent with prescriptions identified in the Monument Management Plan.

The Santa Rosa and San Jacinto Mountains National Monument Act of 2000 required that the Secretary of the Interior and the Secretary of Agriculture complete a management plan by October 24, 2003, for the conservation and protection of the Monument consistent with the requirements of the Act. The proposed management plan and final environmental impact statement was made available to the public in October 2003, and approved in February 2004.

For BLM-administered lands within the Monument, the Monument’s Management Plan serves as both a Resource Management Plan (RMP) and an implementation-level plan. On December 27, 2002, the BLM approved the CDCA Plan Amendment for the Coachella Valley, which addresses BLM lands within the Monument. For the purposes of the Monument Management Plan/RMP, those decisions were brought forward unchanged into the Monument plan, and were not reevaluated. The Monument Management Plan as it affects federal lands, however, amended the 1980 CDCA Plan in several ways:

<u>Recreational Resources</u>

1. Launches of hang gliders, paragliders, ultralights, and similar aircraft from, and landing on, BLM lands within and adjacent to essential Peninsular bighorn sheep habitat in the Monument are not allowed.
2. Discharge of gas and air-propelled weapons and simulated weapons (including paintball and paintball-like weapons) is not allowed within the Monument.
3. Recreational shooting, except for hunting, is not allowed on federal lands within the Monument; hunting shall continue to be permitted according to California Department of Fish and Wildlife regulations.

4. Pets within essential Peninsular bighorn sheep habitat are allowed in designated areas only, and must be on a leash; owners are required to collect and properly dispose of their pet's fecal matter.
5. Pets outside essential Peninsular bighorn sheep habitat are allowed on all federal lands with a leash; owners are required to collect and properly dispose of their pet's fecal matter. Working dogs may be permitted on federal lands with no leash requirement pursuant to an authorization for use of such lands.

Management of Visitation, Facilities, and Uses
The Monument plan establishes various guidelines for facility development, such as direction to develop a Monument architectural theme, to address development on an as-needed basis, to prioritize facility placement in already disturbed areas, and so forth.

Acquisition Strategy
The Monument plan establishes certain criteria to supplement existing acquisition policies, such as identifying strategic significance, threat levels, opportunities, and funding availability.

While the Monument Management Plan does not amend the LMP for the San Bernardino National Forest, it serves as an operational guide tiered to the LMP.

Implementation-level decisions applicable to both BLM-administered public lands and National Forest System lands and consistent with RMP- and LMP-level decisions address the following program areas:

Biological Resources. Actions related to this Monument science plan include the following:

- Inventory public lands to determine distribution of indigenous plant species and non-native species in the Monument to assess protection and eradication needs, respectively.
- Develop and implement an action plan for eradicating noxious, non-native, and invasive plant and animal species as well as an action plan for reintroducing indigenous species.
- Work with partner agencies, tribes, and volunteer groups to update existing inventories of plant and animal species occurrence and distribution and to establish updated models for habitat and baseline conditions for monitoring.
- Coordinate special status species management with the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, the Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan, researchers, and local jurisdictions to promote consistency, effectiveness, and efficiency of recovery actions and monitoring activities.
- Encourage research projects designed to inform and enhance management activities which facilitate recovery of sensitive species including federal and State listed species.

Scientific Resources. Actions related to this Monument science plan include the following:

- Maintain current coverage of resources on GIS layers to assist with research and management.
- Encourage research that promotes the understanding and increased knowledge of the Monument's resources, so long as proposed research is consistent with the objectives, land health standards, and standards and guidelines for the area of interest.
- Develop a combined BLM and USFS permit system to process and approve permits for research on BLM and National Forest System lands within the Monument.
- Post a listing of current research within and adjacent to the Monument on the Monument's website with a link to relevant research information.
- Facilitate the transfer of research information to the public through periodic science forums.

Other. Other implementation-level decisions included in the Monument Management Plan address cultural resources; recreational resources; geological resources; educational resources; visitation, facilities, and uses; water resources; and adaptive management and monitoring. Specific elements of the plan for these program areas are not herein identified as they do not specifically address science.

SECTION 3: SCIENTIFIC MISSION

NLCS/National Conservation Lands science goals and objectives

The goals of science within the NLCS are to:

- gain scientific understanding of NLCS resources and landscapes and the benefits that they provide to the American public; and
- apply scientific understanding to management, education, and outreach.

A principal objective in achieving these goals is to promote scientific study within NLCS units. NLCS units have been designated by Acts of Congress or Presidential Proclamations, in part, for their extraordinary scientific resources. Generating knowledge about natural and social resources of the NLCS is the first step toward understanding these treasures. Therefore, projects in the natural and social sciences that take advantage of these resources should be encouraged.

Science plans: The framework for how the science goals will be achieved includes the development of science plans for individual NLCS units. These science plans will serve as the basis for acquiring a scientifically defensible assessment of NLCS resources, and are to be based on four areas of emphasis:

1. scientific investigation of natural, social, and cultural resources referred to in each unit's enabling legislation;
2. studies that directly provide information to be used in BLM and USFS decisions;
3. multidisciplinary syntheses of science results for planning and implementation processes; and
4. efforts to communicate scientific findings to the public.

Science plans for NLCS units are considered "living" documents; the BLM and USFS will revise and update them frequently. Scientific needs that emerge during the course of implementing a science plan may be added to the plan on an as-needed basis to meet the unit's scientific mission.

Definition of science

"Science" is often thought of only as research. Rather, science may be in the form of data; synthesis or interpretation of data; resource inventories, assessments, and monitoring; research reports and articles in credible publications; or research results from BLM and USFS projects or research providers. Science encompasses social sciences as well as the earth (physical) sciences and biological sciences.

To distinguish "science" from other means of collecting and interpreting information, certain components are necessary:

- start with a question or hypothesis;
- collect data in an unbiased, repeatable fashion; and
- include peer review to ensure that methods, analyses, and interpretations are defensible.

Distinguishing altered systems from natural dynamics of environmental stressors, and identifying if, where, and how resource management can or should counter these stressors is the realm of science.

Scientific mission of the Monument

Understanding that the larger landscape includes conservation and management planning activities of both federal and nonfederal entities is important for considering science on federal lands. Where the science-related actions proposed or recommended within this science plan intersect those of nonfederal jurisdictions, communication and coordination with them should occur, including the Coachella Valley Conservation Commission (which administers the Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan), Agua Caliente Band of Cahuilla Indians (which administers its Tribal Habitat Conservation Plan), University of California's Boyd Deep Canyon Desert Research Station, California Department of Fish and Wildlife, and Mount San Jacinto State Park. The Monument's designating legislation, Public Law 106-351, requires the Secretary of the Interior and the Secretary of Agriculture to make a special effort to consult with representatives of the Agua Caliente Band of Cahuilla Indians during preparation and implementation of the Monument Management Plan.

Ecological systems are naturally dynamic with changes occurring at multiple spatial and temporal scales. Sources of that natural change include seasons, El Niño – La Niña cycles, weather events (hurricanes, tornados, and drought), climate, and fire. Federal resource management within the Monument embraces that flux and does not strive for ecological stasis; the biological richness of the Monument is in part a product of those forces of change over millions of years. However, in this modern (Anthropocene) era many of those "natural" drivers of change have been altered. Anthropogenic climate change has and is predicted to further increase drought frequency, duration, and intensity; reduce snowpack accumulations; reduce aquifer recharge; increase fire frequency and intensity; and increase temperatures. Because people live, work, and recreate in this landscape, anthropogenic fire ignitions have increased, aquifers have been tapped, non-native invasive species have been introduced, and vegetation has been removed or trampled. These stressors are potential science research topics for resource managers.

The scientific mission of the Monument is to identify, prioritize, and answer questions in a research and monitoring framework that will support management of the natural and cultural resources and recreational opportunities found therein and across the larger landscape. Specifically, the scientific mission of the Monument is to:

1. Allow and encourage pertinent science that can directly or indirectly:
    a. inform managers if and when conditions exist that put ecological or cultural resources at risk of being lost or transformed adversely;
    b. inform and evaluate management decisions;
    c. improve and maintain ecosystem resilience and function;
    d. improve and maintain land health;
    e. understand drivers of diversity and viability in plant and animal populations and how management actions may support that diversity and viability;
    f. preserve and understand socio-cultural and paleontological sites;
    g. improve understanding of the impacts of authorized uses; and
    h. improve development, evaluation, and implementation of best management practices.
2. Allow and encourage:
    a. long-term and short-term investigations;
    b. scientific investigations undertaken by agency staffs and by external scientists; and
    c. scientific inquiry across diverse disciplines, as appropriate.
3. Serve as a model system for surrounding areas, so that scientific findings can be exported to other federal and nonfederal lands.

SECTION 4: SCIENTIFIC BACKGROUND

Current scientific baseline of the Monument

Resource inventories, assessments, and monitoring (i.e., data collection, synthesis, and interpretation) regarding significant objects and values found within the Monument are ongoing. Some scientific work is directly linked to implementation of the Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan (CVMSHCP/NCCP) under the auspices of the Coachella Valley Conservation Commission. In the portion of the CVMSHCP/NCCP area covering essential habitat for Peninsular bighorn sheep in the Monument, monitoring currently includes non-motorized recreational use both on and off established trails as it relates to habitat use by bighorn sheep, and research to evaluate the effects of such recreational activity on bighorn sheep. The BLM and USFS are cooperators for the CVMSHCP/NCCP. The BLM's California Desert Conservation Area Plan Amendment for the Coachella Valley (2002) and the Monument Management Plan (2004) were designed to support the conservation goals and objectives of the CVMSHCP/NCCP and design and creation of a Reserve System comprised of private and public conservation lands.

The University of California's Boyd Deep Canyon Desert Research Center, consisting of 6,122 acres of University-owned land located entirely within the Monument, is the premiere research facility in the region. Research undertakings address many diverse topics, including population biology of the Coachella Valley fringe-toed lizard (*Uma inornata*) (federally threatened), long-term monitoring of rodent community composition and abundance, nematode ecology and soil carbon flux, physiology of succulents, hybridization of quail (*Callipepla* spp.), and climate change monitoring and analysis. Research of national significance involves physiological, demographic, competitive, and biogeochemical controls on the response of California's ecosystems to environmental change, and characterization of climate change impacts to California desert and montane ecosystems.

Research projects addressing the Monument's objects and values that have been funded in whole or in part by the BLM include:

- Niche modeling and implications of climate change on the distribution of bighorn sheep, *Ovis canadensis nelsoni*, within the Santa Rosa and San Jacinto Mountain Ranges (Cameron W. Barrows and Michelle L. Murphy: University of California Riverside, Center for Conservation Biology 2010).
- Assessing climate-related changes in water resources in the Santa Rosa and San Jacinto Mountains National Monument (Cameron W. Barrows [principal investigator] and Geoffrey McGinnis [lead field surveyor]: University of California Riverside, Center for Conservation Biology 2014).
- Implementation of the centennial resurvey of the San Jacinto Mountains project towards development of a landscape-scale, long-term monitoring strategy (Lori Hargrove, P. Unitt, D. Stokes, B. Hollingsworth, M. Stepek, G. Fleming, and J. Berrian: San Diego Natural History Museum 2014).
- Drifting to oblivion? Rapid genetic differentiation in an endangered lizard following habitat fragmentation and drought (Amy G. Vandergast [U.S. Geological Survey], Dustin A. Wood [U.S. Geological Survey], Andrew R. Thompson [National Oceanic and Atmospheric Administration], Mark Fisher [Boyd Deep Canyon Desert Research Center, University of California], Cameron W. Barrows [Center for Conservation Biology, University of California Riverside], and Tyler J. Grant [Department of Natural Resource Ecology and Management, University of Iowa] 2015).

Results of these research undertakings, as well as future research needs addressed in this science plan, provide a scientific basis for understanding the Monument's resources, thereby informing BLM and USFS managers (along with managers of other jurisdictions whose decisions have bearing on landscape-scale conservation outcomes) about how best to protect and preserve the objects and values underlying the purposes for which the Monument was designated.

SECTION 5: SCIENCE NEEDS FOR MANAGEMENT DECISIONS

Science to address human impacts

Needs for science originate to a great extent from our understanding of the threats to the sustainability of ecosystem processes and component species of the Monument and of the uncertainty about how these processes and native species will themselves respond in the face of rapid climate change.

The biological and cultural richness of the Monument lies adjacent to densely populated and growing Coachella Valley communities. Suburban neighborhoods and agriculture on the valley floor potentially threaten the Monument's biological assemblages by providing habitat for numerous invasive non-indigenous plants and feral animals. Anthropogenic landscapes also isolate the Monument from protected natural areas to the east and north. Residents of and visitors to the Coachella Valley can benefit the Monument, but also create a potential threat to resource values. On one hand, the Monument provides exceptional opportunities for recreation, identified in the Act of Congress as one purpose for establishing the Monument. Recreational opportunities include hiking, horseback riding, mountain biking, sightseeing, nature appreciation, and camping. Recreation enthusiasts who participate in these activities are likely advocates for the protection of the Monument's objects and values. At the same time, however, an abundance of people visiting the Monument can make the preservation of natural and cultural resources, a second purpose identified by Congress for establishing the Monument, more challenging, thereby increasing the risk that resource values will be adversely affected.

Additional human impacts come from areas outside the Coachella Valley. Air pollution from the Los Angeles Basin deposits nutrients in the form of nitrogen that promotes growth of non-indigenous grasses that, in turn, promotes the spread and increased frequency of wildfires. Climate change presents an overarching global threat, one with unpredictable outcomes. Agency managers must consider, for example, whether climate change will lead to extensive species extinctions, or how species might redistribute themselves along the complex elevational gradients of the Monument. To preserve resource values and provide recreational opportunities, a science-based framework for the Monument is necessary for focusing and prioritizing questions to resolve resource management uncertainties, and for catalyzing a collaborative approach toward managing the Monument as part of a larger landscape.

A science plan that informs management must be able to identify changes in resource conditions that might warrant shifts in current management practices. These data needs are at two scales: broad patterns in vegetation composition at a landscape scale, and finer-scale shifts in the distribution of species populations or impacts to cultural resources.

Knowledge gaps

A central component of the science plan is to identify pressing research needs and hypotheses that when answered and tested will result in improved management practices for ensuring the natural, cultural, and recreational resources of the Monument are protected. Achieving this objective requires, in part, a mechanism to collect data that upon evaluation and analysis will inform managers whether current or future conditions could lead to degradation of the Monument's resources. If such conditions exist or are predicted, are there changes in management practices that could eliminate, control, or mitigate resource degradation? Answering these questions is within the purview of science; this science plan aims to create the framework for how that science should be employed. This science plan has been prepared by building upon existing knowledge through a collaboration of biologists and mangers to capture the breadth of issues, concerns, and questions regarding the natural and cultural resources of the Monument. Hypotheses and a research agenda to test those hypotheses have emerged from this collaboration.

To identify research gaps and inform agency priorities for meeting research needs, the Santa Rosa and San Jacinto Mountains National Monument Manager engaged the Center for Conservation Biology located within the University of California at Riverside. The Center convened a working group comprised of local scientists, naturalists, and other interested and knowledgeable individuals to identify areas of scientific inquiry that would assist agency managers in fulfilling the purpose of the Monument, and prepared a draft of this science plan for BLM and USFS consideration.

Core science questions

The collaborative working group described above developed a list of issues, concerns, and questions; these are identified in **Table 1** below. Priority tasks include collecting baseline information to assess the status and trajectory of natural resources within the Monument, and the establishment of a database to house the resource data as they are collected. Priority research questions should emerge from real or perceived conflicts that arise between the purposes for which the Monument was established: preservation of natural and cultural resources and the provision of recreational opportunities. In addition, the working group identified ongoing or anticipated anthropogenic activities that are changing or otherwise affecting ecological conditions.

The working group further set the stage for identifying research questions based on baseline/ongoing inventories of species, habitats, and communities at risk. Another criterion for prioritization may involve the degree to which land management decisions might result in potential impacts to current patterns of public use. As providing for public recreation is one of the Monument's purposes, decisions that may modify public use should be based on a strong scientific foundation.

Data from which to identify changes in resource conditions constitute a critical element of a science plan. The Deep Canyon Transect is a useful approach for capturing data representing the broad range of Monument ecosystems. The Monument managers propose to transfer the Deep Canyon Transect protocols to additional sites in the Monument, thereby expanding the existing chronosequence database from Deep Canyon. The addition and specific placement of monitoring sites will be based on science questions and hypotheses developed in **Table 1**. Potential new transect locations and associated jurisdictional associations are identified in **Table 2**. Core elements for Phase 1 monitoring are data about indicator or surrogate species, water sources and flows, and recreation impacts.

Table Series 1: Research questions for the Santa Rosa and San Jacinto Mountains National Monument.

Baseline Inventory by Category	Questions	Opportunities / Approaches
Cultural Resources	What is the distribution of cultural sites, including agave roasting pits, habitation sites, and food gathering areas?	• Take advantage of post fire conditions to prioritize cultural site surveys. • Interview remaining tribal elders. • Develop a multi-agency database of cultural sites.
Vegetation and Wildlife	What is the distribution of key plant and wildlife species that can be used as a baseline to assess anthropogenic threats?	• Conduct regular surveys across the gradient of habitats within the Monument. • Develop a multi-agency database of vegetation and wildlife locations.
Vegetation	What is the distribution of vegetation alliances and associations today, and how will these "communities" shift in response to anthropogenic threats?	• Map vegetation alliances and associations every 5-10 years.
Wildlife	What is the invertebrate fauna of Hidden Lake?	• Conduct seasonal surveys using dip nets. • Send collected material to specialists for identification.
Vegetation and Wildlife	What is the trajectory of available water sources within the Monument?	• Resurvey all water sites identified in the 2013-2014 survey effort every five years.
Wildlife	Does the desert slender salamander still exist?	• Conduct repeated surveys in the last known occupied habitats to assess habitat conditions and salamander occupancy.
Cultural Resources + Vegetation and Wildlife	Who conducts inventories of vegetation and wildlife?	• Develop a citizen science support group for the Monument (or simply use the existing Friends of the Desert Mountains), provide them with adequate training, and couple them with experts/scientists so that they can collect and/or support the efforts to collect these data.

General Research Questions by Category	Questions	Opportunities / Approaches
Cultural Resources + Vegetation	Few stands of single-leaf pinyon pines appear to be reproducing within the Monument. By managing / removing/thinning stands of redshank/ribbonwood, can pinyon pine reproduction be enhanced? Can redshank management reduce fire mortality to the pinyons?	• Create plots across slope faces and available soil types partitioned by multiple controls to include thinning and complete removal treatments. • Plant pinyon seeds and/or seedlings in each plot; determine relative germination and survivability. Utilize prescribed burns to test pinyon mortality.
Vegetation and Wildlife	What are the effects of artificial water sources (guzzlers) on wildlife habitat use patterns and abundance? How does the use of artificial water sources impact surrounding vegetation?	• While a variety of options exist, such as radio-tracking, wildlife cameras at and away from guzzlers will best answer this question. • Measure vegetation species and recruitment at sites adjacent to and varying distances from guzzlers.
Wildlife	What are reasons for declines in gray vireos throughout the southern California mountains?	• There are not enough of this species within the Monument to achieve any resolution to this question by focusing just on the Monument. This will require a region-wide assessment, focusing primarily on Forest Service lands.
Wildlife	Do bighorn sheep with access to golf courses have higher/lower disease profiles and higher/lower reproductive fitness as compared to sheep without such access?	• Collect blood samples and/or feces from “golf course sheep” versus sheep with no access to golf courses or other sheep that access golf courses. • Collect reproductive success and survivorship demographic for sheep on golf courses versus non-golf course sheep.
Wildlife	What is the effect of prescribed burning on wildlife use of montane chaparral habitats by mule deer, bighorn sheep, and gray vireos? Will prescribed burns reduce the extent of wildfires and impacts to pinyon pine communities?	• No prescribed burning is currently occurring within the Monument. However, this could prove to be a valuable tool on Forest Service lands. • If a prescribed burning program is feasible, it should be initiated within a clear experimental design that would provide unambiguous before and after assessments of it effects.

Invasive Species-Related Research Questions by Category	Questions	• Opportunities / Approaches
Vegetation	What is the effect of on-going livestock grazing on the vegetation of the Monument?	• Livestock grazing is currently restricted to the Pinyon Flat and upper Palm Canyon regions, making

Invasive Species-Related Research Questions by Category	Questions	• Opportunities / Approaches
		comparisons to non-grazed areas possible. Exclosures within the grazed areas would allow documentation of more subtle differences.
Vegetation	What are the effects of invasive grasses, including fountain grass, Mediterranean split-grass, and brome grasses, on biodiversity and fire frequency within the Monument?	• Document the occurrence extent for each species. • Conduct removal experiments to assess what native species are excluded by the grasses. • Examine the role of the grasses in changing fire frequencies and impact to biodiversity. •
Vegetation and Wildlife	What are the effects of salt cedar (tamarisk) on water, vegetation, and wildlife within the Monument? What happens when the salt cedar is removed? Is rehabilitation of soil and/or vegetation required post-salt cedar removal?	• Salt cedar removal is occurring ad hoc within the Monument, but little or no data are being collected on pre- and post-removal effects. Install wildlife cameras, measure water depths and soil salinity, and quantify vegetation before and after salt cedar removal.

Recreation-Related Research Questions by Category	Questions	• Opportunities / Approaches
Cultural Resources	Does recreation on or proximal to well-used trails increase damage to cultural sites? At what distance from trails does damage to cultural sites decrease?	• Using the available baseline of cultural resources sites, partition those sites by categories of proximity to trails. Revisit sites and evaluate degrees of modern anthropogenic damage.
Wildlife	Does trail use by hikers impact reproductive success and lamb survivorship for bighorn sheep?	• Partition occupied sheep habitat by trail proximity, water availability, and escape habitat (steep terrain) availability. • Assess lamb/ewe recruitment rates and lamb survivorship in each partition to determine what factors were most responsible for any differences in recruitment and survivorship.
Wildlife	Do multiple trails in a given area restrict wildlife movement?	• Assess whether trails may create barriers to genetically-imbued wildlife movements. Trails have been sufficiently extant that if they

Recreation-Related Research Questions by Category	Questions	• Opportunities / Approaches
		represent barriers to wildlife movements, such barriers could be identified.
Cultural—Vegetation and Wildlife	What factors contribute to the public's noncompliance with trail use rules? What could be done to increase compliance? Do public hikes lead by informed volunteers, scientists, or Monument staff change the public's perception of the values that the Monument protects? Do those experiences lead to greater trail use compliance?	• Conduct surveys of trail users to assess their attitudes regarding trail use restrictions, their understanding of why such restrictions are in place, validity or perception of the data that spawned those restrictions, and what, if anything, would promote greater compliance.

Climate Change-Related Research Questions by Category	Questions	• Opportunities / Approaches
Vegetation and Wildlife	What species are at greatest risk of local extinction due to climate change? Are there species that might require assisted migration in order to survive climate change within the Monument?	• Create vulnerability assessments and habitat suitability models for selected species to provide hypotheses related to extinction risks. • Identify climate refugia and remove to the extent possible other stressors such as invasive species from these high-value conservation sites. Design survey frameworks that collect data on these selected species that will validate or refute the hypotheses generated from the models, and will provide data to strengthen the next iteration of models.
Vegetation	What is the distribution of vegetation alliances and associations today and how will these "communities" shift in response to climate change?	• Map vegetation alliances and associations every 5-10 years.
Vegetation and Wildlife	How will invasive species, as well as generalist species, respond to climate change?	• Create vulnerability assessments and habitat suitability models for selected species to provide hypotheses related to extinction risks. •

Climate Change-Related Research Questions by Category	Questions	• Opportunities / Approaches
Wildlife	How will wetland species such as California tree frogs and red-spotted toads respond to climate change?	Design survey frameworks that collect data on these selected species.
Vegetation and Wildlife	What management actions if employed will decrease the risk of local extinction from climate change?	• Design and implement an experimental framework to test the efficacy of management options ranging from assisted migration and reducing stressors within climate refugia (e.g., invasive species) to managing vegetation to ease upslope emigration by such species as bighorn sheep

SECTION 6: MEETING SCIENCE NEEDS

Baseline mapping and monitoring for detecting change in vegetation

Vegetation mapping is currently occurring across much of the wildlands of southern California. Through the efforts of the Coachella Valley Conservation Commission and its partners in implementing the Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan, vegetation within the portions of the Monument considered bighorn sheep habitat are being mapped in 2015-2016 at the alliance level. This level, however, is arguably too coarse for detecting finer-scale changes that might occur within a 5- to 8-year span, the recommended interval between vegetation mapping efforts. Mapping at the more-detailed vegetation association level would allow for the detection of fine-scale changes during this shorter time increment. For instance, identifying changes from a creosote bush-brittlebush association to a creosote bush-white bursage association could occur using the finer-scale approach, whereas both associations are considered to be creosote bush under the alliance level, hence no change would be apparent. Higher-elevation lands above current bighorn sheep habitat also need mapping to complete the “vegetation picture” of the Monument. Vegetation mapping is the highest-value task for creating a critical baseline to measure future landscape-scale changes within the Monument. Its long-term value will be in the repeated mapping efforts at 5- to 8-year intervals.

Finer-scale vegetation mapping along the Deep Canyon Transect conducted by University of California biologists that looks at potential changes in species composition, beyond broad vegetation shifts, offers a model for vegetation data collection surveys. Those 30+ survey routes, each roughly one kilometer in length and generally centered in the Deep Canyon watershed, occur along an elevational gradient from the floor of the Coachella Valley (below 1,000 feet within the Boyd Deep Canyon Desert Research Center) to Santa Rosa Mountain and Toro Peak (both over 8,000 feet in elevation). Data collected from these surveys have contributed to publication of numerous research papers identifying recent shifts in species distributions due to climate change inside the Monument (e.g., Kelly and Goulden 2008; Hargrove and Rotenberry 2011).

Collecting data in a similar manner to that for the Deep Canyon Transect but along a broader swath of lands within the Monument would allow spatial and temporal comparisons that other methodologies may not support. A list of potential new transect locations is shown in **Table 2**. However, expanding that survey methodology in a sustainable manner will require more “boots on the ground” than are available from the Deep Canyon biologists. Therefore, a monitoring program to be implemented with citizen scientists such as those from a nongovernmental organization working alongside agency, academic, and professional biologists is proposed. This approach could serve multiple objectives such as collecting data on natural resource conditions, monitoring trail use, and fostering citizen stewardship for the Monument’s objects and values.

Data collection by citizen scientists will include bighorn sheep occurrence and abundance (sightings of rams, ewes, and lambs; observations of scat), other faunal occurrence and abundance (species sightings; observations of scat), and plant phenology and demographics (observations of species’ reproduction and mortality), all with a principal focus on the species identified in **Table 1**. These data will be tied to precise GPS records and photographs, allowing the data to be sorted by accuracy, dates, times, and locations to give the data greater comparability. Citizen scientists will also monitor water sources within the Monument, continuing the effort initiated by the BLM in 2014. These water sources are critical for many wildlife species, and may be being impacted by climate change. Resurveys every 5 to 8 years will determine whether and to what extent changes are occurring. These citizen scientists could be organized and trained through a local nongovernmental organization.

Table 2. Potential new transect locations and associated jurisdictions.[1]

Potential Transect Location	Associated Jurisdiction
North Lykken Trail	Palm Springs
South Lykken Trail	Palm Springs
Shannon-Garstin-Henderson Trails	Palm Springs
Dunn Road	Cathedral City
Hopalong Cassidy Trail	Palm Desert
Art Smith Trail	Palm Desert
Carrizo Canyon Trail	Palm Desert
Randall Henderson Trail	Palm Desert
Eisenhower Peak Trail	Indian Wells
Bear Creek Oasis Trail	La Quinta
Boo Hoff Trail	La Quinta
La Quinta Cove to Lake Cahuilla Trail	La Quinta
Long Valley and Round Valley Loop Trails	Palm Springs Aerial Tramway
Palm Canyon, Pacific Crest, Cedar Spring, and Live Oak Canyon Trails; Dunn Road	Pinyon Flats and Garner Valley
Deer Springs Trail	Idyllwild

[1]Transect locations associated with Pinyon Flats, Pinyon Crest, and Santa Rosa Mountain Road are already included in the Deep Canyon Transect.

Biodiversity and species monitoring

The Monument is home to the University of California's Boyd Deep Canyon Desert Research Center where students and scientists from around the world have come to conduct research on a myriad of topics. Recent research has empirically identified responses to levels of climate change already occurring (Kelly and Goulden 2008; Hargrove and Rotenberry 2011; Barrows and Fisher 2014). The Research Center has an ongoing monitoring system in place (the "Deep Canyon Transect," Mayhew 1981) that is a trove of information documenting changes within the Monument since the 1970s. Going back even further, Joseph Grinnell surveyed the region now encompassed by the Monument in the early 1900s, archiving his discoveries with specimens and detailed notebooks. Those survey sites have recently been resurveyed by a team from the San Diego Natural History Museum. Other recent research efforts include a first-ever comprehensive survey and habitat analysis for western yellow bats, *Lasiurus xanthinus,* focusing on sites within the Monument and throughout the Colorado Desert (Ortiz and Barrows 2014).

Far from being a “black hole” of unknown species distributions, the biodiversity of the Monument is well documented. This knowledge has established a solid foundation for the development of this science plan. Building upon it through a collaboration of biologists and managers from BLM, USFS, California State Parks, Boyd Deep Canyon Desert Research Center, California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, San Diego Natural History Museum, Bighorn Institute, regional colleges and universities, tribes, and others will capture the breadth of current issues, concerns, and questions regarding the natural and cultural resources of the Monument.

Preparing this science plan entailed identifying a finite list of species found within the Monument, for understanding the effects of potential stressors on these species is a starting point for assessing impacts to the Monument’s natural resources, both on site-specific and landscape scales. Since many hundreds of species occur within the Monument, a working group comprised of local scientists, naturalists, and anyone with an interest and knowledge of the Monument’s flora and fauna was convened to narrow the species list to a manageable number that collectively captures many of the life history traits, elevational distributions, and sensitivity or resilience to existing and potential threats facing the Monument (see **Table 1**). Federal or State listed endangered or threatened species were included due to the legal nexus for management attention even when there is limited habitat within the Monument such as occurs for the desert tortoise. Tracking changes in the distribution of these species will efficiently provide critical insights for managers as to what, how, and why changes are occurring and what management actions might be employed to sustain biodiversity within the Monument.

For the purposes of this science plan, certain flora and fauna have been selected as representative species on which to focus scientific attention at this time (see **Table 3**). As new research questions arise and scientific findings become available, the science plan would be updated with additional species for study in response.

Table 3. Representative species selected for scientific attention.

Elevation Range	Species	Cultural Importance[1]	Geographic Range
low elevation	*Larrea tridentata* (Creosote bush)	x	broad
low elevation	*Fouquieria splendens* (Ocotillo)	x	broad
low elevation	*Simmondsia chinensis* (Jojoba)	x	broad
low elevation	*Encelia farinosa* (Brittlebush)	x	broad
low elevation	*Ambrosia dumosa* (White bursage)		broad
low elevation	*Sauromalus ater* (Chuckwalla)	x	broad
low elevation	*Phrynosoma platyrhinos* (Desert horned lizard)		broad

Elevation Range	Species	Cultural Importance[1]	Geographic Range
low elevation	*Picoides scalaris* (Ladder-backed woodpecker)		broad
low elevation	*Picoides albolarvatus* (White-headed woodpecker)		broad
low-mid elevation	*Washingtonia filifera* (California fan palm, Desert fan palm)	x	moderate
low-mid elevation	*Ferocactus cylindraceus* (California barrel cactus)	x	broad
low-mid elevation	*Agave deserti* (Desert agave)	x	moderate
low-mid elevation	*Senegalia greggii* (Catclaw acacia)	x	broad
low-mid elevation	*Pennisetum setaceum* (Fountain grass)		non-native
low-mid elevation	*Sceloporus magister* (Desert spiny lizard)		broad
low-mid elevation	*Sceloporus orcuttii* (Granite spiny lizard)		moderate
low-mid elevation	*Ovis canadensis nelsoni* (Peninsular bighorn sheep)	x	moderate
low-mid elevation	*Petrosaurus mearnsi* (Banded rock lizard)		moderate
low-mid elevation	*Gopherus agassizii* (Mojave desert tortoise)	x	moderate
low-mid elevation	*Xantusia* spp. (Desert night lizard species complex)		narrow
mid elevation	*Adenostoma sparsifolium* (Red shank)	x	moderate
mid elevation	*Pinus monophylla* (Single-leaf pinyon pine)	x	broad
mid elevation	*Juniperus californica* (California juniper)	x	moderate
mid elevation	*Quercus cornelius-mulleri* (Muller's oak)	x	moderate

Elevation Range	Species	Cultural Importance[1]	Geographic Range
mid elevation	*Arctostaphylos glauca* (Bigberry manzanita)	x	moderate
mid elevation	*Encelia actoni* (Acton encelia)		moderate
mid elevation	*Sceloporus occidentalis* (Western fence lizard)		broad
mid elevation	*Phrynosoma blainvillii* (Coast horned lizard)		broad
mid elevation	*Gymnorhinus cyanocephalus* (Pinyon jay)		broad
mid elevation	*Vireo vicinior* (Gray vireo)		broad
high elevation	*Pinus jeffreyi* (Jeffrey pine)	x	broad
high elevation	*Sceloporus vandenburgianus* (Southern sagebrush lizard)		narrow

[1] "x" denotes species of cultural importance to Native Americans. Their uses of selected perennial plants of the Monument are identified in **Table 5**.

<u>Assessing species sensitivities to changing conditions</u>

To aid managers and landowners in assessing species-level science priorities, tools are available for objectively assigning extinction risks to a changing environment (Barrows et al. 2014). Each tool provides information that should be considered as hypotheses, not measured outcomes. One tool is a vulnerability assessment (VA) which uses available scientific literature to identify species sensitivities to environmental changes, and strives to leverage that information to predict species vulnerability to changing habitat conditions (Coe et al. 2012). Another tool in assessing species sensitivity to changing conditions is habitat suitability modeling (Browning et al. 2005; Rotenberry et al. 2002, 2006; Barrows and Murphy-Mariscal 2012). This approach statistically combines environmental variables at known species locations, such as climate and terrain, to model the complex interaction of factors that constrain the distribution of a species. VAs and habitat suitability models for selected species identified in **Table 3** are provided in **Appendix B** and **Appendix C**, respectively.

Whereas VAs are species-based using available information regarding a species' physiology and habitat needs to identify potential mechanisms that may result in its sensitivity or resilience to shifting conditions, regardless of a particular location or region, habitat suitability models are both species and place-based using species' location data to construct a spatial model that synthesizes features selected by that species in that area. Both approaches have merits and can be employed independently to provide a complementary assessment of how selected species are likely to respond to shifting environmental parameters. Determining where refugia would likely be situated across the diverse and complex landscape is an objective to which niche models are well suited. Determining the mechanisms that might cause a species to persist or be extirpated and that can help direct adaptive management responses is a task better suited to VAs.

Indicator species for monitoring prioritized by vulnerability assessment scores from **Appendix B** are identified in **Table 4**. These analyses will focus research and monitoring on those species and habitats deemed to be most at risk. Results of analyses will also create a spatial framework through habitat suitability models that will identify locations where additional monitoring stations in the Monument are needed for addressing science questions.

Table 4. Indicator species for monitoring prioritized by vulnerability assessment scores ranked from greatest to least risk.[1]

Species[2]	**Score**
Pinus monophylla (Single-leaf pinyon pine)	15
Ovis canadensis nelsoni (Peninsular bighorn sheep)	12
Gopherus agassizii (Mojave desert tortoise)	11
Adenostoma sparsifolium (Red shank)	11
Phrynosoma blainvillii (Coast horned lizard)	10
Arctostaphylos glauca (Bigberry manzanita)	10
Juniperus californica (California juniper)	10
Pinus jeffreyi (Jeffrey pine)	10
Petrosaurus mearnsi (Banded rock lizard)	8
Gymnorhinus cyanocephalus (Pinyon jay)	7
Vireo vicinior (Gray vireo)	7
Sceloporus vandenburgianus (Southern sagebrush lizard)	7
Washingtonia filifera (California fan palm, Desert fan palm)	7
Picoides albolarvatus (White-headed woodpecker)	6
Agave deserti (Desert agave)	6
Senegalia greggii (Catclaw acacia)	6
Encelia actoni (Acton encelia)	6
Picoides scalaris (Ladder-backed woodpecker)	5
Sceloperus magister (Desert spiny lizard)	4

Species[2]	Score
Pennisetum setaceum (Fountain grass)	-7

[1] Colors denote species groups: green = plants, yellow = mammals, pink = reptiles, blue = birds.
[2] Not all species identified in **Table 3** are addressed by vulnerability assessments or habitat suitability models due to limited availability of records.

Native American uses of selected perennial plants

Native American uses of selected perennial plants of the Monument are described in **Table 5**. This information may be an important component of management decision-making.

Table 5. Native American uses of selected perennial plants of the Monument.[1]

Scientific Name	Common Name	Cahuilla Name	Use
Adenostoma fasciculatum	Chamise	u'ut	adhesives, arrows, bows, construction, fencing, firewood, medicine, torches
Adenostoma sparsifolium	Red shank	henily	arrows, clothing, construction, fencing, firewood, food, medicine, throwing sticks
Agave deserti	Desert agave	amul	baskets, ceremonial, cordage, dye, fiber, bowstrings, clothing, cradles, mats, nets, clings, snares, firewood, food, needles
Arctostaphylos glauca	Bigberry manzanita	kelel	beverage, construction, firewood, food, medicine, smoking, tools
Artemisia tridentata	Great Basin sagebrush	wikwat	air purifier, construction, food, medicine
Chilopsis linearis	Desert willow	qaankish	bows, clothing, construction, fiber nets, food, tools, shelter
Cylindropuntia biglovii	Teddy bear cholla		food
Cylindropuntia ganderi	Buckhorn cholla	mutal	food, medicine
Eriogonum fasciculatum	Buckwheat		food, medicine
Ferocactus cylindraceus	California barrel cactus		beverage, food, tools
Fourquieria splendens	Ocotillo	utush	beverage, construction, firewood, food
Juniperus californica	California juniper	yuyily	food, medicine

Scientific Name	Common Name	Cahuilla Name	Use
Larrea tridentata	Creosote bush	atukul	firewood, medicine
Opuntia basilaris	Beavertail cactus	manal	food
Pinus monophylla	Single-leaf pinyon pine	tevat	adhesive, food, air purifier, baskets, beverage, construction, cosmetics, firewood, medicine
Pinus quadrifolia	Four-leaf pinyon pine	tevatwik	adhesive, food, air purifier, baskets, beverage, construction, cosmetics, firewood, medicine
Prosopis glandulosa	Mesquite	ily	adhesive, food, air purifier, baskets, beverage, construction, cosmetics, firewood, medicine
Quercus cornelius-mulleri	Desert scrub oak		food
Senegalia greggii	Catclaw acacia	sichingily	construction, firewood, food
Simmondsia chinensis	Jojoba, goatnut	qawnaxal	beverage, food
Washingtonia filifera	California fan palm	maul	baskets, beverage, bows, ceremonial, firewood, food, sandals, tools
Yucca schidigera	Mohave yucca	hunuvat	construction, decoration, fiber, food, soap

[1]Summarized from information provided by Patricia Garcia, Agua Caliente Band of Cahuilla Indians.

<u>Establishment of a database</u>

To support collection and sharing data that tracks conditions of the Monument's resources, the Monument needs a database system to archive those data and provide for ready data retrieval for analysis. Several respondents to the survey for key research questions identified this need as overarching. Such a natural diversity database should serve all users and potentially be housed in several locations (BLM, USFS, Deep Canyon Desert Research Station, UC Riverside, Coachella Valley Conservation Commission). All sensitive cultural resource locations would need to be kept separately and housed with the appropriate Native American tribes and federal agencies.

SECTION 7: GUIDELINES FOR SCIENCE PROTOCOLS

To ensure that scientific inquiries are effective and efficient, and do not conflict with legal requirements and agency direction, scientific research will follow certain critical protocols and guidelines:

- Scientific inquiries will comply with applicable laws, regulations, policies, and land use plans, including those of nonfederal jurisdictions on whose land research undertakings may also occur.
- Scientific inquiries will not detrimentally impact the long-term health or sustainability of the Monument's objects and values or other resources of the Monument.
- Scientists initiating research projects within the Monument are aware of existing data and should incorporate these data and the methods to acquire these data into projects as applicable for continuity and consistency through time.
- Research within the Santa Rosa Wilderness, San Jacinto Wilderness, and Mount San Jacinto State Wilderness must comply with applicable laws, regulations, and policies governing the protection of wilderness values, including the Wilderness Act of 1964, California Desert Protection Act of 1994, and Omnibus Public Land Management Act of 2009, and any regulations promulgated thereto, as well as applicable BLM, USFS, and State of California policies addressing activities in wilderness areas.
- When applicable, internal and external science inquiries will be encouraged to adopt the BLM's Assessment, Inventory, and Monitoring (AIM) strategy or similar proven approach. The AIM strategy addresses renewable resource data collection specific to vegetation, associated habitats for wildlife, and the supporting ecological components of soil and water. This strategy provides a path forward to systematically identify landscape-scale values and risks. It introduces an approach that will:
    a. prioritize where traditional land health standard assessments are conducted;
    b. prioritize areas for quantitative data collection following a statistically valid sampling design to meet multiple objectives;
    c. utilize remote sensing technologies to detect change across a broad landscape; and
    d. identify priority data for standardization and national geospatial dataset development.

  This integrated approach provides a means for national-level reporting on resource condition, defensible data for informed land management decisions, and a mechanism for agency managers to prioritize field work.
- External scientific projects must apply for and receive a research permit from the BLM and/or USFS, as applicable, when work is conducted on federal lands within the Monument.

<u>Authorization and tracking</u>

Research proposals will be submitted to the Monument Manager and include the following:

- contact information of the principal investigator;
- background information on the question being studied (including any existing research);
- site locations, including geospatial information;
- rationale for research;
- methodology for conducting the research;
- timeline for field work;
- deliverables; and
- outline of a public outreach effort, if requested by the BLM or USFS.

The Monument Manager will review the proposal for completeness and consult with the appropriate BLM and USFS resource specialists to determine the scientific validity and integrity of the proposal, applicability to landscape management of the federal lands inside the Monument boundary, and potential impacts to resource values and uses. In coordination with the BLM Palm Springs-South Coast Field Manager and the District Ranger for the San Jacinto Ranger District of the San Bernardino National Forest, the Monument Manager will determine whether the proposal:

- is consistent with this science plan;
- meets the Monument's scientific mission; and
- is consistent with applicable laws, regulations, policies, and land use plans.

If the proposal is accepted:

- The Field Manager and/or the District Ranger, in consultation with the Monument Manager, will determine what, if any, National Environmental Policy Act (NEPA) analysis is required to carry out the inquiry, and if needed, will determine an appropriate avenue for preparing such analysis.
- Resource specialists will review the proposal to determine what mitigation measures or stipulations may need to be included in the authorization.
- The California Desert District designated scientist or the San Bernardino National Forest resource manager will prepare a research permit for the applicant, in consultation with the applicable program leader at the Field, District, or State Office in the case of the BLM or with the applicable program leader at the Ranger District, Forest Supervisor's Office, or the Regional Office and with the approval of the Field Manager and/or the District Ranger.
- The research permit will be sent to the applicant for review and signature, and returned to the Field Manager and/or the District Ranger for final signature.
- Reporting for all scientific investigations will require:
    a. progress reports to be filed with the Monument Manager on a schedule mutually determined appropriate for the project; and
    b. a final report that includes an executive summary; research background and results, relevancy of the results to management of the Monument, public outreach efforts (as applicable), and copies of published papers resulting from the scientific inquiry.

If permit stipulations are not adhered to, the Field Manager and/or District Ranger may elect to cancel the research permit, in writing. If the proposal is not accepted, the Field Manager and/or the District Ranger will provide written notification and justification to the applicant as soon as possible regarding the decision.

SECTION 8: INTEGRATING SCIENCE INTO MANAGEMENT

The BLM and USFS will encourage direct communications among scientists, the Monument Manager, the Field Manager/District Ranger, and the California Desert District Manager/San Bernardino National Forest Supervisor. The Monument Manager will be responsible for ensuring that scientific findings are communicated to upper-level managers. Managers will then be able to use these findings according to their professional judgment to make applicable management decisions affecting the Monument.

Integrating scientific findings into management decisions should not end scientific inquiry into a specific topic. In fact, using science in the decision-making process should provide an opportunity to identify future science needs for adaptive management for specific agency and Monument objectives.

SECTION 9: ORGANIZATION AND COMMUNICATION OF COMPLETED SCIENCE

Internal communications

- All scientific data, except for locations of cultural resource sites, will be stored, organized, and shared on a share drive or share point site, accessible to all staff in the BLM California Desert District and San Bernardino National Forest. The Monument Manager will organize periodic presentations of scientific results to District and Forest staff.
- The Monument Manager will comply in a timely manner with all requests for completed scientific investigations (reports, publications, etc.) from BLM and USFS management levels.
- The Monument Manager, in coordination with Public Affairs Officers of the BLM California Desert District and the San Bernardino National Forest, will strive to make information on science projects within the Monument accessible to the general public in conformity with federal data sharing laws and regulations.

Collaboration and partners

Collaboration and open communication with existing and potential science partners is critical to the success of implementing the science plan. This collaboration will ensure that research on the Monument is pertinent to the protection and preservation of its objects and values, and provides a scientific basis for management decisions that affect the Monument by the BLM, USFS, and other jurisdictions. Collaborative partnerships include:

Federal agencies:

- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Bureau of Reclamation
- National Park Service: Joshua Tree National Park

State agencies:

- California Department of Fish and Wildlife
- California Department of Parks and Recreation: Mount San Jacinto State Park, Anza-Borrego Desert State Park
- Coachella Valley Mountains Conservancy

Colleges and universities:

- University of California at Riverside
- University of California at Irvine
- California State University at San Bernardino
- College of the Desert

Native American tribes:

- Agua Caliente Band of Cahuilla Indians
- Augustine Band of Cahuilla Indians
- Cabazon Band of Mission Indians
- Cahuilla Band of Mission Indians
- Los Coyotes Band of Cahuilla Mission Indians
- Morongo Band of Cahuilla Mission Indians
- Ramona Band of Mission Indians

- San Manuel Band of Mission Indians
- Santa Rosa Band of Mission Indians
- Soboba Band of Luiseno Indians
- Torres-Martinez Desert Cahuilla Indians

Local government:
- Coachella Valley Conservation Commission
- Coachella Valley Association of Governments
- Coachella Valley Water District
- Desert Water Agency
- Imperial Irrigation District
- Riverside Board of Supervisors
- Riverside County Flood Control and Water Conservation District
- Riverside County Regional Park and Open Space District
- Cities of Cathedral City, Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm Springs, and Rancho Mirage

Non-Profit Organizations:
- Friends of the Desert Mountains
- Friends of Big Morongo Canyon Preserve
- Center for Natural Lands Management
- Southern California Mountains Foundation
- Desert Trails Coalition
- Sierra Club
- San Diego Natural History Museum

The BLM and USFS may develop other partnerships to address the Monument's science needs. Outreach to existing and potential partners and collaborators will occur through posting this science plan on the Monument's website, mailing the plan to known and likely potential partners, using social media to promote the plan, and other media designed for public outreach.

SECTION 10: LITERATURE CITED

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Legislative and administrative direction resources

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Forest Service

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Service First

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Appendix A
Unit Legislation

114 STAT. 1362 PUBLIC LAW 106-351—OCT. 24, 2000

Public Law 106-351
106th Congress

Oct. 24, 2000
[H.R. 3676]

Santa Rosa and San Jacinto Mountains National Monument Act of 2000.
16 USC 431 note.

An Act

To establish the Santa Rosa and San Jacinto Mountains National Monument in the State of California.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Santa Rosa and San Jacinto Mountains National Monument Act of 2000".

(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

Sec. 1. Short title; table of contents.
Sec. 2. Establishment of Santa Rosa and San Jacinto Mountains National Monument, California.
Sec. 3. Management of Federal lands in the National Monument.
Sec. 4. Development of management plan.
Sec. 5. Existing and historical uses of Federal lands included in Monument.
Sec. 6. Acquisition of land.
Sec. 7. Local advisory committee.
Sec. 8. Authorization of appropriations.

SEC. 2. ESTABLISHMENT OF SANTA ROSA AND SAN JACINTO MOUNTAINS NATIONAL MONUMENT, CALIFORNIA.

(a) FINDINGS.—Congress finds the following:

(1) The Santa Rosa and San Jacinto Mountains in southern California contain nationally significant biological, cultural, recreational, geological, educational, and scientific values.

(2) The magnificent vistas, wildlife, land forms, and natural and cultural resources of these mountains occupy a unique and challenging position given their proximity to highly urbanized areas of the Coachella Valley.

(3) These mountains, which rise abruptly from the desert floor to an elevation of 10,802 feet, provide a picturesque backdrop for Coachella Valley communities and support an abundance of recreational opportunities that are an important regional economic resource.

(4) These mountains have special cultural value to the Agua Caliente Band of Cahuilla Indians, containing significant cultural sites, including village sites, trails, petroglyphs, and other evidence of their habitation.

(5) The designation of a Santa Rosa and San Jacinto Mountains National Monument by this Act is not intended to impact upon existing or future growth in the Coachella Valley.

(6) Because the areas immediately surrounding the new National Monument are densely populated and urbanized, it is anticipated that certain activities or uses on private lands outside of the National Monument may have some impact upon

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the National Monument, and Congress does not intend, directly or indirectly, that additional regulations be imposed on such uses or activities as long as they are consistent with other applicable law.

(7) The Bureau of Land Management and the Forest Service should work cooperatively in the management of the National Monument.

(b) ESTABLISHMENT AND PURPOSES.—In order to preserve the nationally significant biological, cultural, recreational, geological, educational, and scientific values found in the Santa Rosa and San Jacinto Mountains and to secure now and for future generations the opportunity to experience and enjoy the magnificent vistas, wildlife, land forms, and natural and cultural resources in these mountains and to recreate therein, there is hereby designated the Santa Rosa and San Jacinto Mountains National Monument (in this Act referred to as the "National Monument").

(c) BOUNDARIES.—The National Monument shall consist of Federal lands and Federal interests in lands located within the boundaries depicted on a series of 24 maps entitled "Boundary Map, Santa Rosa and San Jacinto National Monument", 23 of which are dated May 6, 2000, and depict separate townships and one of which is dated June 22, 2000, and depicts the overall boundaries.

(d) LEGAL DESCRIPTIONS; CORRECTION OF ERRORS.—

(1) PREPARATION AND SUBMISSION.—As soon as practicable after the date of the enactment of this Act, the Secretary of the Interior shall use the map referred to in subsection (c) to prepare legal descriptions of the boundaries of the National Monument. The Secretary shall submit the resulting legal descriptions to the Committee on Resources and the Committee on Agriculture of the House of Representatives and to the Committee on Energy and Natural Resources and the Committee on Agriculture, Nutrition, and Forestry of the Senate.

(2) LEGAL EFFECT.—The map and legal descriptions of the National Monument shall have the same force and effect as if included in this Act, except that the Secretary of

the Interior may correct clerical and typographical errors in the map and legal descriptions. The map shall be on file and available for public inspection in appropriate offices of the Bureau of Land Management and the Forest Service.

SEC. 3. MANAGEMENT OF FEDERAL LANDS IN THE NATIONAL MONUMENT.

(a) BASIS OF MANAGEMENT.—The Secretary of the Interior and the Secretary of Agriculture shall manage the National Monument to protect the resources of the National Monument, and shall allow only those uses of the National Monument that further the purposes for the establishment of the National Monument, in accordance with—

(1) this Act;

(2) the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.);

(3) the Forest and Rangeland Renewable Resources Planning Act of 1974 (16 U.S.C. 1600 et seq.) and section 14 of the National Forest Management Act of 1976 (16 U.S.C. 472a); and

(4) other applicable provisions of law.

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(b) ADMINISTRATION OF SUBSEQUENTLY ACQUIRED LANDS.—Lands or interests in lands within the boundaries of the National Monument that are acquired by the Bureau of Land Management after the date of the enactment of this Act shall be managed by the Secretary of the Interior. Lands or interests in lands within the boundaries of the National Monument that are acquired by the Forest Service after the date of the enactment of this Act shall be managed by the Secretary of Agriculture.

(c) PROTECTION OF RESERVATION, STATE, AND PRIVATE LANDS AND INTERESTS.—Nothing in the establishment of the National Monument shall affect any property rights of any Indian reservation, any individually held trust lands, any other Indian allotments, any lands or interests in lands held by the State of California, any political subdivision of the State of California, any special district, or the Mount San Jacinto Winter Park Authority, or any private property rights within the boundaries of the National Monument. Establishment of the National Monument shall not grant the Secretary of the Interior or the Secretary of Agriculture any new authority on or over non-Federal lands not already provided by law. The authority of the Secretary of the Interior and the Secretary of Agriculture under this Act extends only to Federal lands and Federal interests in lands included in the National Monument.

(d) EXISTING RIGHTS.—The management of the National Monument shall be subject to valid existing rights.

(e) NO BUFFER ZONES AROUND NATIONAL MONUMENT.—Because the National Monument is established in a highly urbanized area—

(1) the establishment of the National Monument shall not lead to the creation of express or implied protective perimeters or buffer zones around the National Monument;

(2) an activity on, or use of, private lands up to the boundaries of the National Monument shall not be precluded because of the monument designation, if the activity or use is consistent with other applicable law; and

(3) an activity on, or use of, private lands, if the activity or use is consistent with other applicable law, shall not be directly or indirectly subject to additional regulation because of the designation of the National Monument.

(f) AIR AND WATER QUALITY.—Nothing in this Act shall be construed to change standards governing air or water quality outside of the designated area of the National Monument.

SEC. 4. DEVELOPMENT OF MANAGEMENT PLAN.

(a) DEVELOPMENT REQUIRED.—

(1) IN GENERAL.—Not later than 3 years after the date of the enactment of this Act, the Secretary of the Interior and the Secretary of Agriculture shall complete a management plan for the conservation and protection of the National Monument consistent with the requirements of section 3(a). The Secretaries shall submit the management plan to Congress before it is made public.

(2) MANAGEMENT PENDING COMPLETION.—Pending completion of the management plan for the National Monument, the Secretaries shall manage Federal lands and interests in lands within the National Monument substantially consistent with current uses occurring on such lands and under the general guidelines and authorities of the existing management plans

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of the Forest Service and the Bureau of Land Management for such lands, in a manner consistent with other applicable Federal law.

(3) RELATION TO OTHER AUTHORITIES.—Nothing in this subsection shall preclude the Secretaries, during the preparation of the management plan, from implementing subsections (b) and (i) of section 5. Nothing in this section shall be construed to diminish or alter existing authorities applicable to Federal lands included in the National Monument.

(b) CONSULTATION AND COOPERATION.—

(1) IN GENERAL.—The Secretaries shall prepare and implement the management plan required by subsection (a) in accordance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and in consultation with the local advisory committee established pursuant to section 7 and, to the extent practicable, interested owners of private property and holders of valid existing rights located within the boundaries of the National Monument. Such consultation shall be on a periodic and regular basis.

(2) AGUA CALIENTE BAND OF CAHUILLA INDIANS.—The Secretaries shall make a special effort to consult with representatives of the Agua Caliente Band of Cahuilla Indians regarding the management plan during the preparation and implementation of the plan.

(3) WINTER PARK AUTHORITY.—The management plan shall consider the mission of the Mount San Jacinto Winter Park Authority to make accessible to current and future generations the natural and recreational treasures of the Mount San Jacinto State Park and the National Monument. Establishment and management of the National Monument shall not be construed to interfere with the mission or powers of the Mount San Jacinto Winter

Park Authority, as provided for in the Mount San Jacinto Winter Park Authority Act of the State of California.

(c) COOPERATIVE AGREEMENTS.—

(1) GENERAL AUTHORITY.—Consistent with the management plan and existing authorities, the Secretaries may enter into cooperative agreements and shared management arrangements, which may include special use permits with any person, including the Agua Caliente Band of Cahuilla Indians, for the purposes of management, interpretation, and research and education regarding the resources of the National Monument.

(2) USE OF CERTAIN LANDS BY UNIVERSITY OF CALIFORNIA.—In the case of any agreement with the University of California in existence as of the date of the enactment of this Act relating to the University's use of certain Federal land within the National Monument, the Secretaries shall, consistent with the management plan and existing authorities, either revise the agreement or enter into a new agreement as may be necessary to ensure its consistency with this Act.

SEC. 5. EXISTING AND HISTORICAL USES OF FEDERAL LANDS INCLUDED IN MONUMENT.

(a) RECREATIONAL ACTIVITIES GENERALLY.—The management plan required by section 4(a) shall include provisions to continue to authorize the recreational use of the National Monument, including such recreational uses as hiking, camping, mountain

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biking, sightseeing, and horseback riding, as long as such recreational use is consistent with this Act and other applicable law.

(b) MOTORIZED VEHICLES.—Except where or when needed for administrative purposes or to respond to an emergency, use of motorized vehicles in the National Monument shall be permitted only on roads and trails designated for use of motorized vehicles as part of the management plan.

(c) HUNTING, TRAPPING, AND FISHING.—

(1) IN GENERAL.—Except as provided in paragraph (2), the Secretary of the Interior and the Secretary of Agriculture shall permit hunting, trapping, and fishing within the National Monument in accordance with applicable laws (including regulations) of the United States and the State of California.

(2) REGULATIONS.—The Secretaries, after consultation with the California Department of Fish and Game, may issue regulations designating zones where, and establishing periods when, no hunting, trapping, or fishing will be permitted in the National Monument for reasons of public safety, administration, or public use and enjoyment.

(d) ACCESS TO STATE AND PRIVATE LANDS.—The Secretaries shall provide adequate access to nonfederally owned land or interests in land within the boundaries of the National Monument, which will provide the owner of the land or the holder of the interest the reasonable use and enjoyment of the land or interest, as the case may be.

(e) UTILITIES.—Nothing in this Act shall have the effect of terminating any valid existing right-of-way within the Monument. The management plan prepared for the National Monument shall address the need for and, as necessary, establish plans for the installation, construction, and maintenance of public utility rights-of-way within the National Monument outside of designated wilderness areas.

(f) MAINTENANCE OF ROADS, TRAILS, AND STRUCTURES.—In the development of the management plan required by section 4(a), the Secretaries shall address the maintenance of roadways, jeep trails, and paths located in the National Monument.

(g) GRAZING.—The Secretaries shall issue and administer any grazing leases or permits in the National Monument in accordance with the same laws (including regulations) and Executive orders followed by the Secretaries in issuing and administering grazing leases and permits on other land under the jurisdiction of the Secretaries. Nothing in this Act shall affect the grazing permit of the Wellman family (permittee number 12-55-3) on lands included in the National Monument.

(h) OVERFLIGHTS.—

(1) GENERAL RULE.—Nothing in this Act or the management plan prepared for the National Monument shall be construed to restrict or preclude overflights, including low-level overflights, over lands in the National Monument, including military, commercial, and general aviation overflights that can be seen or heard within the National Monument. Nothing in this Act or the management plan shall be construed to restrict or preclude the designation or creation of new units of special use airspace or the establishment of military flight training routes over the National Monument.

(2) COMMERCIAL AIR TOUR OPERATION.—Any commercial air tour operation over the National Monument is prohibited

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unless such operation was conducted prior to February 16, 2000. For purposes of this paragraph, “commercial air tour operation” means any flight conducted for compensation or hire in a powered aircraft where a purposes of the flight is sightseeing.

(i) WITHDRAWALS.—

(1) IN GENERAL.—Subject to valid existing rights as provided in section 3(d), the Federal lands and interests in lands included within the National Monument are hereby withdrawn from—

(A) all forms of entry, appropriation, or disposal under the public land laws;

(B) location, entry, and patent under the public land mining laws; and

(C) operation of the mineral leasing and geothermal leasing laws and the mineral material laws.

(2) EXCHANGE.—Paragraph (1)(A) does not apply in the case of—

(A) an exchange that the Secretary determines would further the protective purposes of the National Monument; or

(B) the exchange provided in section 6(e).

SEC. 6. ACQUISITION OF LAND.

(a) ACQUISITION AUTHORIZED; METHODS.—State, local government, tribal, and privately held land or interests in land within the boundaries of the National Monument may be acquired for management as part of the National Monument only by—

(1) donation;

(2) exchange with a willing party; or

(3) purchase from a willing seller.

(b) USE OF EASEMENTS.—To the extent practicable, and if preferred by a willing landowner, the Secretary of the Interior and the Secretary of Agriculture shall use permanent conservation easements to acquire interests in land in the National Monument in lieu of acquiring land in fee simple and thereby removing land from non-Federal ownership.

(c) VALUATION OF PRIVATE PROPERTY.—The United States shall offer the fair market value for any interests or partial interests in land acquired under this section.

(d) INCORPORATION OF ACQUIRED LANDS AND INTERESTS.—Any land or interest in lands within the boundaries of the National Monument that is acquired by the United States after the date of the enactment of this Act shall be added to and administered as part of the National Monument as provided in section 3(b).

(e) LAND EXCHANGE AUTHORIZATION.—In order to support the cooperative management agreement in effect with the Agua Caliente Band of Cahuilla Indians as of the date of the enactment of this Act, the Secretary of the Interior may, without further authorization by law, exchange lands which the Bureau of Land Management has acquired using amounts provided under the Land and Water Conservation Fund Act of 1965 (16 U.S.C. 4601-4 et seq.), with the Agua Caliente Band of Cahuilla Indians. Any such land exchange may include the exchange of federally owned property within or outside of the boundaries of the National Monument for property owned by the Agua Caliente Band of Cahuilla Indians within or outside of the boundaries of the National Monument.

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The exchanged lands acquired by the Secretary within the boundaries of the National Monument shall be managed for the purposes described in section 2(b).

SEC. 7. LOCAL ADVISORY COMMITTEE.

(a) ESTABLISHMENT.—The Secretary of the Interior and the Secretary of Agriculture shall jointly establish an advisory committee for the National Monument, whose purpose shall be to advise the Secretaries with respect to the preparation and implementation of the management plan required by section 4.

(b) REPRESENTATION.—To the extent practicable, the advisory committee shall include the following members:

(1) A representative with expertise in natural science and research selected from a regional college or university.

(2) A representative of the California Department of Fish and Game or the California Department of Parks and Recreation.

(3) A representative of the County of Riverside, California.

(4) A representative of each of the following cities: Palm Springs, Cathedral City, Rancho Mirage, La Quinta, Palm Desert, and Indian Wells.

(5) A representative of the Agua Caliente Band of Cahuilla Indians.
(6) A representative of the Coachella Valley Mountains Conservancy.
(7) A representative of a local conservation organization.
(8) A representative of a local developer or builder organization.
(9) A representative of the Winter Park Authority.
(10) A representative of the Pinyon Community Council.

(c) TERMS.—

(1) STAGGERED TERMS.—Members of the advisory committee shall be appointed for terms of 3 years, except that, of the members first appointed, one-third of the members shall be appointed for a term of 1 year and one-third of the members shall be appointed for a term of 2 years.

(2) REAPPOINTMENT.—A member may be reappointed to serve on the advisory committee upon the expiration of the member's current term.

(3) VACANCY.—A vacancy on the advisory committee shall be filled in the same manner as the original appointment.

(d) QUORUM.—A quorum shall be eight members of the advisory committee. The operations of the advisory committee shall not be impaired by the fact that a member has not yet been appointed as long as a quorum has been attained.

(e) CHAIRPERSON AND PROCEDURES.—The advisory committee shall elect a chairperson and establish such rules and procedures as it deems necessary or desirable.

(f) SERVICE WITHOUT COMPENSATION.—Members of the advisory committee shall serve without pay.

(g) TERMINATION.—The advisory committee shall cease to exist on the date upon which the management plan is officially adopted by the Secretaries, or later at the discretion of the Secretaries.

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SEC. 8. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated such sums as are necessary to carry out this Act.

Approved October 24, 2000.

LEGISLATIVE HISTORY—H.R. 3676:
HOUSE REPORTS: No. 106-750 (Comm. on Resources).
CONGRESSIONAL RECORD, Vol. 146 (2000):
July 25, considered and passed House.
Oct. 5, considered and passed Senate.

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123 STAT. 991 PUBLIC LAW 111-11—MAR. 30, 2009

Public Law 111-11
111th Congress

Mar. 30, 2009
[H.R. 146]

Omnibus
Public Land
Management Act
of 2009.
16 USC 1 note.

An Act

To designate certain land as components of the National Wilderness Preservation System, to authorize certain programs and activities in the Department of the Interior and the Department of Agriculture, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Omnibus Public Land Management Act of 2009".
(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

Sec. 1. Short title; table of contents.

THE FOLLOWING CONSISTS OF EXCERPTS RELEVANT TO THE SANTA ROSA AND SAN JACINTO MOUNTAINS NATIONAL MONUMENT ONLY.

TITLE I—ADDITIONS TO THE NATIONAL WILDERNESS PRESERVATION SYSTEM

Subtitle L—Riverside County Wilderness, California

Sec. 1851. Wilderness designation.
Sec. 1852. Wild and scenic river designations, Riverside County, California.
Sec. 1853. Additions and technical corrections to Santa Rosa and San Jacinto Mountains National Monument.

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TITLE II—BUREAU OF LAND MANAGEMENT AUTHORIZATIONS

Subtitle A—National Landscape Conservation System

Sec. 2001. Definitions.
Sec. 2002. Establishment of the National Landscape Conservation System.
Sec. 2003. Authorization of appropriations.

123 STAT. 1061 PUBLIC LAW 111-11—MAR. 30, 2009

TITLE I—ADDITIONS TO THE NATIONAL WILDERNESS PRESERVATION SYSTEM

Subtitle L—Riverside County Wilderness, California

SEC. 1851. WILDERNESS DESIGNATION.

(a) DEFINITION OF SECRETARY.—In this section, the term "Secretary" means—

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(1) with respect to land under the jurisdiction of the Secretary of Agriculture, the Secretary of Agriculture; and

(2) with respect to land under the jurisdiction of the Secretary of the Interior, the Secretary of the Interior.

(b) DESIGNATION OF WILDERNESS, CLEVELAND AND SAN BERNARDINO NATIONAL FORESTS, JOSHUA TREE NATIONAL PARK, AND BUREAU OF LAND MANAGEMENT LAND IN RIVERSIDE COUNTY, CALIFORNIA—

(1) DESIGNATIONS.—

(D) SANTA ROSA WILDERNESS ADDITIONS.—In accordance with the Wilderness Act (16 U.S.C. 1131 et seq.), certain land in the San Bernardino National Forest, California, and certain land administered by the Bureau of Land Management in Riverside County, California, comprising approximately 2,149 acres, as generally depicted on the map titled "Santa Rosa-San Jacinto National Monument Expansion and Santa Rosa Wilderness Addition", and dated March 12, 2008, is designated as wilderness and is incorporated in, and shall be deemed to be a part of, the Santa Rosa Wilderness designated by section 101(a)(28) of Public Law 98-425 (98 Stat. 1623; 16 U.S.C. 1132 note) and expanded by paragraph (59) of section 102 of Public Law 103-433 (108 Stat. 4472; 16 U.S.C. 1132 note).

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(2) MAPS AND DESCRIPTIONS.—

(A) IN GENERAL.—As soon as practicable after the date of the enactment of this Act, the Secretary shall file a map and legal description of each wilderness area and wilderness addition designated by this section with the Committee on Natural Resources of the House of Representatives and the Committee on Energy and Natural Resources of the Senate.

(B) FORCE OF LAW.—A map and legal description files under subparagraph (A) shall have the same force and effect as if included in this section, except that the Secretary may correct errors in the map and legal description.

(C) PUBLIC AVAILABILITY.—Each map and legal description filed under subparagraph (A) shall be filed and made available for public inspection in the appropriate office of the Secretary.

(3) UTILITY FACILITIES.—Nothing in this section prohibits the construction, operation, or maintenance, using standard industry practices, of existing utility facilities located outside of the wilderness areas and wilderness additions designated by this section.

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(d) ADMINISTRATION OF WILDERNESS.—

(1) MANAGEMENT.—Subject to valid existing rights, the land designated as wilderness or as a wilderness addition by this section shall be administered by the Secretary in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.), except that—

(A) any reference in that Act to the effective date of that Act shall be deemed to be a reference to—

(i) the date of the enactment of this Act; or

(ii) in the case of the wilderness addition designated by subsection (c) [which is not included in this excerpt of Public Law 111-11 as subsection (c) addresses Joshua Tree National Park Potential Wilderness], the date on which the notice required by such subsection is published in the Federal Register; and

(B) any reference in that Act to the Secretary of Agriculture shall be deemed to be a reference to the Secretary that has jurisdiction over the land.

(2) INCORPORATION OF ACQUIRED LAND AND INTERESTS.—Any land within the boundaries of a wilderness area or wilderness addition designated by this section that is acquired by the United States shall—

(A) become part of the wilderness area in which the land is located; and

(B) be managed in accordance with this section, the Wilderness Act (16 U.S.C. 1131 et seq.), and any other applicable law.

(3) WITHDRAWAL.—Subject to valid rights in existence on the date of enactment of this Act, the land designated as wilderness by this section is withdrawn from all forms of—

(A) entry, appropriation, or disposal under the public land laws;

(B) location, entry, and patent under the mining laws; and

(C) disposition under all laws pertaining to mineral and geothermal leasing or mineral materials.

(4) FIRE MANAGEMENT AND RELATED ACTIVITIES.—

(A) IN GENERAL.—The Secretary may take such measures in a wilderness area or wilderness addition designated

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by this section as are necessary for the control of fire, insects, and diseases in accordance with section 4(d)(1) of the Wilderness Act (16 U.S.C. 1133(d)(1)) and House Report 98-40 of the 98th Congress.

(B) FUNDING PRIORITIES.—Nothing in this section limits funding for fire and fuels management in the wilderness areas and wilderness additions designated by this section.

(C) REVISION AND DEVELOPMENT OF LOCAL FIRE MANAGEMENT PLANS.—As soon as practicable after the date of enactment of this Act, the Secretary shall amend the local fire management plans that apply to the land designated as a wilderness area or wilderness addition by this section.

(D) ADMINISTRATION.—Consistent with subparagraph (A) and other applicable Federal law, to ensure a timely and efficient response to fire emergencies in the wilderness areas and wilderness additions designated by this section, the Secretary shall—

(i) not later than 1 year after the date of enactment of this Act, establish agency approval procedures (including appropriate delegations of authority to the Forest Supervisor, District Manager, or other agency officials) for responding to fire emergencies; and

(ii) enter into agreements with appropriate State or local firefighting agencies.

(5) GRAZING.—Grazing of livestock in a wilderness area or wilderness addition designated by this section shall be administered in accordance with the provisions of section 4(d)(4) of the Wilderness Act (16 U.S.C. 1133(d)(4)) and the guidelines set forth in House Report 96-617 to accompany H.R. 5487 of the 96th Congress.

(6) NATIVE AMERICAN USES AND INTERESTS.—

(A) ACCESS AND USE.—To the extent practicable, the Secretary shall ensure access to the Cahuilla Mountain Wilderness [which is not located within the Santa Rosa and San Jacinto Mountains National Monument] by members of an Indian tribe for traditional cultural purposes. In implementing this paragraph, the Secretary, upon the request of an Indian tribe, may temporarily close to the general public use of one or more specific portions of the wilderness area in order to protect the privacy of traditional cultural activities in such areas by members of the Indian tribe. Any such closure shall be made to affect the smallest practicable area for the minimum period necessary for such purposes. Such access shall be consistent with the purpose and intent of Public Law 95-341 (42 U.S.C. 1996), commonly referred to as the American Indian Religious Freedom Act, and the Wilderness Act (16 U.S.C. 1131 et seq.).

(B) INDIAN TRIBE DEFINED.—In this paragraph, the term “Indian tribe” means any Indian tribe, band, nation, or other organized group or community of Indians which is recognized as eligible by the Secretary of the Interior for the special programs and services provided by the United States to Indians because of their status as Indians.

(7) MILITARY ACTIVITIES.—Nothing in this section precludes—

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(A) low-level overflights of military aircraft over the wilderness areas or wilderness additions designated by this section;

(B) the designation of new units of special airspace over the wilderness areas or wilderness additions designated by this section; or

(C) the use or establishment of military flight training routes over wilderness areas or wilderness additions designated by this section.

SEC. 1852. WILD AND SCENIC RIVER DESIGNATIONS, RIVERSIDE COUNTY, CALIFORNIA.

Section 3(a) of the Wild and Scenic Rivers Act (16 U.S.C. 1274(a)) (as amended by section 1805) is amended by adding at the end the following new paragraphs:

"(202) PALM CANYON CREEK, CALIFORNIA.—The 8.1-mile segment of Palm Canyon Creek in the State of California from the southern boundary of section 6, township 7 south, range 5 east, San Bernardino meridian, to the San Bernardino National Forest boundary in section 1, township 6 south, range 4 east, San

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Bernardino meridian, to be administered by the Secretary of Agriculture as a wild river, and the Secretary shall enter into a cooperative management agreement with the Agua Caliente Band of Cahuilla Indians to protect and enhance river values.

SEC. 1853. ADDITIONS AND TECHNICAL CORRECTIONS TO SANTA ROSA AND SAN JACINTO MOUNTAINS NATIONAL MONUMENT.

(a) BOUNDARY ADJUSTMENT, SANTA ROSA AND SAN JACINTO MOUNTAINS NATIONAL MONUMENT.—Section 2 of the Santa Rosa and San Jacinto Mountains National Monument Act of 2000 (Public Law 106-351; 114 U.S.C. 1362; 16 U.S.C. 431 note) is amended by adding at the end the following new subsection:

"(e) EXPANSION OF BOUNDARIES.—In addition to the land described in subsection (c), the boundaries of the National Monument shall include the following lands identified as additions to the National Monument on the map titled 'Santa Rosa-San Jacinto National Monument and Santa Rosa Wilderness Addition', and dated March 12, 2008:

"(1) The 'Santa Rosa Peak Area Monument Expansion'.

"(2) The 'Snow Creek Area Monument Expansion'.

"(3) The 'Tahquitz Peak Area Monument Expansion'.

"(4) The 'Southeast Area Monument Expansion', which is designated as wilderness in section 512(d), and is thus incorporated into, and shall be deemed part of, the Santa Rosa Wilderness.".

(b) TECHNICAL AMENDMENTS TO THE SANTA ROSA AND SAN JACINTO MOUNTAINS NATIONAL MONUMENT ACT OF 2000.—Section 7(d) of the Santa Rosa and San Jacinto Mountains National Monument Act of 2000 (Public Law 106-351; 114 U.S.C. 1362; 16 U.S.C. 431 note) is amended by striking "eight" and inserting "a majority of the appointed".

123 STAT. 1094 PUBLIC LAW 111-11—MAR. 30, 2009

TITLE II—BUREAU OF LAND MANAGEMENT AUTHORIZATIONS

Subtitle A—National Landscape Conservation System

SEC. 2001. DEFINITIONS.

In this subtitle:

(1) SECRETARY.—The term "Secretary" means the Secretary of the Interior.

(2) SYSTEM.—The term "system" means the National Landscape Conservation System established by section 2002(a).

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SEC. 2002. ESTABLISHMENT OF THE NATIONAL LANDSCAPE CONSERVATION SYSTEM.

(a) ESTABLISHMENT.—In order to conserve, protect, and restore nationally significant landscapes that have outstanding cultural, ecological, and scientific values for the benefit of current and future generations, there is established in the Bureau of Land Management the National Landscape Conservation System.

(b) COMPONENTS.—The system shall include each of the following areas administered by the Bureau of Land Management:

(1) Each area that is designated as—

(A) a national monument;

(B) a national conservation area;

(C) a wilderness study area;

(D) a national scenic trail or national historic trail designated as a component of the National Trails System;

(E) a component of the National Wild and Scenic Rivers System; or

(F) a component of the National Wilderness Preservation System.

(2) Any area designated by Congress to be administered for conservation purposes, including—

(A) the Steens Mountain Cooperative Management and Protection Area;

(B) the Headwaters Forest Reserve;

(C) the Yaquina Head Outstanding Natural Area;

(D) public land within the California Desert Conservation Area administered by the Bureau of Land Management for conservation purposes; and

(E) any additional area designated by Congress for inclusion in the system.

(c) MANAGEMENT.—The Secretary shall manage the system—

(1) in accordance with any applicable law (including regulations) relating to any component of the system included under subsection (b); and

(2) in a manner that protects the values for which the components of the system were designated.

(d) EFFECT.—

(1) IN GENERAL.—Nothing in this subtitle enhances, diminishes, or modifies any law or proclamation (including regulations relating to the law or proclamation) under which the components of the system described in subsection (b) were established or are managed, including—

(A) the Alaska National Interest Lands Conservation Act (16 U.S.C. 3101 et seq.);

(B) the Wilderness Act (16 U.S.C. 1131 et seq.);

(C) the Wild and Scenic Rivers Act (16 U.S.C. 1271 et seq.);

(D) the National Trails System Act (16 U.S.C. 1241 et seq.); and

(E) the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.).

(2) FISH AND WILDLIFE.—Nothing in this subtitle shall be construed as affecting the authority, jurisdiction, or responsibility of the several States to manage, control, or regulate fish and resident wildlife under State law or regulations, including the regulation of hunting, fishing, trapping and recreational shooting on public lands managed by the Bureau of

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Land Management. Nothing in this subtitle shall be construed as limiting access for hunting, fishing, trapping, or recreational shooting.

SEC. 2003. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated such sums as are necessary to carry out this subtitle.

Approved March 30, 2009.

LEGISLATIVE HISTORY—H.R. 146:
CONGRESSIONAL RECORD, Vol. 155 (2009):
Mar. 2, 3, considered and passed House.
Mar. 17-19, considered and passed Senate, amended.
Mar. 25, House concurred in Senate amendments.
DAILY COMPILATION OF PRESIDENTIAL DOCUMENTS (2009):
Mar. 30, Presidential remarks and statement.

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Appendix B
Vulnerability Assessments

Addressing the risk that species face from climate change is especially challenging as the more-pronounced impacts will likely be felt in the decades to come. Vulnerability assessments (VAs) are one of two methods presented in this science plan (along with habitat suitability models presented in **Appendix C**) to provide hypotheses for how selected species within the Monument will respond to a warmer and drier climate. Climate VAs for each species consist of 21 multiple-choice questions grouped into four categories based on the relative vulnerability of that species related to its habitat, physiology and phenology, biotic interactions, and conservation (see questionnaire below). These questions were adapted from previously conducted VAs (Coe et al. 2012; Davidson et al. 2012), modified to fit the unique desert conditions within the Monument and for applicability to the broad natural history characteristics of the 20 species for which VAs were prepared. The questionnaire includes “0” for none known, unknown, or no consensus. If with additional research those questions were answered with an indication of high vulnerability, the VA scores would need to be adjusted. These potential adjustments are shown below in **Tables B1** (plants) and **B2** (vertebrates).

Vulnerability assessment questionnaire

HABITAT

H1. Area and distribution: Is the area or location of the species’ habitat expected to change?

a. Area used expected to decline or shift from current location (SCORE = 1)
b. Area used expected to stay the same and in the approximately same location (SCORE = 0)
c. Area used expected to increase and include the current location (SCORE = -1)

H2. Habitat specialization: Does the species require specific habitat types / habitat components?

a. Specific habitat type/components required. Species is a habitat specialist (SCORE = 1)
b. Projected changes are unlikely to affect habitat quality (SCORE = 0)
c. Species will utilize a wide range of habitats. Species is a habitat generalist (SCORE = -1)

H3. Habitat quality: Are features of the habitat associated with increased survival expected to change?

a. Projected changes are likely to negatively affect habitat quality (SCORE = 1)
b. Projected changes are unlikely to affect habitat quality (SCORE = 0)
c. Projected changes are likely to positively affect habitat quality (SCORE = -1)

H4. Ability to colonize new areas: What is the potential for this species to disperse?

a. Low ability to disperse (SCORE = 1)
b. Moderate dispersal abilities (SCORE = 0)
c. Very mobile, dispersal to track shifting habitats is expected (SCORE = -1)

PHYSIOLOGY AND PHENOLOGY

PS1. Physiological threshold: Are limiting physiological conditions expected to change?

a. Projected changes in temperature and moisture are likely to exceed upper physiological thresholds (species occupies a narrow climate regime) (SCORE = 1)
b. Projected changes in temperature or moisture will primarily remain within physiological tolerances, OR species is inactive during limiting periods. (species occupies a moderate climate regime) (SCORE = 0)
c. Projected changes in temperature or moisture will decrease current incidents where lower physiological tolerances are exceeded (species' distribution extending into cold or wet extreme conditions. Species occupying broad climatic regimes) (SCORE = -1)

PS2. Exposure to weather-related disturbance: Are disturbance events (e.g. severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?

a. Projected changes in disturbance events will likely decrease survival or reproduction (SCORE = 1)

b. Survival and reproduction are not strongly affected by disturbance events OR disturbance events not expected to change (SCORE = 0)

c. Projected changes in disturbance events will likely increase survival or reproduction (SCORE = -1)

PS3. Limitations to daily activity period: Are projected climate shifts expected to influence activity patterns or phenology?

a. Duration of daily active periods likely to be reduced or growing periods likely shortened (SCORE = 1)
b. Duration of daily active periods or growing and flowering periods unchanged or not limited by climate, such as species with broad climatic distributions (SCORE = 0)
c. Duration of daily active periods, or flowering and growing periods likely to increase (SCORE = -1)

PS4. Survival during resource fluctuation: Does this species have flexible strategies to cope with limiting resources over multiple years?

a. Species has no flexible strategies to cope with variable resources across multiple years (SCORE = 1)
b. Unknown, or no consensus (SCORE = 0)
c. Species has flexible strategies to cope with variable resources across multiple years such as seed bank storage, shut down activities, or reliance on stored resources (SCORE = -1)

PS5. Mismatch potential – cues: Does this species use temperature or moisture cues to initiate germination, hibernation, migration, or reproductive activity?

a. Species uses temperature or moisture cues to initiate activity or phenology (SCORE = 1)
b. Unknown (SCORE = 0)
c. Species does not primarily use temperature or moisture cues to initiate activity or phenology (SCORE = -1)

PS6. Mismatch potential – event timing: Are activates related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?

a. Species' fitness is tied to discrete resource peaks that are expected to change (SCORE = 1)
b. Unkown (SCORE = 0)
c. Fitness not tied to utilizing discrete resource peaks (SCORE = -1)

PS7. Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to resource peaks?

a. Species reproduces once per year or less (SCORE = 1)
b. Unknown (SCORE = 0)
c. Species reproduces more than once per year, or has the ability to reproduce asexually (SCORE = -1)

BIOTIC INTERACTIONS

B1. Predators/parasites/insect herbivores (e.g. bark beetles, tent caterpillars, coyotes, ravens): Are populations for these trophic levels expected to change with respect to this species?

a. Predators/Parasites/Insect herbivores are expected to be increased by projected changes (SCORE = 1)
b. Predators/Parasites/Insect herbivores are not expected to be impacted by projected changes (SCORE = 0)
c. Unknown (SCORE = 0)
d. Predators/Parasites/Insect herbivores are expected to be reduced by projected changes (SCORE = -1)

B2. Symbionts (mycorhizzal fungi, restricted pollinators, plants that are exclusively used for nesting, cover): Are populations of symbiotic species expected to change?

a. Symbiotic species populations are expected to be negatively impacted by projected changes (SCORE = 1)
b. Symbiotic species populations are not expected to be impacted by projected changes (SCORE = 0)
c. No known symbionts (SCORE = 0)
d. Symbiotic species populations increased/enhanced due to expected changes (SCORE = -1)

B3. Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?

a. Disease prevalence is expected to increase with projected changes (SCORE = 1)
b. No known effects of expected changes on disease prevalence (SCORE = 0)
c. Disease prevalence is expected to decrease with projected changes (SCORE = -1)

B4. Competitors/invasive species: Are populations of important competing/invasive species expected to change?

a. Major competitor/invasive species are expected to be positively impacted by projected changes (SCORE = 1)
b. Focal species has a variety of competitive relationships OR no expected impacts of projected changes (SCORE = 0)
c. The focal species is considered to be a competing/invasive species are expected to be negatively impacted by projected changes (SCORE = -1)

CONSERVATION FACTORS

C1. Is this species protected under the state or federal Endangered Species Act?

a. Yes (SCORE = 1)
b. No (SCORE = 0)

C2. Is this species considered a keystone species (other species abundance are dependent upon this species' occurrence)?

a. Yes (SCORE = 1)
b. No (SCORE = 0)

C3. Are there anthropogenic constraints to this species' dispersal to reach shifts in suitable habitat, on lands both within and surrounding the Monument?

a. Yes (SCORE = 1)
b. No (SCORE = 0)

C4. Does this species provide and important ecosystem function (e.g. detritivore, carbon sink, pollinator)?

a. Yes (SCORE = 1)
b. No (SCORE = 0)

C5. Does this species engender interest among Monument visitors regarding its well-being?

a. Yes (SCORE = 1)
b. No/Unknown (SCORE = 0)

CULTURAL FACTORS

CU1. Does this species have significance as a cultural resource?

a. Yes (SCORE = 1)
b. No/Unknown (SCORE = 0)

TOTAL: max = 21 (sensitive), min = -15 (resilient)

Species-specific information used to answer each question is based on information available in published journals and online research sources. One multiple-choice answer with a corresponding score was selected for each question based on the species' vulnerability and response to expected climate change impacts in the southwestern United States. These projected changes include:

- an increase in both mean summer temperature and minimum winter temperatures (Hayhoe et al. 2004; Diffenbaugh et al. 2008; Kerr 2008);
- a decrease in average precipitation and an increase in the frequency and intensity of drought (Hayhoe et al. 2004; Dominguez et al. 2012; Gao et al. 2012);
- an increase in the variability of precipitation patterns (Diffenbaugh et al. 2008; Kerr 2008); and
- an increase in wildfire frequency and intensity (Westerling et al. 2006), which is a function of fuel buildup of biomass from exotic grasses due to high deposition rates of atmospheric nitrogen and water availability.

Identifying species to be the focus of a monitoring framework addressing impacts of climate change includes assessing potential extirpation risks specific to an upward shift in temperature. Vulnerability assessments have a numerical risk ranking system which is integral to their construction. Within each of the categories, species were given a negative, positive, or neutral score to quantify their expected response to each variable based on available information. Questions assigned positive score values indicate an expected vulnerability of the species to climate change; a neutral or unknown impact to the species received a point value of zero; and expected resiliency to climate change by a species received a negative score value. Conservation factors were scored as being either 1 (conservation priority) or zero (not a conservation priority). Total vulnerability assessment scores were broken down as follows:

21 to 13	highly vulnerable
12 to 6	likely vulnerable
5 to -1	neutral / impact unknown
-2 to -8	likely resilient
-9 to -15	resilient

Vulnerability assessment scores ranked from greatest to least risk due to climate change impacts are shown in **Table 4** of the main body of the science plan.

One constraint in using VAs is that the available literature is uneven in providing answers regarding how each species might respond to a warming and more arid climate. For this reason, scoring how a species will respond to future conditions can be subjective. This limitation is mitigated by having the VAs prepared by a single biologist familiar with the species; whatever inherent biases were introduced, they should be consistent across all species considered here. Species for which there was not sufficient published information to assess the risk criteria were not analyzed for vulnerability. Scoring sheets and literature used to support those scores for the 20 species analyzed are provided below. A summary for all 20 species is also provided below in **Tables B1** (plants) and **B2** (vertebrates).

<u>**VA questionnaire results**</u>

Table B1. Summary vulnerability assessment scores for the 10 species of selected plants.

	Desert agave	Catclaw acacia	Red shank	Bigberry manzanita	Acton encelia	California juniper	Fountain grass	Jeffrey pine	Single-leaf pinyon pine	California fan palm
Habitat										
H1: area and distribution	0	1	1	1	1	1	-1	1	1	1
H2: habitat specialization	0	1	1	1	0	0	-1	1	1	1
H3: habitat quality	1	1	1	1	1	0	-1	1	1	0
H4: ability to colonize new areas	1	-1	1	0	-1	0	-1	0	0	0

	Desert agave	Catclaw acacia	Red shank	Bigberry manzanita	Acton encelia	California juniper	Fountain grass	Jeffrey pine	Single-leaf pinyon pine	California fan palm
Physiology and Phenology										
PS1: physiological thresholds	0	0	0	1	1	1	0	0	1	0
PS2: exposure to weather-related disturbance	1	1	1	1	1	1	-1	1	1	0
PS3: limitations to daily activity period	0	0	0	0	0	1	0	0	1	0
PS4: survival during resource fluctuation	0	-1	1	0	-1	-1	-1	-1	1	0
PS5: mismatch potential: cues	1	-1	1	0	1	1	-1	1	1	1
PS6: mismatch potential: event timing	-1	1	1	0	1	0	0	1	0	-1
PS7: resilience to timing mismatch	-1	-1	1	1	0	1	-1	1	1	0
Biotic Interactions										
B1: predators/parasites/insect herbivores	0	1	0	0	0	0	0	1	1	1
B2: symbionts	1	1	1	0	1	1	1	0	1	0
B3: disease	0	0	0	1	0	0	0	0	1	0
B4: competitors/invasive species	0	0	0	1	0	1	-1	0	1	1
Conservation Factors										
C1: conservation status	0	0	0	0	0	0	0	0	0	0
C2: keystone species status	1	1	0	0	0	0	0	1	0	0
C3: anthropogenic constraints	0	0	0	0	0	1	0	0	0	0
C4: ecosystem function	0	1	1	1	1	1	1	1	1	1
C5: interest of Monument visitors	1	0	0	0	0	0	0	0	0	1
Cultural Factors										

	Desert agave	Catclaw acacia	Red shank	Bigberry manzanita	Acton encelia	California juniper	Fountain grass	Jeffrey pine	Single-leaf pinyon pine	California fan palm
CU1: significant cultural resource	1	1	0	1	0	1	0	1	1	1
TOTAL										
Total (based on current information)	**6**	**6**	**11**	**10**	**6**	**10**	**-7**	**10**	**15**	**7**
Potential (adjusted) score[1]	**12**	**10**	**14**	**17**	**13**	**16**	**-4**	**13**	**19**	**16**

[1]If with additional research the VA questions were answered with an indication of high vulnerability, potential adjusted scores are identified in this row.

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Table B2. Summary vulnerability assessment scores for the 10 species of selected vertebrates.

	Pinyon jay	Wihite-headed woodpecker	Ladder-backed woodpecker	Gray vireo	Banded rock lizard	Coast horned lizard	Southern sagebrush lizard	Mojave desert tortoise	Desert spiny lizard	Peninsular bighorn sheep
Habitat										
H1: area and distribution	1	1	1	1	1	1	1	1	1	1
H2: habitat specialization	1	1	0	1	1	1	1	0	0	1
H3: habitat quality	1	1	1	1	0	1	0	1	1	1
H4: ability to colonize new areas	-1	-1	-1	-1	1	1	0	0	0	-1
Physiology and Phenology										
PS1: physiological thresholds	1	0	-1	0	0	1	1	1	0	0
PS2: exposure to weather-related disturbance	1	1	1	1	1	1	1	1	1	1
PS3: limitations to daily activity period	0	0	0	0	1	1	1	1	0	0
PS4: survival during resource fluctuation	-1	-1	1	1	1	1	1	1	0	1
PS5: mismatch potential: cues	-1	1	1	1	1	1	1	1	0	1
PS6: mismatch potential: event timing	1	0	-1	0	0	1	1	1	0	1
PS7: resilience to timing mismatch	-1	1	1	-1	1	-1	-1	-1	-1	1
Biotic Interactions										
B1: predators/parasites/insect herbivores	1	0	0	1	0	0	0	0	0	0
B2: symbionts	1	0	0	0	0	0	0	0	0	0
B3: disease	0	0	0	0	0	0	0	0	0	1
B4: competitors/invasive species	0	0	0	1	0	0	0	0	0	0

	Pinyon jay	Wihite-headed woodpecker	Ladder-backed woodpecker	Gray vireo	Banded rock lizard	Coast horned lizard	Southern sagebrush lizard	Mojave desert tortoise	Desert spiny lizard	Peninsular bighorn sheep
Conservation Factors										
C1: conservation status	0	0	0	0	0	0	0	1	0	1
C2: keystone species status	1	1	1	0	0	0	0	0	0	0
C3: anthropogenic constraints	0	0	0	1	0	0	0	1	1	1
C4: ecosystem function	1	0	0	0	0	0	0	0	0	0
C5: interest of Monument visitors	1	1	1	0	0	1	0	1	1	1
Cultural Factors										
CU1: significant cultural resource	0	0	0	0	0	0	0	1	0	1
TOTAL										
Total (based on current information)	**7**	**6**	**5**	**7**	**8**	**10**	**7**	**11**	**4**	**12**
Potential (adjusted) score[1]	**9**	**15**	**12**	**14**	**13**	**15**	**12**	**16**	**10**	**16**

[1]If with additional research the VA questions were answered with an indication of high vulnerability, potential adjusted scores are identified in this row.

Based on the VAs, plant species that will likely be most severely impacted by climate change include single-leaf pinyon pine, red shank, Jeffrey pine, California juniper, and bigberry manzanita. All are mid- to high-elevation species. Based on observations on the north side of the Coachella Valley in Joshua Tree National Park, pinyon, juniper, and manzanita are showing widespread die-offs, possibly from the levels of warming and drying that have already occurred. Die-offs in these species are less apparent within the Monument; however, even there observers have rarely noted reproduction in these species, indicating that these populations may not be sustaining themselves. Among the vertebrate indicator species, desert tortoise, coast horned lizards, and Peninsular bighorn sheep appear to be most at risk.

For those species for which both VAs and habitat suitability models were prepared, results reveal strong parallels—models for pinyons, red shank, coast horned lizards, and desert tortoises all indicate high risk levels. Taken together, based on VAs and habitat suitability models, additional species at higher risk include Peninsular bighorn sheep, Acton brittlebush, and bigberry manzanita.

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Vertebrates

Coast horned lizard

Habitat: Phrynosoma blainvillii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: *Area and distribution*	**Is the area or location of the species' habitat expected to change?**	*Phrynosoma blainvillii* occurs in inland and coastal regions of California and northwestern Baja California at elevations from sea level to 2000 m (Hager and Brattstrom 1997). In response to climate change the habitat for this species will likely shift westward and upwards in elevation. Within Joshua Tree National Park, to the northeast of the Monument, this species occupies higher elevation habitat, and it has been projected that its suitable habitat may shift outside of the Park boundaries almost completely as climate continues to change (Hoines et al. 2015).	1
H2: *Habitat specialization*	**Does the species require specific habitat types / habitat components?**	This species can be found in a variety of habitats including grassland, scrubland, broadleaf woodland, and coniferous forest (Stebbins 2003). It utilizes lowland sandy washes where scattered shrubs provide shade and cover and fine, loose soil for burrowing (Stebbins 2003). The diet of this species is primarily composed of harvester and other native ant species, although it will opportunistically feed on other arthropods and insects (Stebbins 2003). The area of some of the habitat types this lizard inhabits is likely to change, as is the abundance of native ants, due to climate change.	1
H3: *Habitat quality*	**Are features of the habitat associated with increased survival expected to change?**	Yes. Native ants cease foraging during peak mid-day temperatures while invasive non-native Argentine ants (*Linepithema humile*) remain unaffected. Therefore, increased temperatures might benefit Argentine ant populations within this lizards range, displacing native ant colonies which are the main component of this species diet (Dukes and Mooney 1999). Horned lizards given a diet of native ants species maintained positive growth rates, while growth rates with a diet of Argentine ants were negative (Suarez and Case 2002). Projected changes are, therefore, expected to negatively affect habitat quality and directly impact this species growth and the rate to reach reproductive maturity.	1
H4: *Ability to colonize new areas*	**What is the potential for this species to disperse?**	*P. blainvillii* are a slow moving, relatively sedentary species. Movements for a similar species, *P. mcallii* (flat-tailed horned lizard), have been documented as being 35-133 m for males and 28-119 m for females (Wone and Beauchamp 2003). Movements for *P. blainvillii* are likely similar, which results in them having relatively low ability to disperse.	1

Physiology and Phenology: Phrynosoma blainvillii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Yes. Adults of this species are active at temperatures around 26.9˚C whereas hatchlings tolerate and are active at higher temperatures, around 30.1˚C (Hager and Brattstrom 1997). Temperatures of 41˚C restrained this lizard's impulse to burrow beneath sand, however when forced to burrow it is able to tolerate temperatures of 43˚C (Cowles and Bogert 1944). Temperatures due to climate change will likely exceed upper physiological thresholds for this species in its current range.	1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Rainfall events are expected to become more stochastic over the next century due to climate change. Drought conditions coupled with high hatchling mortality (Hager and Brattstrom 1997) may greatly impact recruitment of this species. Depleted harvester ant availability during drought conditions limits summer and fall activity of this species to conserve energy and minimize competition with hatchlings (Hager and Brattstrom 1997). Prolonged drought conditions could impact the survivorship of this species by reducing prey resource abundance. Increased wildfire frequency due to temperature increase and die-off of vegetation would also negatively impact the survivorship of this slow-moving species.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	*P. blainvillii* has unimodal diurnal activity during the spring and bimodal activity during the summer, when temperatures force them to seek shade at mid-day (Hager and Brattstrom 1997). Temperature increases and increased variability in precipitation will likely limit the daily activity period of this species.	1
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	No. This species has no flexible strategies to cope with variable resources across multiple years. It is very dependent on the presence of precipitation.	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Yes. This species is sensitive to temperature cues to initiate diurnal activity patterns (Cowles and Bogert 1944), and likely moisture and temperature cues to stimulate reproduction.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	The reproductive cycle of this species begins in March (Goldberg 1983) likely timed to coincide with peak ant abundance due to winter precipitation. Hatchlings emerge in mid-summer when adult activity is decreasing, thus minimizing competition for food resources between the two age classes (Hager and Brattstrom 1997). Warmer temperatures and stochastic rainfall events may result in low availability of food resources causing negative consequences for reproduction and hatchling survivorship.	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Yes. Clutches are laid April through July and average 7-16 eggs (Goldberg 1983, Stebbins 2003). Females may lay two clutches in one year (Goldberg 1983).	-1

Biotic Interactions: Phrynosoma blainvilii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Predators of this species include roadrunners, raptors and canids, snakes and domestic cats (Gerson 2011, Manaster 2002). It is unclear how predator levels will change with respect to climate change. Increased temperatures might benefit invasive Argentine ant populations within the species range, displacing native ant colonies which are the main component of this species diet (Dukes and Mooney 1999).	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	None known.	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Unknown.	0

Conservation Factors: Phrynosoma blainvilii

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Habitat fragmentation, urbanization, and roadways are likely barriers to dispersal of this slow moving lizard. Another horned lizard (*Phrynosoma mcallii*) exhibited road avoidance behavior towards a well-travelled, four-lane road (Barrows et al. 2006); coast horned lizards will likely respond similarly to roadways.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	None known.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	This species engenders interest among both professional and amateur herpetologists. It is a slow moving lizard species, therefore easy to catch and admire. Many adults have nostalgic childhood memories of owning horned lizards, or "horny toads".	1

Cultural Factors: Phrynosoma blainvilii

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Unknown.	0
		Total	**10**

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Banded rock lizard

Habitat: Petrosaurus mearnsi

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Petrosaurus mearnsi* (Banded rock lizard), an insectivorous, iguanid lizard that inhabits areas with large granitic boulders on the eastern desert slopes of the San Jacinto and Santa Rosa Mountains, the coast ranges of Riverside and San Diego Counties, south into the northern third of Baja California, Mexico (Stebbins 2003, DeLisle 1991, McKay 1975). It can be found from elevations near sea level up to 1,100 m (Stebbins 2003). Within the National Monument, it is expected that increased temperatures due to climate change will cause periods of reduced diurnal activity, and suitable climatic conditions for this species may shift upwards in elevation. However, this species has low dispersal capabilities and is restricted to rocky outcroppings. These restrictions will compromise its ability to shift its niche. The extent of suitable habitat for this species will likely be greatly reduced, and climate refugia (currently suitable habitat comprised of important landscape and climatic features) will be critical for the persistence of this species within the National Monument, as was shown for similar insectivorous, saxicolous lizards (Barrows and Fisher 2014).	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Yes, this species is restricted to rock surfaces, and can be found inhabiting rock outcrops, boulder piles and canyon walls (Marlow 2000). DeLisle (1991) observed that the only time individuals were seen leaving a rock surface was while foraging for insects that were landing on nearby plants; the lizard would immediately return to the rock thereafter.	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Habitat features related to increased survival, such as rocky outcroppings, are not expected to dramatically change. This species does not have a specialized diet, however a reduction in food abundance (insects) related to prolonged drought would impact this species.	0
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	This species has poor dispersal capabilities. Over two years DeLisle (1991) only observed four individuals leaving rocky surfaces to travel upon the ground to another boulder <1 m away. This species is restricted to rocky outcroppings that are isolated from each other. Isolated suitable habitat, along with their limited movements, confers low abilities to colonize new areas.	1

Physiology and Phenology: Petrosaurus mearnsi

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	This species will remain active until air and rock temperatures exceed 32-37 ˚C (90-99 ˚F) and 42-50 ˚C (107-122 ˚F), respectively (DeLisle 1991). The maximum air temperature with recorded activity by this species was 38˚C (100˚F) in San Diego County (DeLisle 1991). Projected changes in temperature will likely remain within physiological tolerances. This species will respond behaviorally to higher than average air temperatures by decreasing the duration of its activity (See section PS3). Decreased activity may lead to an inability to obtain sufficient resources to maintain body quality. Conversely, to compensate for increased metabolic requirements or potentially reduced food availability individuals may need to remain active for longer periods to forage which would increase exposure to detrimental temperatures and increase predation risk (Rose 1981).	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Precipitation events are expected to become more stochastic over the next century, and prolonged drought events are predicted. Warmer temperatures and stochastic rainfall events may result in low availability of food resources causing negative consequences for reproduction and survivorship.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Yes. This species is sensitive to temperature cues to initiate diurnal activity (DeLisle 1991). This species will likely respond to a warming climate by adjusting its diurnal activity and seeking shelter in crevices when daily temperatures exceed tolerances.	1
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	No. The banded rock lizard has no flexible strategies to cope with variable resources across multiple years. It is dependent on the presence of insects, the abundance of which is dependent upon precipitation and temperature.	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	This species uses temperature cues to initiate hibernation and reproductive activity. Individuals are inactive from October through February-March, and emerge from hibernation earlier at warmer sites (DeLisle 1991). Egg laying has been recorded as occurring in late June-early July in San Diego County (DeLisle 1991), and one month later for populations occurring in mountain areas (Cozens 1978, as cited in Delisle 1991).	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	It is not known how closely this species' activities are tied to discrete peaks in available resources.	0
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	No. This species will lay one clutch of 2-6 eggs between June-August each year (Stebbins 2003).	1

Biotic Interactions: Petrosaurus mearnsi

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	This species is insectivorous and will consume a variety of insects, such as bees, ants, beetles, flies, caterpillars, as well as arachnids, and flowers (Stebbins 2003, DeLisle 1991). It is not known how insect populations will respond to climate change. If water is not limiting insect abundance may increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999). If water is limiting due to drought conditions, insect abundance will be negatively impacted. This species' flexible diet may act as a buffer against climate change impacts to its prey base. Potential predators of this species include ravens, shrikes, and rattlesnakes (Marlow 2000, DeLisle 1991). Deslie (1991) did not observe any broken or regenerated tails which would suggest predation attempts on the banded rock lizards studied. The microhabitat of this species (vertical walls, rocky outcrops) may prevent predation attempts (Marlow 2000).	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Several species of endoparasites have been found in species closely related to the banded rock lizard: the short-nosed rock lizard (*P. repens*) which co-occurs with the banded rock lizard in Baja California, and the San Lucan banded rock lizard (*P. thalassinus*; Bursey and Goldberg 2007). Although no information documents the occurrence or prevalence of parasites of the banded rock lizard, there are likely many. It is not known how the prevalence of these parasitic species will change with climate change.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Although this species co-occurs with several other lizard species (Stebbins 2003, DeLisle 1991), it does not appear to have an important competitor.	0

Conservation Factors: Petrosaurus mearnsi

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Roadways and habitat fragmentation may be barriers to dispersal, however this species exhibits limited movement and is restricted to rocky outcroppings which are isolated from each other. Therefore, those limitations may constrain potential dispersal more than anthropogenic constraints.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	No.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Not known.	0

Cultural Factors: Petrosaurus mearnsi

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Not known.	0
		Total	**8**

Barrows, C.W. & Fisher, M. (2014) Past, present and future distributions of a local assemblage of congeneric lizards in southern California. *Biological Conservation*, **180**, 97-107.

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Desert spiny lizard

Habitat: Sceloporus magister

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	The spiny lizard species group contains six other species plus *Sceloporus magister* and represents the largest radiation of *Sceloporus* lizards, occupying every North American desert (Leache and Mulcahy 2007). Currently the range of *S. magister* extends from northern Mexico and Baja California to Nevada and southwestern Colorado, and from Texas to California (Stebbins 2003). In California, it is found in arid regions of Riverside County, and on the slopes of the Peninsular Range east to the Colorado River, south into Baja California, and north into Inyo County as well asalso in the Inner Coast Ranges (Stebbins 2003, Jones and Lovich 2009). Within the National Monument, it is expected that increased temperatures due to climate change will cause periods of reduced diurnal activity, and suitable climatic conditions for this species may shift upwards slightly in elevation. Barrows and Fisher (2014) modelled current and projected suitable habitat within the National Monument for this species and found a reduction in habitat from 243,204 ha to 99,780 ha due to a 3˚C temperature increase. This corresponds to a 56% reduction in suitable habitat extent. This species has low dispersal capabilities which will compromise its ability to track niche shifts. Therefore the extent of suitable habitat for this species will likely be greatly reduced, and climate refugia (currently suitable habitat comprised of important landscape and climatic features) will be critical for the persistence of this species within the National Monument. The model projected that only 24,850 ha of habitat refugia may be available to this species within the Monument after a 3˚C temperature increase (Barrows and Fisher 2014).	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	*Sceloporus magister* ranges from near sea level to 1520 m and inhabits both arid and semi-arid regions, from grasslands to mountain slopes (Stebbins 2003). They are commonly found in montane shrublands and slopes, desert flats, various arid and semi-arid woodlands including Joshua trees, palm oases, mesquite-yucca grassland, juniper and mesquite woodlands, creosote scrubs, riparian edges, and cottonwood-willow zones in washes (Degenhardt et al. 1996, Stebbins 2003). This species occupies a wide variety of habitat types.	0
H3: Habitat quality	**Are features of the habitat associated with increased**	Projected changes are unlikely to affect habitat quality, except in certain communities within the Monument, such as Joshua tree woodland and palm oases. Given the adaptability of this	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
	survival expected to change?	species, it is safe to assume that populations that are less dependent on these habitats will be more successful (NatureServe 2013). This species does not have a very specialized arthropod diet, however a reduction in food abundance (insects, small invertebrates) overall related to prolonged drought would impact this species.	
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	*S. magister* has moderate dispersal abilities.	0

Physiology and Phenology: Sceloporus magister

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	Are limiting physiological conditions expected to change?	37˚C (98.6˚F) is considered the maximum normal temperature voluntarily tolerated by this species, with temperatures exceeding 43˚C (109˚F) proving fatal (Brattstrom 1965). Average body temperatures of 35˚C (95˚F) have been reported (Cowles and Bogart 1944). Projected changes in temperature will likely remain within physiological tolerances for adults. Of the four *Sceloporus* lizards that Barrows and Fisher (2014) studied, *Sceloporus magister* occupied the hottest temperature gradient within the National Monument. This species may respond behaviorally to higher than average air temperatures by decreasing activity. Projected temperatures will likely remain within physiological tolerances for this species over much of its distribution within the National Monument.	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	*S. magister* may be negatively impacted by increased flash flooding in arroyos and riparian habitat (NatureServe 2013). Precipitation events are expected to become more stochastic over the next century, and prolonged drought events are predicted. Warmer temperatures and stochastic rainfall events may result in low availability of food resources (insects, small invertebrates) causing potentially negative consequences for growth rate, reproduction, and survivorship.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	*S. magister* is diurnal but inhabits a broad climatic envelope, so changes to climate will most likely not impact survival or reproduction. They are commonly active from March through October, and take shelter during periods of excessive heat and cold. They have occasionally been spotted basking on rocks in the winter (NatureServe 2013).	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Unknown.	0
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Unknown.	0
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Unknown. Parker and Pianka (1973) reported a mean clutch size (8.4 eggs) that was smaller than that reported by Fitch (12.4 eggs; 1970), and stated that the wide variation may be due to site-specific factors influencing egg production. No information was found that confirms whether growth rates are reduced when food availability is low, as was shown for another *Sceloporus* species, *S. vandenburgianus* (Sinervo and Adolph 1994); since clutch size has been shown to increase with body size in this species (Parker and Pianka 1973), reduced growth rates could reduce fecundity.	0
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	*S. magister* becomes sexually mature between 2 and 3 years of age. Spring and early summer are their most common breeding season, but the season may be prolonged until August. Individuals often lay a clutch of 3 to 19 eggs, and young emerge between August and September, occasionally October. Females may lay more than one clutch during favorable years (Stebbins 2003, Parker and Pianka 1973).	-1

Biotic Interactions: Sceloporus magister

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?	*S. magister* are ambush predators. Their primary prey are small arthropods including ants, beetles, grasshoppers, spiders, centipedes, caterpillars and occasionally other small lizards, nestlings, and vegetation (Stebbins 2003, Vitt and Ohmart 1974). It is unknown how these prey species will be impacted by climate change; however, *S. magister*'s flexible diet may act as a buffer against climate change impacts to its prey base. Potential predators of this species include snakes, birds, coyotes, and foxes (Vitt and Ohmart 1974). It is not known how the populations of these predators will be impacted by climate change.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	None known.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Several sympatric *Sceloporus* species occur within the National Monument. Barrows and Fisher (2014) projected decreased niche overlap between *S. magister* and *S. occidentalis* (western fence lizard) with *S. occidentalis* suitable habitat shifting farther upslope than *S. magister*. No competition was observed between *S. orcutti* (granite spiny lizard) and *S. magister* although large portions of their ranges overlap (Barrows and Fisher 2014).	0

Conservation Factors: Sceloporus magister

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	Is this species protected under the state or federal Endangered Species Act?	No, this species is not protected under the Endangered Species Act.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	The desert spiny lizard is sensitive to habitat fragmentation by heavily urbanized areas and heavily traveled roads or highways, which they rarely cross successfully. Other potential barriers to movement include major rivers or other large bodies of water (NatureServe 2013).	1
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	No.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	As a charismatic vertebrate and an arboreal lizard, *S. magister* may be of interest to amateur herpetologists.	1

Cultural Factors: Sceloporus magister

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Unknown.	0
		Total	**4**

Barrows, C.W. & Fisher, M. (2014) Past, present and future distributions of a local assemblage of congeneric lizards in southern California. *Biological Conservation*, **180**, 97-107.

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Fitch, H.S. (1970) Reproductive cycles in lizards and snakes. *Misc. Publ. University of Kansas Museum of Natural History*, **52**, 1-247.

Jones, L. & Lovich, R (eds). (2009) *Lizards of the American southwest: a photographic field guide*. Rio Nuevo Publishers, Tucson, Arizona.

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Parker, W.S. & Pianka, E.R. (1973) Notes on the ecology of the Iguanid lizard, *Sceloporus magister*. *Herpetologica*, **29(2)**, 143-152.

Sinervo, B. & Adolph, S.C. (1994) Growth plasticity and thermal opportunity in *Sceloporus* lizards. *Ecology*, **75(3)**, 76-790.

Stebbins, R.C. (2003) *A field guide to western reptiles and amphibians*, third edition. Houghton Mifflin Company, New York.

Vitt, L.J. & Ohmart, R.D. (1974) Reproduction and ecology of a Colorado River population of *Sceloporus magister* (Sauria: Iguanidae). *Herpetologica*, **30(4)**, 410-417.

Southern sagebrush lizard

Habitat: Sceloporus vandenburgianus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Sceloporus vandenburgianus* (Southern sagebrush lizard), an insectivorous lizard, is found only in the mountains of southern California (San Gabriel, San Bernardino, San Jacinto, Santa Rosa, Laguna, Palomar, and Cuyamaca Mountains) south into northern Baja California (San Pedro Matir Mountains) at elevations of 4000-8500 ft (1219- 2590 m; Goldberg 1975, Van Denburgh 1922). Populations occurring in the San Gabriel Mountains occupied areas dominated by pines (Goldberg 1975). This species will also occur in sagebrush, pinyon-juniper, manzanita and ceanothus shrubland habitats (NatureServe 2015). *Sceloporus vandenburgianus* is considered by some to be a subspecies of *Sceloporus graciosus,* which has a more northern distribution (Barrows and Fisher 2014, Stebbins 2003). Within the National Monument, it is expected that increased temperatures due to climate change will cause periods of reduced diurnal activity, and suitable climatic conditions for this species may shift upwards in elevation. Barrows and Fisher (2014) modelled current and projected suitable habitat within the National Monument for this species and found a reduction in habitat from 18,990 ha to 8210 ha due to a 3˚C temperature increase. This corresponds to a 57% reduction in suitable habitat extent. This species has low dispersal capabilities which will compromise its ability to track niche shifts. Therefore the extent of suitable habitat for this species will likely be greatly reduced, and climate refugia (currently suitable habitat comprised of important landscape and climatic features) will be critical for the persistence of this species within the National Monument. It was projected that only 4620 ha of habitat refugia may be available to this species within the Monument after a 3˚C temperature increase (Barrows and Fisher 2014).	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Of the four *Sceloporous* lizards that Barrows and Fisher (2014) studied, *Sceloporus vandenburgianus* occupied the coolest temperature gradient within the National Monument. This species prefers rock surfaces, and pine or incense cedar trunks and stumps as perch microhabitat, and exhibits substrate preferences (Barrows and Fisher 2014, Van Derburgh 1922). It typically occupies areas that have some low shrubs and open ground (NatureServe 2015).	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Habitat features related to increased survival are not expected to dramatically change. This species does not have a very specialized arthropod diet; however, a reduction in food abundance (insects, small invertebrates) related to prolonged drought would impact this species.	0
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	This species has moderate dispersal capabilities. In areas experimentally depopulated of sagebrush lizards, recolonization from surrounding areas occurred quickly, reaching pre-depopulation numbers by the following year (M'Closkey et al. 1997).	0

Physiology and Phenology: Sceloporus vandenburgianus

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	38.2˚C (100˚F) is considered the maximum normal temperature voluntarily tolerated by this species, with temperatures exceeding 45˚C (113˚F) proving fatal (Brattstrom 1965). Body temperatures of 22.7 ˚C (73˚F) have been observed in the field, with experimental temperatures as low as 5˚C (41˚F) not proving fatal (Cunningham 1966). Projected changes in temperature will likely remain within physiological tolerances for adults; however, eggs of this species experience higher mortality at higher temperatures (Adolph 1990). Higher temperatures would limit their latitudinal distribution, and heat waves may significantly impact reproduction at the lower elevation limits of this species. This species may respond behaviorally to higher than average air temperatures by decreasing activity. It can be expected that decreased activity may lead to an inability to obtain sufficient resources to maintain body quality. Conversely, to compensate for increased metabolic requirements or potentially reduced food availability individuals may need to remain active for longer periods to forage. Such prolonged activity would increase exposure to detrimental temperatures and increase predation risk (Rose 1981).	1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Precipitation events are expected to become more stochastic over the next century, and prolonged drought events are predicted. Warmer temperatures and stochastic rainfall events may result in low availability of food resources (insects, small invertebrates) causing negative consequences for growth rate (Sinervo and Adolph 1994), reproduction, and survivorship.	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Yes. This species is sensitive to temperature cues to initiate diurnal activity. This species will likely respond to a warming climate by adjusting its diurnal activity and seeking shelter in crevices when daily temperatures exceed tolerances.	1
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	No. The southern sagebrush lizard has no flexible strategies to cope with variable resources across multiple years. It is dependent on the presence of insects, the abundance of which is dependent upon precipitation and temperature.	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	This species uses temperature cues to initiate hibernation and reproductive activity (Sinervo and Adolph 1994, Goldberg 1975). Individuals are inactive from October through March, coincident with snowfall for populations inhabiting higher elevations (Sinervo and Adolph 1994) and emergence from hibernation is dependent on annual weather conditions (Goldberg 1975).	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	In years with warm winter and spring months and high rainfall, twice the number of yearling individuals reproduced (Tinkle et al. 1993), likely due to abundant resources. This trend indicates that fecundity will be reduced in years when resources are limited (due to prolonged drought or extreme heat, the prevalence of which is expected to increase). Additionally, growth rates in this species are reduced when food availability is low (Sinervo and Adolph 1994). Low growth rate may result in reduced fecundity for this species, since clutch size has been shown to increase with body size (Goldberg 1975).	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Yes. It is estimated that approximately 60% of females lay two clutches of eggs per year, the first of which is laid in mid-June, the second in early to mid-July (Goldberg 1975). Body size is positively correlated with clutch size, but not correlated with occurrence of a second egg clutch (Goldberg 1975). Adults of the closely related species, *Sceloporus graciosus*, have a life span of approximately 6 years, become reproductively active in their second year, and may produce an average of eight clutches in their lifetime (Derickson 1976).	-1

Biotic Interactions: Sceloporus vandenburgianus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	This species will consume a variety of insects and small invertebrates, such as ants, beetles, flies, lepidopterans, grasshoppers, and termites, as well as mites, spiders, and scorpions (Stebbins 2003, Van Derburgh 1922). It is not known how insect populations will respond to climate change. If water is not limiting insect abundance may increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999). If water is limiting due to drought conditions, insect abundance will be negatively impacted. The flexible diet of this species may act as a buffer against climate change impacts to its prey base. Potential predators of this species include a variety of predatory birds and snakes (NatureServe 2015, Cunningham 1959). It is not known how climate change will impact these species.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Several species of endoparasites have been found in this species (Goldberg et al. 1997, Wood 1935). It is not known how the prevalence of these parasitic species will change with climate change.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Although this species co-occurs with several other lizard species (Adolph 1990, Rose 1976, Goldberg 1975), it does not appear to have an important competitor. Models developed by Barrows and Fisher (2014) suggest that the southern sagebrush lizard's extent of suitable habitat within the National Monument overlaps more with *S. orcuttii* currently, than it did during a colder or hotter climate scenario, indicating that interaction between the two will decrease with climate change.	0

Conservation Factors: Sceloporus vandenburgianus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Roadways and habitat fragmentation may be barriers to dispersal, however this species exhibits limited movement and is restricted to rocky outcroppings which are isolated from each other. Therefore, those limitations may constrain potential dispersal more than anthropogenic constraints.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	No.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Not known.	0

Cultural Factors: Sceloporus vandenburgianus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Not known.	0
		Total	**7**

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Mojave desert tortoise

Habitat: Gopherus agassizii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	The Mojave population of *Gopherus agassizii*, which occurs north and west of the Colorado River, is one of three populations of desert tortoise recognized (USFWS 1990, Crozier et al. 1999). They typically occur at elevations between 0 and 1220 m (Stebbins 1985). To assess how tortoises might respond to a changing climate, Barrows (2011) modeled shifts in suitable tortoise habitat within Joshua Tree National Park under different climate change scenarios. With a moderate 2˚C increase in temperature and 50 mm decrease in precipitation, suitable tortoise habitat was reduced by roughly 66% in the Mojave Desert portion of the Park and 88% in the Sonoran Desert portion. Additionally, their suitable habitat shifted from a mean elevation of 675 m to 897 m under the same climate prediction. Similar shifts and reductions in this species' suitable habitat are expected to occur within the National Monument.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	No. Because *G. agassizii* construct burrows, soil composition is an important factor of habitat suitability (Anderson et al. 2000, Barrows 2011). Other important habitat characteristics are topographic ruggedness, elevation, and both north and east slope aspect (Barrows 2011). These physical habitat components are not expected to change.	0
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Habitat features related to increased survival, such as topographic ruggedness and soil conditions are not expected to dramatically change. However, a reduction in food abundance related to prolonged drought would impact this species.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Although slow moving, this species has moderate dispersal abilities. One individual was documented as having dispersed 32 km between mountain ranges (Edwards et al. 2004).	0

Physiology and Phenology: Gopherus agassizii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	*Gopherus agassizii* is well adapted to variable precipitation and temperature extremes common to its desert habitat. Adaptations include the ability to burrow and hibernate beneath ground, reducing water loss, energy expenditure and exposure to temperatures that may exceed their physiological tolerances (Nagy and Medica 1986, Duda et al. 1999). Maximum temperatures voluntarily experienced by this species has been reported as 37.8˚C (100˚F), and critical maximum as 39.5˚C (103˚F; Brattstrom 1965). A climate shift toward a more	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
		variable, hotter-drier condition (Kerr 2008) would likely stress desert tortoise populations, especially due to their ectothermia. This species has temperature-dependent sex determination increasing the potential for skewed sex ratios as a result of rising air temperatures due to climate change. Optimal incubation temperature has been found to be between 31-32˚C, with higher temperatures producing male-dominated clutches (Lewis-Winokur and Winokur 1995).	
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	An important stress factor of climate change could be more frequent drought (Parmesan et al. 2000). Severe drought conditions have been documented as having greatly affected *G. agassizii* survival rates (Turner et al. 1984, Peterson 1994, Longshore et al. 2003), especially due to the consequent reduction in annual biomass, the primary food source for desert tortoise(Jennings 2002). Additionally, restricted access to water increases tortoise exposure to osmotic stress through build-up of dietary salts and nitrogenous wastes in bladders (Nagy and Medica 1986), and decreases their chances to achieve a net annual energy profit (Peterson 1996).	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Yes. During unproductive drought periods, *G. agassizii* responds by conserving energy through increased time spent within burrows, and reduced activity as a tortoise waits out the dry period (Duda et al. 1999). This species will likely respond to a warming climate by adjusting its diurnal activity and seeking shelter/burrows when daily temperatures exceed tolerances. Higher temperatures and more variable precipitation would decrease the tortoise daily activity and most likely result in increased physiological and osmotic stress.	1
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	*G. agassizii* has a low field metabolic rate (Peterson 1996) and a large bladder within which it can store water and dietary salts, enabling a tortoise to endure spans of variable rainfall; however, prolong spans of drought conditions would cause great osmotic stress to the tortoise and affect survival rates. Additionally, the abundance/availability of the primary food source of the species relies on precipitation. While the tortoise is adapted to cope with resource fluctuations inherent to a desert environment, the species does not have strategies to cope with prolonged periods of limiting resources.	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Temperature is an important cue for the reproductive cycle of this species. Testosterone levels and spermatogenesis in males, and vitellogenesis and ovarian maturation in females, both occur during increasing and peak air temperatures, respectively (Rostal et al. 1994). Although hibernation is thought to be initiated and terminated by temperature cues, endogenous conditions may also play a role in triggering hibernation behavior (Nussear et al. 2007).	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Precipitation impacts tortoise reproductive ecology. Clutch phenology is timed to coincide with forage availability for hatchlings, which depends on previous rainfall events (Lovich et al. 2012). Insufficient rainfall and forage can lead to lower recruitment and clutch frequencies (Lovich et al. 1999). Temperature is known to affect the rate of egg development, incubation time, and sex determination (Lewis-Winokur and Winokur 1995, Lovich et al. 2012).	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Individuals in this population typically reach sexually maturity around 17 years of age, and have an estimated lifespan of 32 years, with females usually shorter-lived than males (Curtin et al. 2009). They can produce one to two clutches per year. Their longevity can offer a buffer against climate variations (Morris et al. 2008) allowing them to forgo reproduction until more favorable conditions without a dramatic impact to population growth.	-1

Biotic Interactions: Gopherus agassizii

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	It is unclear how predator levels will change with respect to climate change.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	*G. agassizii* are susceptible to several diseases, including upper-respiratory tract disease (UTRD), cutaneous dyskeratosis, and urinary tract disease (Homer et al. 1998, Christopher et al. 2003), of which URTD has been considered a major cause of tortoise population decline (USFWS 1994). The effect that climate change may have upon the prevalence of disease among desert tortoise populations is uncertain; however, drought conditions may exacerbate the tortoises' disease susceptibility (Christopher et al. 2003).	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	None known.	0

Conservation Factors: Gopherus agassizii

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	The Mojave population of *G. agassizii* is listed as a threatened species at the state and federal levels under the Endangered Species Act (USFWS 1990).	1
C2: Keystone species status	**Is this species considered a keystone species (other species abundances are dependent upon this species' occurrence)?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Estimates of gene flow between tortoise populations have determined that populations have exchanged migrants at a rate greater than one migrant per generation, and radiotelemetry studies have determined that tortoises sometimes move long distances between populations (Edwards et al. 2004). However anthropogenic barriers are increasingly hindering this species' movement and gene flow (Boarman et al. 1997). Their ability to overcome barriers is dependent upon availability of species-specific crossing structures beneath roadway barriers, and human assistance (Boarman et al. 1997, Edwards et al. 2004).	1
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g.,**	None known.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
	detritivore, carbon sink, pollinator)?		
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	The desert tortoise has interested many student, professional, and amateur herpetologists and it has been widely studied due to its listed status and unique physiological requirements. It is the state reptile of California and Nevada. It is a popular pet and captive tortoise adoption programs are offered in California, Nevada, Arizona and Utah.	1

Cultural Factors: Gopherus agassizii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes, the desert tortoise was extensively utilized by native Americans across its range. Desert tortoise shells were ground into powder by the Yavapai and used to relieve stomach and urinary tract afflictions, as well as being used as ceremonial rattles, digging utensils and bowls (Schneider 1996). Their carapace fragments made convenient spoons, and scoops, and their meat was consumed after being roasted or stewed (Schneider 1996). Tortoises also carry great symbolic and spiritual importance, and their forms are depicted in petroglyphs and as decorative motifs in basketry or pottery (Schneider 1996).	1
		Total	**11**

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Peninsular bighorn sheep

Habitat: Ovis canadensis nelsoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	Peninsular bighorn sheep are a distinct population segment of a subspecies of desert bighorn sheep, *Ovis canadensis nelsoni* (USFWS 2011). Peninsular bighorn sheep occur on the desert slopes of southern California's Peninsular Range from the San Jacinto Mountains south into Baja California, Mexico, at elevations between 100 and 1400 m (USFWS 2011). Suitable habitat for the Peninsular bighorn sheep is expected to decrease in extent and increase in elevation. Barrows and Murphy (2010) modelled suitable habitat within the National Monument in response to climate change and found a 34% reduction in habitat extent corresponding a 3˚C temperature increase and 75mm precipitation decrease, as well as an increase in elevation. Mountain ranges with suitable upper-elevation habitat may serve as refugia for bighorn sheep allowing them to respond to climate change by shifting upwards in elevation (Epps et al. 2004, Barrows and Murphy 2010).	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Yes. *O. c. nelsoni* is associated with habitat that offers appropriate forage and consists of visually unobstructed, moderate to steep mountainous terrain, which maximizes its ability to detect and escape from potential predators (Bleich et al. 1990). Bighorn sheep do not have specific browse requirements but rather feed on a variety of plants, with composition of diets varying between sites, seasons, availability and quality (Wehausen 2006). Individuals will utilize washes, alluvial fans, and valley floors for dispersal and browsing opportunities (USFWS 2011). Water sources are an important habitat component for bighorn sheep (Blong and Pollard 1968, Cunningham and Ohmart 1986, Andrew 1994, Bleich et al. 2010) the availability of which could be reduced due to predicted increases in drought frequency caused by climate change (Parmesan et al. 2000). Physical separation of essential habitat components (water and forage relative to lambing areas and escape terrain) is a concern if habitat shifts occur due to climate change (USFWS 2011).	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. Because precipitation has been shown to have a significant positive influence on forage quality and consequent *O. c. nelsoni* reproductive success (Wehausen 1987), long drought periods could cause population declines. The longevity and high survivorship of ewes could help offset periods of low recruitment (Wehausen 2006). Availability and quality of forage and water is expected to decline and will most likely adversely impact bighorn sheep populations. Populations of bighorn sheep inhabiting lower-elevations have been shown to be more vulnerable than those at higher elevations where temperatures are lower and annual precipitation is higher (Epps	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
		et al. 2004, Epps et al. 2006). Because this distinct population segment occupies elevations between 100-1400 m (lower than other populations of this subspecies) projected changes are likely to negatively impact this population.	
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	*O. c. nelsoni* is very mobile, and both males and ewes have been found to move between Mojave Desert mountain ranges (Bleich et al. 1990, Bleich et al. 1996). Therefore, the ability of sheep to disperse and track habitat shifts in response to climate change will be high. However, because bighorn sheep metapopulations are naturally fragmented, the ability for them to move between metapopulations in response to climate change will be determined by the amount of connectivity maintained between habitats (Epps et al. 2006).	-1

Physiology and Phenology: Ovis canadensis nelsoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	*O. c. nelsoni* is well adapted physiologically and behaviorally to conditions in desert environments (Hansen 1982). To minimize water loss and tolerate dehydration, bighorn sheep are able to concentrate their urine and remove water from their feces almost as effectively as camels (Hansen 1982, Cain et al. 2006).	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Water sources are an important habitat component for bighorn sheep (Blong and Pollard 1968, Cunningham and Ohmart 1986, Andrew 1994, Bleich et al. 2010), the availability of which could be reduced as the result of predicted increases in drought frequency caused by climate change (Parmesan et al. 2000). On the other hand, increased drought and temperatures could kill vegetation not adapted to those conditions, thus increasing wildfire potential, at least in the short run. Post-fire habitat would be more open, thus, may be more suitable as bighorn sheep habitat (Etchberger et al. 1989). The reduction of water availability due to drought outweighs potential benefits of wildfire.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Nocturnal activity during times of greatest heat stress, and selection of bedding sites with cooler microclimates aids in avoidance of heat gains (Hansen 1982, Cain et al. 2006). If day-time temperatures increase due to climate change, it can be assumed that periods of inactivity may increase to avoid heat stress and nocturnal foraging activity may increase to compensate.	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	This species has no flexible strategies to cope with variable resources across multiple years. It is dependent on the presence of precipitation.	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Yes. Peak birthing of lambs occurs during spring months and is timed to coincide with peak forage abundance after winter rains. Breeding occurs six months prior and is likely cued by temperature or forage quality/availability.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Yes. Compared to other ungulates, bighorn sheep have an extended lambing season to maximize fecundity despite unpredictable environmental conditions. Lambing season ranges from December through June, with peaks following annual winter rains and is timed to coincide with peak plant quality and abundance in spring (Rubin et al. 2000, Wehausen 2006). Decreases in precipitation are projected in this region as a result of climate change which may lead to poor health in lactating ewes thus low survivorship of lambs.	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Females reproduce once per year or less.	1

Biotic Interactions: Ovis canadensis nelsoni

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Mountain lions are the primary predator of bighorn sheep and have caused populations to decline to low densities in California mountain ranges (Wehausen 1996). It is unclear how predator levels will change with respect to climate change.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Bighorn sheep are susceptible to several diseases, including respiratory disease via lungworm, epizootic hemorrhagic disease, bluetongue virus thought to be transmitted via interactions with domestic livestock species, and bacterial or viral pneumonia thought to be influenced by the predisposition of existing infection (Foreyt and Jessup 1982, Wehausen et al. 1987, Mullens and Dada 1992, Noon et al. 2002). Occurrence of bluetongue may decrease with climate change as midges (*Culicoides* spp.), the vector, require water to reproduce, a resource which may become more scarce. Physiological stress brought on by climate change may make sheep more sensitive to disease or other stress factors, such as disturbance by hikers, although there is no literature to elucidate the extent to which this disturbance might occur in the future. Drought conditions may cause sheep to aggregate in higher densities around available water sources, increasing the possibility for disease transmission.	1
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Unknown.	0

Conservation Factors: Ovis canadensis nelsoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	Yes, this taxon was listed as threatened (USFWS 2011) and federally endangered (USFWS 1998) under the California Endangered Species Act.	1
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Bighorn sheep metapopulations are naturally fragmented. Anthropogenic barriers to dispersal and connectivity, such as roadways, fencing and canals, have limited gene flow and impeded the permeability of the landscape for sheep traversing between metapopulations, and between mountain ranges. Nuclear and mitochondrial DNA analyses of 27 bighorn sheep populations show a reduction of up to 15% in gene diversity over the 40 years since most anthropogenic barriers have been erected (Epps et al. 2005).	1
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Unknown.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Yes. Peninsular bighorn sheep are charismatic and endangered, therefore sightings excite wildlife enthusiasts and photographers.	1

Cultural Factors: Ovis canadensis nelson

Trait/Quality Assessed	Trait/Quality Assessed	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Bighorn sheep were an important source of meat for native North Americans, and their horns have been used for ceremonial spoons and utensil handles (Ballenger 1999). Petroglyphs depicting the species are common in across the western states.	1
		Total	**12**

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Gray vireo

Habitat: Vireo vicinior

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Vireo vicinior* (Gray vireo) is a small songbird that has patchy breeding distribution across much of the southwestern United States in southern locales of California and Nevada, central Utah, southwestern and southeastern Colorado, southeastern Arizona, northwestern Baja California, and north-central New Mexico south into western Texas and Coahuila (NatureServe 2015). Within California, this species is a summer resident in Inyo, Kern, Los Angeles, Riverside and San Bernardino Counties (Unitt 2008, NatureServe 2015) and may overwinter irregularly in Anza-Borrego Desert State Park in San Diego County (Unitt 2000). Grinnell and Swarth (1913) estimated 16 pairs of gray vireos per mi^2 (6.2 per km^2) in the San Jacinto Mountains (900-2000 m elevation), which was considered low density by Unitt (2008). This assumption has led to the conclusion that this species may never have been common in this area. Now this species may be nearly extirpated from this area (Hargrove and Unitt 2014). In Deep Canyon, Santa Rosa Mountains, Weathers (1983, as cited in Unitt 2008) reported Gray vireo densities of 4 per km^2; only three individuals were found between 2005-2007 at the same site (Hargrove and Unitt 2014). North American Breeding Bird Surveys reported a 3.9% survey-wide average annual population decline between 1966-1996, and 1.1% decline from 1980-1996 (NatureServe 2015). According to Hargrove and Unitt (2014) this species appears to be extirpated from at least half of the sites where it has been recorded as occurring, and declining at many of the sites were it currently persists. Within the National Monument, it is expected that increased temperatures due to climate change will cause upslope shifts in suitable habitat, such as was shown by Hargrove and Rotenberry (2011) for other bird species.	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	In the San Jacinto area of southern California, this species occupies chaparral dominated by chamise or red shank (*Adenostoma fasciculatum* and *A. sparsifolium*, respectively), scrub oak, manzanita, *ceanothus* spp., pinyon, and sagebrush habitats where *Adenostoma* is nearby or intermixed (Unitt 2008). Pinyon-juniper woodland habitat, intermixed with sagebrush, is utilized by gray vireos in the mountains of the Mojave Desert (Winter and Hargrove 2004). According to Vulnerability Assessments (this report), pinyon and red shank are projected to decrease in extent and quality due to climate change which would limit the availability of this species' preferred habitat types. This species may be negatively impacted by grazing activities where shrub cover is removed or converted to grassland (NatureServe 2015).	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. This species prefers core habitats (not edges), unbroken chaparral, and shrublands that are mature or late in post-fire succession (USDA Forest Service 1994). Large areas of undisturbed habitat may be required to support pairs (Barlow 1977). Habitat edges and disturbance is expected to increase across this species range as urbanization, wildfire, and recreation pressures increase over time, resulting in less favorable habitat for this species.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	This species travels from its breeding territories in the southwestern United States to its wintering territories in coastal desert along the Gulf of California (NatureServe 2015, Bates 1992). Thus, the species has a high potential for dispersal.	-1

Physiology and Phenology: Vireo vicinior

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Little is known about this species' physiological heat threshold (Winter and Hargrove 2004).	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Yes. Gray vireos favor habitats that are mature or late in post-fire succession. Therefore, increased fire return intervals and unnatural fire intensities that modify the cover and composition of favorable habitats or eliminate mature habitats will negatively impact this species (USDA Forest Service 1994, Unitt 2008). Predictions of increased frequency and intensity of drought have been predicted for the southwestern United States (Archer and Predick 2008) which will be detrimental to this species (Barlow 1977).	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Not known.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	This species has no flexible strategies to cope with variable resources across multiple years. It is very dependent on a reliable source of insect prey throughout the year and the fruits of the elephant tree (*Bursera microphylla*) in its wintering habitat.	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Information is limited. Arrival of individuals to nesting areas varies among locations, e.g., birds arrive in San Diego County in late March while more northern areas do not see arrivals until early May (Winter and Hargrove 2004), indicating that migration timing is cued by temperature.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Although no concrete evidence exists in the literature, clutch production is likely timed to coincide with insect abundance, although warmer temperatures due to climate change may cause earlier insect emergence (Bruzgul and Root 2010). If Gray vireos can demonstrated an ability to temporally shift their breeding cycle in response to warming temperatures. a potential event timing mismatch with insect emergence will be less likely.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Males may live at least 4-5 years (Winter and Hargrove 2004), and individuals become reproductively active at one year of age. The potential of this species to produce more than one brood has been reported (Erlich et al.1988, as cited in DeLong and Williams 2006; Barlow et al. 1999, as cited in Unitt 2008). Gray vireos may re-nest after a failed nest attempt (DeLong and Williams 2006). Average clutches contain 3-4 eggs, incubation takes12-14 days, and the nestling period is 13-14 days (Winter and Hargrove 2004).	-1

Biotic Interactions: Vireo vicinior

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	This species forages on insects, particularly Orthopteran and Coleopteran species, Lepidoptera larvae, and geometrids, during the breeding season (NatureServe 2015, Unitt 2008). It is not known how insect populations will respond to climate change, although if water is not limiting insect abundance may increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999). Gray vireos, their eggs, and nestlings have many potential predator species including Cooper's hawk, Loggerhead shrike, Scott's and Hooded orioles, Bewick's wren, Northern mockingbird, Western scrub-jay, Mexican jay, rats, chipmunks, reptiles, coyotes, bobcats, and gray foxes (Hargrove and Unitt 2014, Winter and Hargrove 2004). Nest predation by jays, rock squirrels and chipmunks destroyed 50% of the nests found at Colorado National Monument in 1995 (Dexter 1998, as cited in Winter and Hargrove 2004). Hargrove and Unitt (2014) found predation by Western scrub-jays negatively impacted nesting success greater than cowbird parasitism. Western scrub-jay's opportunistic and diverse diet and habitat flexibility will likely buffer it against climate change impacts better than Gray vireos over much of their range (Hoines et al. *in press*). Furthermore, increased temperatures could result in increased foraging activity for nest predators, such as snakes (Becker and Weisberg 2014).	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	The distribution of Gray vireos and the main component of their winter diet, the fruits from the elephant tree, closely overlap which suggest a mutualistic relationship (Bates 1992). Gray vireos and ash-throated flycatchers (*Myiarchus cinerascens*) are the main dispersers of *B. microphylla* (Bates 1992). It is not known how *B. microphylla* may be impacted by climate change or other stressors in the future.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	None known.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Brown-headed cowbirds (*Molothrus ater*) are brood parasites of gray vireos. Unitt (2008) cited parasitism incidence rates ranging from 4 to 20% from studies conducted outside of California, and DeLong and Williams (2006) cited rates of 24 to 71% in New Mexico. Parasitism rates and impacts to gray vireo reproductive success have not been well studied in California (Unitt 2008). Gray vireos have been extirpated from locations near Cajon Pass in California where parasitism was documented (Winter and Hargrove 2004). Most parasitized Gray vireo nests are abandoned, and successive parasitism can lead to season-long nesting failure (DeLong and Williams 2006). Livestock and equestrian facilities should be cited away from suitable Gray vireo habitat so as not to promote greater cowbird abundance (Kimball and Molina 2006). It is unknown if cases of Brown-headed cowbird nest parasitism will increase with climate change, but cowbirds are not likely to decrease.	1

Conservation Factors: Vireo vicinior

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act, but is on the United States Fish and Wildlife Service's national list of Birds of Conservation Concern (USFWS 2002). Within California, where it is a breeding resident species and has a very limited range, it has been assigned S2: Imperiled status (NatureServe 2015).	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Livestock grazing may be considered an anthropogenic constraint that would hinder their movements in the National Monument. Human recreational pressures (e.g., off-road vehicle use, recreational shooting) may also cause disturbance to nesting Gray vireos (Kimball and Molina 2006).	1
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	None known.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	No.	0

Cultural Factors: Vireo vicinior

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	None known.	0
		Total	**7**

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Pinyon Jay

Habitat: Gymnorhinus cyanocephalus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Gymnorhinus cyanocephalus* is widely distributed across the southwestern U.S., central Oregon, Idaho, Montana and Wyoming. It is primarily associated with pinyon-juniper woodland, but is also found in areas with ponderosa pine, sagebrush, scrub oak and chaparral (Balda 2002). A reduction in pinyon-juniper woodland would translate into a considerable reduction in pinyon jay habitat within the within the Monument.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Pinyon jays are primarily associated with pinion-juniper woodland. To assess how pinyon pines (*Pinus monophylla*) and California juniper (*Juniperus californica*) might respond to a changing climate, models of shifts in both species' suitable habitat within Joshua Tree National Park, to the northeast of the Monument, were assessed under different climate change scenarios. With a 3˚C increase in mean maximum temperature, suitable pinyon pine habitat was reduced by roughly 96% within the Park and 85% regionally. Juniper habitat was reduced by 78% within the Park and 45% regionally (Hoines et al. 2015). This translates into a considerable reduction in Pinyon jay habitat due to climate change. A similar response by these species may be anticipated within the Monument.	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	As climate changes and periodic rainfall events change, habitat quality may be diminished due to limited rainfall and changing hydrology of the landscape. This species' diet is composed mainly of pinyon seeds and insects, the abundance of which can be negatively affected by reduced rainfall. Insect abundance is anticipated to increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999) when water is not limiting.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	*G. cyanocephalus* has been known to wander hundreds of kilometers into new territories when pine-crops fail (Balda and Bateman 1971, Balda 2002). This species is a very able disperser which improves the chances for colonization of pinyon pines in new areas in response to climate-induced niche shifts.	-1

Physiology and Phenology: Gymnorhinus cyanocephalus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	A lower critical temperature limit of -5˚C was reported for this species (Cannon 1973). Although an upper physiological threshold has not been reported in the literature, birds have been observed panting when exposed to high temperatures	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
		(Balda 2002). Projected increases in temperature of 3˚C over the next century (IPCC 2007) may place this species near its threshold heat tolerance and may cause increased energy expenditure and physiological stress. This species nests in late winter when lower temperatures might negatively affect survivorship of nestlings. Higher minimum winter temperatures are expected due to climate change which would reduce negative impact to nestlings during winter.	
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Rainfall events are expected to become more stochastic over the next century which could increase the potential for prolonged drought conditions. Die-offs of pinyon pines have been documented as a result of severe drought in Arizona (Ogle et al. 2000). Die-off of California juniper within nearby Joshua Tree National Park has been observed at the driest portion of their distribution (Barrows and Murphy, *unpubl. data*). Drought conditions would cause a reduction in food abundance and habitat which would negatively impact *G. cyanocephalus*.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Foraging occurs in the early morning, and most activity is during the morning and evening (Balda and Bateman 1971). Daytime foraging will likely decrease in response to increased temperatures, but activity in early morning and evenings may increase to compensate.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	This species is omnivorous, enabling a switch in diet if supply of a particular food source is low. Also, it caches seeds in fall for later use in winter and spring during the breeding season (Balda 2002, Marzluff and Balda 1992). *G. cyanocephalus* will delay breeding when food resources are scarce (Lignon 1978).	-1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	This species predominately uses food abundance to initiate reproductive cycle (Lignon 1978).	-1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Pinyon seed and immature green cone abundance initiate gonadal development in males of this species (Lignon 1978), even in the absence of typical cues such as warm weather and photoperiod (Marzluff and Balda 1992). Because larger clutches are produced following abundant pine crops the previous fall (Marzluff and Balda 1992), stochastic rainfall events which impact pinyon seed crops may cause negative consequences for species reproduction the following year.	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Reproduction typically occurs after two years of age. Mated pairs produce one successful brood per year during late winter (Balda 2002) and multiple nesting attempts are possible through summer until a successful brood is produced (Balda and Bateman 1971, Marzluff and Balda 1992). Lignon (1978) reported instances where several breeding pairs produced clutches more than once in the same year in response to abundant food supplies, indicating the potential for this species to capitalize on abundant food crops which may buffer the population during times of food scarcity.	-1

Biotic Interactions: Gymnorhinus cyanocephalus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Nestlings of this species are often parasitized by larvae of a blood-sucking fly (Calliphoridae family). An increase in winter minimum temperatures due to climate change could result in greater abundance of these flies, which are active on warm winter days. Larvae hatch within the nostrils of nestlings and obtain blood meals first from nasal tissue and then from the bellies of the nestlings (Balda 2002). Growth and development of nestlings may be greatly impacted by these parasites.	1
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	*G. cyanocephalus* have a mutualist relationship with pinyon pines in that the pines depend upon the jays for seed dispersal and the jays depend upon the pinyon seeds for sustenance (Lignon 1978). Pinyon pines are expected to be negatively impacted by climate change.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Two cases of West Nile Virus have been reported in *G. cyanocephalus* (Crosbie et al. 2008); however, there is no indication that this is a wide spread disease among pinyon jay populations. It is unknown how the prevalence of this disease will be influenced by climate change.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Competitors for *G. cyanocephalus* food crops are likely to be negatively impacted by climate change impacts to pinyon pines; however pinyon pine seeds may not constitute the bulk of their diets, or they may be able to switch to other food items.	0

Conservation Factors: Gymnorhinus cyanocephalus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act. It is listed as Vulnerable by the IUCN due to population declines arising from pinyon-juniper habitat loss (BirdLife International 2012).	0
C2: Keystone species status	**Is this species considered a keystone species?**	This species is considered to have a keystone mutualism with pinyon pines which depend upon *G. cyanocephalus* for dispersal.	1
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	This species is an able disperser and has been known to wander hundreds of kilometers into new territories in search of food (Balda and Bateman 1971, Balda 2002). Because of their documented ability to disperse into new territories, anthropogenic constraints do not seem to hinder their movements.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	This species is the main disperser of pinyon pine seeds.	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	*G. cyanocephalus* may attract ornithology enthusiasts to the National Monument. This species has been widely studied due to its mutualism with pinyon pines.	1

Cultural Factors: Gymnorhinus cyanocephalus

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Unknown	0
		Total	**7**

Balda, R.P. (2002) Pinyon jay (*Gymnorhinus cyanocephalus*) In: *The Birds of North America*, Poole, A. (ed.). Cornell Lab of Ornithology, Ithaca, New York. Available at: http://bna.birds.cornell.edu/bna/species/605 (accessed 17 March 2016).

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White-headed woodpecker

Habitat: Picoides albolarvatus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Picoides albolarvatus* (White-headed woodpecker) occurs in western North America, from southern California and west-central Nevada, north through eastern and southwest Oregon, north-central Washington, western and northern Idaho into south-central British Columbia (Garrett et al. 1996). This species is found in pine-dominated mixed conifer forests (Garrett et al. 1996) at elevations of 1200-1800 m during the nesting season, or at lower elevations (above 850 m) during the winter season (NatureServe 2015, Garret et al. 1996). There are two subspecies of *Picoides albolarvatus*: *P. a. albolarvatus* occurs across most of this species' range, whereas *P. a. gravirostris* occurs from the San Gabriel Mountains south to the southern edge of its distribution in southern California (Garrett et al. 1996). The southern subspecies has a larger bill which is a result of local adaptation to feeding on the large cones of Coulter pine, *Pinus coulteri* (Mellen-McLean et al. 2013, Alexander and Burns 2006, Garrett et al. 1996, Lignon 1973). Above-average cone production in ponderosa pine has been linked to above average temperatures in California (Maguire 1956, as cited in Krannitz and Duralia 2004), which will provide good food resources for the White-headed woodpecker under a warming climate scenario; however, rapid soil drying due to increased temperatures, along with increased drought conditions will likely reduce ponderosa pine recruitment at lower elevations. Therefore, it is expected that increased temperatures due to climate change will cause upslope shifts in suitable habitat, such as was shown by Hargrove and Rotenberry (2011) for other bird species within the National Monument. Because this species already occupies "sky-islands", or mountain-top habitat within southern California (Alexander and Burns 2006), the area for this species to shift upwards in elevation may be greatly restricted.	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Yes. This species is a cavity nester and relies on large-diameter standing snags, stumps, or hollow trees for nesting (NatureServe 2015). With the exception of southern California, where this species is also associated with Coulter pine, White-headed woodpeckers are closely associated with ponderosa pine (*P. ponderosa*) throughout the majority of their range (Garrett et al. 1996, Lignon 1973). Open-canopy areas, especially burned patches with snags, are utilized for nesting and closed-canopy forests are utilized for both pine cone and insect forage; the proximity of these two habitats to each other appears to be an important indicator of suitable habitat for this species (Latif et al. 2014, Mellen-McLean et al. 2013, Hollenbeck et al. 2011). Higher abundances of this species have been tied to areas where more than one species of cone-producing pine trees occur (Garret et al. 1996).	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. Due to suppression of low-intensity natural fire regimes, ponderosa pine forests are being replaced by Douglas fir (*Pseudotsuga menziesii*) and true fir (*Abies* spp.), making these areas prone to intense stand-replacing fires (NatureServe2015). Loss of mature and old-growth ponderosa pine habitat due to fire suppression, intense fire, and logging has been linked to local White-headed woodpecker population declines (Mellen-McLean et al. 2013, Garret et al. 1996). Although vulnerability assessments were not conducted for Ponderosa pine and Coulter pine, the seeds of which are important food sources for the White-headed woodpecker, two related pine species were studied: Jeffrey pine (the seeds of which are also utilized by White-headed woodpeckers) and single-leaf pinyon pine (*P. monophylla*). Both of those species ranked high in their projected sensitivity to climate change impacts. It is very likely that other pine species will respond similarly and negatively to climate change.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	This species is generally sedentary and will occupy the same home range throughout the year. However, individuals have been documented as moving within mountain ranges, and dispersing up to 150 km from known breeding areas (Mellen-McLean et al. 2013, Garret et al. 1996), indicating good dispersal capabilities.	-1

Physiology and Phenology: Picoides albolarvatus

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	No information was found regarding this species' physiological heat threshold.	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Rainfall events are expected to become more stochastic over the next century which could increase the potential for prolonged drought conditions that, while increasing cavity-nesting site opportunities, would negatively impact food abundance. Increased intensity and severity of wildfires would negatively impact habitat quality. The extent and quality of suitable habitat within southern California for the White-headed woodpecker has already been compromised due to beetle outbreaks, drought, and wildfire, and is further threatened by development, logging, and habitat fragmentation (Alexander and Burns 2006). This suite of stressors is projected to continue into the future.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Not known.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	This species does not exhibit seed-caching behavior, most likely because pine seeds are extracted in pieces from unopened cones (Garrett et al. 1996). It is dependent on a reliable source of insect prey through spring and early summer and seeds of pine trees from late summer through winter (Mellen-McLean et al. 2013, and citations therein). Several species of pine occur within the San Jacinto-Santa Rosa Mountains National Monument, which White-headed woodpeckers may utilize for forage, including Pacific ponderosa pine, Coulter pine, Jeffrey pine (*P. jeffreyi*), sugar pine (*P. lambertiana*) and incense cedar (*Calocedrus decurrens*). This variety of winter food sources may buffer this species during times of food scarcity or seed crop failure.	-1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	In a study of a different woodpecker species, the Northern flicker, Weibe and Gerstmar (2010) found that eggs were laid earlier in the season when average daily temperatures in late April- early May were higher, and warmer-than-average temperatures five days prior to egg laying was linked to rapid follicular development. It is not known whether White-headed woodpeckers would respond similarly to increased temperatures. Because nesting may be initiated by insect abundance (see section PS6), earlier onset of increased temperatures may shift nesting of White-headed woodpeckers to earlier in the season due to increased insect activity.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	This species' diet is composed mainly of pine seeds and insects, the abundance of which can be negatively affected by rainfall shortages. Insect abundance is anticipated to increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999) when water is not limiting. Because this species is non-migratory, there is greater potential for it to track changes in the timing of food abundance (Dunn 2004). Relative to other woodpeckers, White-headed woodpeckers initiate nesting later, which may be due to their reliance on outer-bark dwelling insects that are active when temperatures become warmer later in the spring (Mellen-McLean et al. 2013, Kozma 2009). Nest survival of this species was positively correlated with maximum daily temperature, which may be related to increases in insect activity or microclimate within cavities where nests are located (Hollenbeck et al. 2011). Based on this information, increased warming (within physiological tolerances) may have a positive impact on this species.	-1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	No. Mated pairs produce one clutch per year in late May and average clutches contain 4-5 eggs (Mellen-McLean et al. 2013).	1

Biotic Interactions: Picoides albolarvatus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	No consensus. This species forages on insects during the breeding season (Mellen-McLean et al. 2013). It is not known how insect populations will respond to climate change, although if water is not limiting insect abundance may increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999). Despite the lack of substantial scientific evidence for climate change impacts to insect pests, we would expect that shifts in annual mean temperature causing decreased frequency of freezing temperatures will effect some life cycles, and therefore increase populations of associated pest insects. Fire suppression and stress brought about by increased frequency and intensity of droughts may further increase the susceptibility of pine stands to beetle outbreaks, such as mountain pine beetle (*Dendroctonus ponderosae*). Cavity-nesting species, such as the white-headed woodpecker, may respond favorably to pine beetle infestations that cause increased tree mortality (Saab et al. 2014). Small rodents are potential predators of White-headed woodpecker nests, including golden-mantled ground squirrels (*Spermophilus lateralis*) and yellowpine chipmunks (*Neotamias amoenus*) (Wightman et al. 2010). Predation was found to be the most common cause of nest failure, particularly in areas with high shrub cover and down wood cover where small mammal populations tend to be higher (Mellen-McLean et al. 2013, Wightman et al. 2010). Prolonged drought conditions due to climate change would cause increased down wood cover which may increase nest predation.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure**	Young that become impacted by ectoparasites, such as bottlefly, may be abandoned by parents (Mennen-McLean et al. 2013). While there have been no documented cases of White-headed woodpeckers infected with West Nile Virus, it has been confirmed in several other woodpeckers species (Mennen-	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
	in this species expected to change?	McLean et al. 2013). It is not known how the prevalence of West Nile Virus will be influenced by climate change.	
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Unknown. Although Hairy woodpeckers (*P. villosus*) are sympatric with the white-headed woodpecker in Washington State, they differ in foraging behavior, nest chronology and nest-site selection (Kozma 2009). When feeding on cones, male White-headed woodpeckers were dominant to both sexes of Hairy woodpeckers while female White-headed woodpeckers were subordinate to both sexes (Lignin 1973). In portions of Oregon and California, another sympatric species is the Acorn woodpecker (*Melanerpes formicivorus*), but this species generally prefers habitats that are more oak (*Quercus* sp.) dominated. Several species of birds have been shown to be aggressive towards White-headed woodpeckers at nest sites, including Pygmy nuthatches, Western bluebirds, Mountain bluebirds, and European starlings (Mennen-McLean et al. 2013). It is not known whether climate change may result in greater competition between sympatric species, or how it will impact competing species.	0

Conservation Factors: Picoides albolarvatus

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act. This species is considered "imperiled" and vulnerable to extirpation in Nevada, Oregon, Washington and Idaho, and "critically imperiled" in British Columbia; this species does not have a state rank in California (NatureServe 2015, Mellen-McLean et al. 2013).	0
C2: Keystone species status	**Is this species considered a keystone species?**	Yes. Because this species is a primary excavator, it creates cavities that can then be used for roosting, denning, and nesting by other species (Kozma 2009).	1
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	There is little evidence to suggest white-headed woodpeckers are disturbed by human presence (Mellen-McLean et al. 2013). Because they tend to be able dispersers (see section H4), anthropogenic constraints will are not likely to hinder their movements.	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	None known.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Woodpeckers are generally liked by children due to their association with popular cartoon characters. The drumming it produces when pecking on the outside of trees draws the attention of Monument visitors.	1

Cultural Factors: Picoides albolarvatus

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	None known.	0
		Total	**6**

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Dukes, J.S. & Mooney, H.A. (1999) Does global change increase the success of biological invaders? *Trends in Ecology and Evolution*, **14(4)**, 135-139.

Dunn, P. (2004) Breeding dates and reproductive performance. *Advances in Ecological Research*, **35**, 69-87.

Garrett, K.L., Raphael, M.G. & Dixon, R.D. (1996) *White-headed woodpecker (Picoides albolarvatus): the birds of North America online*, Poole, A (ed.). Cornell Lab of Ornithology, Ithaca, New York. Available at: http://bna.birds.cornell.edu/bna/species/252 (accessed 17 March 2016).

Hargrove, L. & Rotenberry, J.T. (2011) Spatial structure and dynamics of breeding bird populations at a distribution margin, southern California. *Journal of Biogeography*, **38**, 1708-1716.

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Kozma, J.M. (2009) Nest-site attributes and reproductive success of white-headed and hairy woodpeckers along the east-slope Cascades of Washington State. In: *Tundra to tropics: connecting birds, habitats and people*, Rich, T.D., Arizmendi, C., Demarest D. & Thompson, C. (eds). Proceedings of the 4th international Partners in Flight conference, 13-16 February 2008, McAllen, Texas.

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Wiebe, K.L. & Gerstmar, H. (2010) Influence of spring temperatures and individual traits on reproductive timing and success in a migratory woodpecker. *The Auk*, **127(4)**, 917-925.

Wightman, C.S., Saab, V.A., Forristal, C., Mellen-McLean, K. & Markus, A. (2010) White-headed woodpecker nesting ecology after wildfire. *The Journal of Wildlife Management*, **74(5)**, 1098–1106.

Ladder-backed woodpecker

Habitat: Picoides scalaris

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Picoides scalaris* (Ladder-backed woodpecker) is found east of the San Jacinto mountain range in southern California, north to the Inyo-San Bernardino County line, west to eastern Kern County and the Antelope Valley, and south throughout the Anza-Borrego desert region of western San Diego County (Unitt 1984, Small 1994). Its range then extends throughout the southwest into Texas, and south through most of Mexico (Lowther 2001). Within the National Monument, it is expected that increased temperatures due to climate change will cause upslope shifts in suitable habitat. Already Ladder-backed woodpecker distribution has significantly increased in average elevation by 307 m (from 820 to 1127 m) between 1979 to 2007, due to a mean maximum temperature increase of 3.8˚C (Hargrove 2010).	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	This species utilizes a variety of habitats across its broad distribution. In California, this species inhabits desert scrub dominated by Joshua trees (*Yucca brevifolia*) or agave species below 2300 m (Short 1971, Short and Sandstrom 1982). It occurs with Nuttall's woodpecker (*P. nuttallii*) in coastal sage scrub and dry wash scrub (Weaver 2011). In the absence of Nuttall's woodpecker it can also be found in riparian and desert-edge woodlands (Short 1971). In the Southwest it has been found in desert habitat dominated by mesquite, palo verde, catclaw, hackberry, and cholla cacti (Austin 1976). It is found throughout the Chihuahuan and Sonoran deserts in desert scrub and thorn forests and in Central America in pine and pine-oak woodlands (Short 1971, Short and Sandstrom 1982). This species rests in mesquite, elderberry, scrub oak, willows, and on telephone poles (Unitt et al. 2004).	0
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Projected changes are likely to negatively affect habitat quality for this species. *Picoides scalaris* forages for insects in Joshua trees, cactus, mesquite, agaves, cottonwood, acacias, and willows. Availability of agaves and yuccas are a key factor in occurrence in San Diego County (Unitt et al. 2004). It forages in scrub oaks and live oaks at the cismontane and transmontane chaparral-desert ecotone (Short 1971). Many of these perennial plant species that provide foraging and nesting habitat may respond negatively to climate change thus altering the availability of insects for the woodpecker.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Although non-migratory, *Picoides scalaris* inhabits a broad range and is expected to readily track shifts in essential habitat components.	-1

Physiology and Phenology: Picoides scalaris

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	This species inhabits a broad climatic regime, with much of its territory in arid and warm climates (Short 1971, Short and Sandstom 1982). The projected shifts in climate for the National Monument will likely open up areas of habitat that have previously not been colonized due to physiological intolerances to frost.	-1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Rainfall events are expected to become more stochastic over the next century which could increase the potential for prolonged drought conditions that would negatively impact food abundance. Bolger et al. (2005) found that arthropod declines due to drought conditions caused reproductive failure in four species of passerine birds inhabiting southern California. Drought conditions would likely impact the Ladder-backed woodpecker similarly.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Not known.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	No. *Picoides scalaris* actively hunts for insects in vegetation, and relies on insect populations remaining sustainable through resource fluctuation (Lowther 2001). They do not cache food resources.	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Unknown. In a study of a different woodpecker species, the Northern flicker, Weibe and Gerstmar (2010) found that eggs were laid earlier in the season when average daily temperatures in late April-early May were higher, and warmer-than-average temperatures five days prior to egg laying was linked to rapid follicular development. It is not known whether Ladder-backed woodpeckers would respond similarly to increased temperatures. Nesting may be initiated by insect abundance; earlier onset of increased temperatures may shift nesting of Ladder-backed woodpeckers to earlier in the season due to increased insect activity.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Breeding season commences in April-May (Lowther 2001). It is unknown if climate change will alter event timing. This species' diet consists mainly of larval arthropods, as well as caterpillars and ants (Schroeder et al. 2013, Scott et al. 1977). Insect abundance is anticipated to increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999) when water is not limiting; however, the abundance of arthropods can be negatively affected by rainfall shortages. Because this species is non-migratory, there is greater potential for it to track changes in the timing of food abundance (Dunn 2004).	-1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	No. This species has one clutch of 3 to 7 eggs per year (Lowther 2001).	1

Biotic Interactions: Picoides scalaris

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	*Picoides scalaris* forages on arthropods (Schroeder et al. 2013, Scott et al. 1977). It is not known how arthropod populations will respond to climate change. If water is not limiting, arthropod abundance may increase with a warmer climate due to milder winters and shorter generation times (Dukes and Mooney 1999). Information regarding brood parasitism or predators of this species was not found (Jongsomjit and Arata 2008).	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	None known.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure**	Not known.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
	in this species expected to change?		
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	No expected impacts from population changes in competitor or invasive species.	0

Conservation Factors: Picoides scalaris

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act, and is considered of Least Concern by the IUCN (Lowther 2001).	0
C2: Keystone species status	**Is this species considered a keystone species?**	Yes. Because this species is a primary excavator, it creates cavities that can then be used by secondary cavity nesting species. Declines in *P. scalaris* abundance may negatively impact populations of secondary cavity nesters (Schroeder et al. 2013).	1
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	No known anthropogenic constraints to dispersal.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	None known.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Woodpeckers are generally liked by children due to their association with popular cartoon characters. There is general interest among local birders for this species, and they are easily observed.	1

Cultural Factors: Picoides scalaris

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	None known.	0
		Total	**5**

Austin, G.T. (1976) Sexual and seasonal differences in foraging of ladder-backed woodpeckers. *Condor*, **78**, 317-323.

Bolger, D.T., Patten, M.A. & Bostock, D.C. (2005). Avian reproductive failure in response to an extreme climatic event. *Oecologia*, **142**, 398-406.

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Dunn, P. (2004) Breeding dates and reproductive performance. *Advances in Ecological Research*, **35**, 69-87.

Hargrove, L. (2010) Limits to species' distributions: spatial structure and dynamics of breeding bird populations along an ecological gradient. Dissertation, University of California, Riverside, California. Available at: http://escholarship.org/uc/item/8nr976ss (accessed 17 March 2016).

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Vegetation

Red Shank

Habitat: Adenostoma sparsifolium

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1:* *Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Adenostoma sparsifolium* (Red shank) is a native, sclerophyllous perennial shrub that occurs in disjunct populations from the South Coast Ranges south into northern Baja California (Marion 1943, Howard 1993) between 275-2000 m in elevation (Jones 2013). It is most abundant in Riverside and San Diego Counties along the Peninsular Range, particularly the San Jacinto and Santa Rosa Mountains (Howard 1993), but also occurs in San Bernardino County and in each coastal county up to San Luis Obispo (Calflora 2015). Inn San Luis Obispo and Santa Barbara counties populations of red shank dominate stands and few other shrub species occur, whereas red shank occurs in mixed species stands at its more southern locales (Beatty 1987). Excepting in the Santa Monica Mountains, all populations of this species occur greater than 80km (50 miles) inland (Hanes 1965). It can be found on dry slopes, flats, and ravines, in pinyon woodland and chaparral communities (Jones 2013). It is estimated that red shank dominates only 2.5% of California's chaparral (Marion 1943), whereas its congener, *A. fasciculatum* (chamise), has a more widespread distribution and is prevalent in chaparral (Hanes 1965). Weins et al (2012) determined that an average of 90% of red shank seeds were empty (aborted), which they linked to inbreeding. Evidence exists to suggest red shank is suffering continued population decline across its range, while chamise is proving to be better suited to the environments where the two species co-exist (Weins et al. 2012). It can be expected that the habitat extent of red shank will decline due to climate change, particularly since red shank may be relic from a moister climate regime (Weins et al. 2012). An upward shift in elevation would also be predicted for this species. Due to its low recruitment and seedling survival rates, such a shift is unlikely.	1
H2:* *Habitat specialization	**Does the species require specific habitat types / habitat components?**	Yes, this species is a moderate habitat specialist. Red shank typically occurs on shallow, coarse gravelly or sandy soils (Marion 1947), that are derived from loosely-cemented Miocene sandstone or granite (in the northern and southern portions of its range, respectively; Marion 1947, Hanes 1965). For successful seedling establishment, this species requires disturbed sites (mechanical clearing or landslides) where loose mineral soil has been exposed. This soil is easily penetrated by	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
		both seedling roots and surface water (Weins et al. 2012). Summer rains increase seedling survival chances by reducing the drought window.	
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. Summer rainfall increases seedling survival, which may be one reason for the higher density of red shank populations in the San Jacinto Mountains (Weins et al. 2012). Although predictions indicate greater precipitation stochasticity, increased frequency and intensity of drought is expected (Archer and Predick 2008), along with higher maximum temperatures for the southwestern United States. Therefore, survival of seedlings is expected to be reduced.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Due to low seed set and low overall seed viability, seedling recruitment is rare for this species (Howard 1993). Hanes (1965) reported only one site where *A. sparsifolium* seedlings were found after a search of four regions along the species' entire distribution. Only half of the seedlings at that site survived the summer. The limited distribution of this species maybe due to low recruitment (Hanes 1965). Reproduction may also occur vegetatively via the lignotuber (Howard 1993, James 1984), and exposed roots may produce shoots (Weins et al. 2012). However, clonal reproduction is rare and never extensive. Therefore, recruitment may be limited to seed (Weins et al. 2012). Accounts of seed dispersal were not found in the literature. Based on the low viability of seeds and their short-lived nature, dispersed seeds would presumably have little chance of germination, even if seeds were dispersed to the rare microhabitats that favored red shank germination and survival. Chamise and red shank do not have overlapping flowering periods and, therefore, do not hybridize (Hanes 1965).	1

Physiology and Phenology: Adenostoma sparsifolium

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Projected changes in temperature will primarily remain within physiological tolerances at higher elevations where this species occurs. Hanes (1965) documented temperatures over 100˚F (37˚C) at sites where *A. sparsifolium* occurred, and average maximum temperatures during mid-summer were above 90˚F. The leaves of this species are covered with a sticky resin that may serve to reflect radiation (Howard 1993).	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Precipitation events are expected to become more stochastic over the next century, and drought periods are projected to increase. Compared to chamise, red shank seedlings are less resistant to drought due to higher minimum seasonal water potentials and greater susceptibility to water stress induced cavitation of stem xylem (Weins et al. 2012). This species is long-lived (100+ years; Howard 1993), and fire-adapted. It can resprout from the lignotuber after above-ground biomass has been burned (Howard 1993). These traits may buffer it against the increased frequencies of fire predicted with climate change. However, increased wildfire frequencies will deplete lignotuber stores and will be detrimental to this species if fires return before burned plants have had time to recover. Approximately 6% of adult mortality has been reported following fire (Weins and Slaton 2012), and post-fire establishment by seed is not common (Hanes 1965).	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Not known.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	This species will shed stems and bark during normal summer and fall drought periods to reduce transpiration (Hanes 1965). Despite this adaptation to water-stress, this species does not have flexible strategies to cope with extended periods of water stress. Approximately 15% of adults succumb during prolonged (5-year) drought periods (Weins et al. 2012, Weins and Slaton 2012).	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Germination occurs in spring and is probably cued by moisture. Morning fog may be important for seeding germination and survival in some areas (Hanes 1965). Timing and intensity of rainfall is expected due to climate change, so germination will likely be impacted. If rainfall occurs earlier in the spring, seedlings may have a longer drought period over the summer, unless a rare summer rain event occurs. Flowering and seed set occurs in late summer/early fall, and the timing is likely due to the soil characteristics of the sites where this species is found which enable water-retention into the dry season (Beatty 1987). Flowering occurs every year regardless of rainfall in the previous winter (Hanes 1965). Therefore, changes in temperature and/or moisture will not impact reproductive activity. Stem growth begins in February and is most active from June to mid-August (Howard 1993). It is not known whether temperature or moisture cues initiate stem growth activity.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Yes. Seedlings typically must survive a 4-6 month drought period after germination (Davis et al. 1998). If timing of fires, which usually occur late summer-fall, were to occur earlier in the summer due to reduced soil moisture, seedlings would survive a longer drought period with greater difficulty. An increase in the frequency of summer rains would be advantageous to the survival of seedlings (Weins et al. 2012). However, according to climate change projections, such a shift is not expected to occur.	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Flowering occurs once per year, from August to September or October (Howard 1993, Beatty 1987) but low successful recruitment via seed is typical. This species can vegetatively reproduce; however, clonal reproduction is rare and never extensive. Therefore, recruitment may be limited to seed (Weins et al. 2012).	1

Biotic Interactions: Adenostoma sparsifolium

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Weins et al. (2012) found 3.1% of the red shank flowers they examined exhibited predation, the majority by egg-laying insects which turned the ovaries into galls. It is difficult to generalize how climate change may impact these insects. We might assume that shifts in annual mean temperature causing decreased frequency of freezing temperatures will effect some life cycles, and, therefore, increase populations of associated pest insects.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
		Mills (1983) found little evidence that insect predation effects seedling establishment of red shank's congener, chamise, and chamise seedlings were less preferred by herbivores than another co-occurring chaparral species, *Ceanothus greggii* (Desert ceanothus). In post-fire years 1 and 2, respectively, 27% and 42 % of tagged red shank shrubs were browsed by herbivores compared to 7% and 30% of chamise, indicating herbivore preference for red shank (Mills 1986). However herbivory was found to have no effect on growth or survival of post-fire stump sprouts of either species.	
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	It is speculated that the primary pollinators of red shank may have gone extinct due to increased aridity since the mid-Holocene, and, therefore, fertilization is achieved through self-pollination (Weins et al. 2012). Inbreeding due to self-pollination is apparent in red shank. In some populations self-pollination is forced due to the petals of flowers not even opening (Weins et al. 2012). Plants have an increased likelihood of survival in the desert when arbuscular mycorrhizal (AM) fungi form associations with their roots (St. John 2000, and Stutz et al. 2000, as cited by Apple et al. 2005). *A. sparsifolium* are known to have beneficial associations with AM fungi (Allen 1991), which help with water efficiency and nutrient uptake, especially in more stressful climates. Colonization of AM fungi associated with Mojavean shrubs have been documented fluctuating with annual precipitation patterns, and are shown to decrease significantly during periods of drought (Apple et al. 2005). In a climate with increased periods of drought, mycorrhizal fungi colonization will most likely be reduced.	1
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	None known.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	None known.	0

Conservation Factors: Adenostoma sparsifolium

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Red shank seedling establishment has been found adjacent to anthropogenic clearing and dirt tracks, which uncovered mineral soil, and along roadside drainage channels where water runoff from summer storms accumulates (Hanes 1965, Weins et al. 2012). It is unlikely that there are anthropogenic constraints to this species dispersal; rather, anthropogenic disturbance may facilitate establishment.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. *A. sparsifolium* fixes atmospheric carbon and provides habitat structure. It is browsed by small mammals and livestock, and lizards may use the branches as basking sites (Howard 1993).	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Not likely.	0

Cultural Factors: Adenostoma sparsifolium

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Although there are accounts that the Cahuilla Indians used the root and branch of red shank to create small throwing clubs, called rabbit sticks or *na-hat-em* (Barrows 1900), no information was found regarding other unique historical uses of red shank.	0
		Total	**11**

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Desert Agave

Habitat: Agave deserti

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Agave deserti* is a long-lived perennial that occurs on sandy flats and rocky slopes in the Sonoran and Mojave deserts of southern California, and into Arizona and northern Baja California (Munz 1974). There are two varieties of *Agave deserti*: variety *deserti* occurs within southern California and northern Baja California and has numerous rosettes, whereas var. *simplex* occurs in both southern California (Mojave Desert) and Arizona and has one or few rosettes (Gentry 1982). The elevational range of this species is 90-1620 m (Turner et al. 2005). It is expected that increased temperatures due to climate change will cause upslope shifts in suitable habitat for many species However, Kelly and Goulden (2008) found a mean decrease in elevation (-50 m) for *A. deserti* between 1977 and 2006-2007, despite a temperature increase of 0.63˚C during that timeframe. It was the only species out of ten species studied that did not shift upwards in elevation. These findings, coupled with this species' wide elevational range and adaptation to desert climate extremes, lead to the conclusion that the locations of this species' habitat will not dramatically change due to moderate levels of climate change.	0
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Seedlings that germinate next to a nurse plant, such as big galleta (*Hilaria rigida*) and white bur-sage (*Ambrosia dumosa*), or in sheltered microhabitats, where soil surface temperatures are lower than the surrounding area, have been shown to have increased survival (Jordan and Nobel 1979, Nobel 1984). It is unknown how the abundance of nurse plants or microhabitat sites might be influenced by climate change.	0
H3: Habitat quality:	**Are features of the habitat associated with increased survival expected to change?**	Yes. Seedling *A. deserti* require enough soil moisture to generate sufficient water storage capacity that will allow them to endure the first drought (Nobel 1984). Therefore, seedling establishment is often episodic (Jordan and Nobel 1979). Predictions of increased frequency and intensity of drought (Archer and Predick 2008), along with higher maximum temperatures have been predicted for the southwestern United States. Therefore, germination and survival of seedlings are expected to be reduced.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	An individual of this species can produce approx. 65,000 seeds in one inflorescence before dying (1977). However, Germination requirements greatly limit seedling establishment. Additionally, seed predation by rodents is high for this species (Nobel 1977). The majority of individuals are produced vegetatively (Jordan and Nobel 1979) especially by var. *deserti*. Clonal individuals would be close to the parent plant. Therefore its dispersal abilities are low.	1

Physiology and phenology: Agave deserti

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	No. Projected changes in temperature or moisture will primarily remain within physiological tolerances. *A. deserti* may experience increased growth and productivity in response to higher atmospheric CO_2 concentration; however, higher CO_2 levels may only be advantageous if water is not limiting (Graham and Nobel 1996). Seedlings that are acclimated to high temperatures may withstand tissue temperatures exceeding 60˚C (140˚F); however, sheltered microhabitats are required to prevent damage from high temperatures (Nobel 1984).	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Yes. Precipitation events are expected to become more stochastic over the next century, and rainfall is an important cue for flowering/reproduction (see section PS5).	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	*A. deserti* are CAM species, which means that CO_2 uptake occurs during the night and stomata are closed during the day to reduce water loss. Stomata can remain closed during severe drought conditions to conserve water, making this species well adapted to arid environments. Projected climate shifts are unlikely to negatively influence daily physiological activity periods associated with this species' CAM metabolism.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	No consensus. This species has the ability to vegetatively reproduce, which allows for preservation of genetic information until environmental conditions are sufficient for seed production and the germination of new individuals to occur. However, rainfall events are expected to become more variable due to climate change, and, although drought tolerant, adults may not withstand severe drought conditions over multiple years.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Yes. This species is sensitive to temperature and moisture cues to initiate reproduction (Nobel 1987) and germination (Nobel 1977). Flowering of this species is best predicted by the number of wet days occurring two year previously (Nobel 1987). Maximum germination in a laboratory setting occurred at a seed temperature of 23˚C (73˚F) with 86% of seeds germinating after 10 days (Nobel 1977). However, when the seed was exposed to drying after 3 days of wet conditions, only 18% of seeds germinated at 23˚C after 10 days, indicating this species requires rainy periods which result in prolonged soil moisture content during the winter and spring months to germinate.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Activities related to the fecundity and survival of this species are not tied to discrete peaks in available resources, but are dependent upon the duration and frequency of rainfall events (refer to previous sections).	-1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Reproduction and seed production result from one inflorescence at the end of an individual's life. However, this species also reproduces vegetatively, and rosettes become independent of the parent plant after about 14 years (Nobel 1987). Mean age at flowering is estimated to be 55 years, so a parent plant could produce several rosettes, which will also eventually flower, during its lifespan. A single colony of agaves may survive over several generations due to vegetative reproduction until environmental conditions are conducive to trigger flowering.	-1

Biotic Interactions: Agave deserti

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Seed predation is a major factor limiting the recruitment of this species. Nobel (1977) reported that 84% of *A. deserti* seeds experimentally placed on the ground during winter and spring were removed by rodents in a 24-hour period. Ungulates, lagomorphs and rodents will also eat the leaves, especially during drought periods. It is unknown how these predators themselves will be impacted overall due to climate change.	0

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Although birds and insects probably pollinate *A. deserti* (Turner et al. 2005), the main pollinators of this species are likely bats, which would have a mutualistic relationship with Agaves. Howell and Roth (1981) found that declines in reproductive success of several agaves species, including *A. deserti*, corresponded to declines in nectar-feeding bat populations in southern Arizona. Habitat destruction and exploitation of agaves was cited as a cause for bat declines; however, bats may be further negatively impacted by climate change as a result of increased water stress in lactating females (Adams and Hayes 2008). Plants have an increased likelihood of survival in the desert when arbuscular mycorrhizal (AM) fungi form associations with their roots (St. John 2000, and Stutz et al. 2000, as cited by Apple et al. 2005). Mycorrhizal fungi infection improves drought tolerance and nutrient and water uptake in *Agave deserti* (Cui and Nobel 1992). Colonization of AM fungi associated with Mojavean shrubs have been documented fluctuating with annual precipitation patterns, and are shown to decrease significantly during periods of drought (Apple et al. 2005). In a climate with increased periods of drought, mycorrhizal fungi colonization will most likely be reduced.	1
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	None known.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	None known.	0

Conservation Factors: Agave deserti

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C2: Keystone species status	**Is this species considered a keystone species?**	Yes. Desert agave is important to wildlife for shelter and food resources (Gentry 1982). Its relative impact on its ecosystem is disproportionately large compared to its abundance, thereby distinguishing it as a keystone species (Paine 1995).	1
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	No. It does not appear that there are any anthropogenic constraints that would hinder their movements in the National Monument.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	None known.	0
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	We presume Monument visitors are interested in flowering events, which are rare, and are attracted to the tall, prominent stalks and bright flowers that are produced by this species when it reproduces. Additionally, this species' historic use and importance to Southern Californian Indian tribes may also generate interest among Monument visitors.	1

Cultural factors: Agave deserti

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes. Cahuilla Indians of Southern California made much use of *A. deserti* for food and fiber; the stalk, leaves, and blossoms were all cooked, eaten, and used in various ways (Barrows 1900). According to Gentry (1982), in addition to the Cahuilla Indians, "[o]ther tribes known to use *A. deserti* […] are the Pimas and Papagos of both Arizona and Sonora, the Yumans, Kamias, Chemehuevis, and Yavapais along the Rio Colorado, and the Diguenos and Cocopahs of northern Baja California. Other adjacent tribes, such as the Utes and Apaches, received cooked *A. deserti* in trade". Mescal pits, used to roast agaves, are common throughout the *A. deserti* range, from the desert slopes of the San Jacinto Mountains south along the Peninsular Range into Mexico (Castetter et al. 1938).	1
		Total	**6**

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Bigberry manzanita

Habitat: Arctostaphylos glauca

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Arctostaphylos glauca* occurs broadly throughout California and Baja Mexico, but is limited in its distribution in the deserts and at elevations below 1372 m (Vasek and Clovis 1976, Howard 1993). With increasing levels of aridity and periods of drought, we anticipate the range of *A. glauca* to shrink. Locations likely to be most affected include the higher elevation zones within the deserts, where this species is already a minor component of the flora composition.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	In the Los Padres National Forest this species is correlated with rocky slopes within a narrow temperature range (27.5-28.3˚C), often on dry, shallow soils (Meentemeyer et al. 2001). While these habitat components will not change, *A. glauca* requires fire for regeneration. Pronounced periods of drought due to climate change may diminish fire potential by eliminating the seed bank of fire-carrying invasive species. A decreased fire potential will also diminish the regeneration capacity of this species (Hanes 1971, Keeley and Keeley 1977, Keeley and Zedler 1978, Fulton and Carpenter 1979). This species requires long fire-return intervals that allow individuals to mature and produce greater amounts of seeds and also allows fuel loads to accumulate to ensure fire intensities sufficient to crack this species' hard seed coat (Howard 1993).	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Individual plants cope with drought stress through branch dieback (Brooks and Ferrin 1994), yet the accumulated stress of increased periods of drought may cause whole plants to die. Gitlin and colleagues (2006) found a significant difference in the mortality of the congener *Arctostaphylos pungens* at 40 m away from washes, presumably due to depth to water table, during a drought.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	This species has moderate dispersal capabilities. Silverstein (2005) has shown that *A. glauca* seeds are consumed by coyotes, can be deposited away from the source populations, and still maintain the ability to germinate. Coyotes are large mammals with large home ranges that allow for *A. glauca* to colonize new locations.	0

Physiology and Phenology: Arctostaphylos glauca

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Drought is predicted to increase in intensity and duration. *A. glauca* copes with periods of drought through branch dieback to manage water stress. It is likely that the changes in drought will be greater than what *A. glauca* individuals are adapted to tolerate.	1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	*A. glauca* is an obligate seeder and seeds germinate post-fire. While *A. glauca* requires fire for seeds to germinate, the reproductive output increases with age for individuals. Therefore, an increased fire-return interval would be expected to be negative for *A. glauca* (Keeley and Keeley 1977).	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Unknown.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Individual plants cope with drought stress through branch dieback (Brooks and Ferrin 1994), yet the accumulated stress of increased periods of drought may cause whole plants to die. Gitlin and colleagues (2006) found a significant difference in the mortality of *Arctostaphylos pungens* at 40 m away from washes, presumably due to depth to water table, during a drought. Yet, it is unknown how *A. glauca* would cope with multi-year drought events, especially because seedlings mortality is high during summer droughts (Howard 1993).	0
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	No. Fire initiates germination in this species.	0
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Unknown.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	No. *A. glauca* produces flowers only once each year, typically from December through May.	1

Biotic Interactions: Arctostaphylos glauca

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Unknown.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Unknown.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Branch dieback is caused by a fungus that is most injurious during hot temperatures (Brooks and Ferrin 1994).	1
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Invasive species are likely to compete with individuals for water and other nutrients. Invasive grasses are not direct competitors, but carry fire which could eliminate adult *A. glauca* if fire-return intervals increase. In the Los Padres National Forest, *A. glauca* abundance is negatively correlated with *Adenostoma fasciculatum* abundance (Meentemeyer et al. 2001). It is not known how the abundance of *A. fasciculatum* will change with climate change.	1

Conservation Factors: Arctostaphylos glauca

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No. This species is not protected under the Endangered Species Act.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Unknown.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. This species serves as a carbon sink by fixing carbon through photosynthesis. Birds, rodents, and coyotes will consume the fruits and seeds produced by this species (Howard 1993).	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Unknown.	0

Cultural Factors: Arctostaphylos glauca

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes, the fruit of this species has been historically eaten fresh, dried and ground into flour, or made into cider and jelly (Yanovsky 1936, Sweet 1962, Barrows 1900). Fruits and leaves were used medicinally to treat bronchitis, poison oak, and other diseases (Sweet 1962). Branches of this species were also used to construct shelters (Barrows 1900).	1
		Total	**10**

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Acton encelia

Habitat: Encelia actoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Encelia actoni* is found on rocky slopes, mesas, and roadsides (Baldwin et al. 2012, Benson and Darrow 1954). According to Consortium of California Herbaria (CCH) records, most documented occurrences fall within elevations of 488-1524m, with outliers documented at elevations as low as 183m and up to approximately 2012m. Its range extends from western Nevada into Death Valley, White Mountains, San Jacinto, Palomar Mountains, the western Mojave and Colorado deserts of California, and slightly into northern Baja California (Clark 1998, Munz 1958, Benson and Darrow 1954). It is found in both creosote bush scrub and interior cismontane vegetation communities (Munz 1958). Within Joshua Tree National Park, to the northeast of the Monument, this extent of this species' suitable habitat was projected to decrease by 90% with climate change (Hoines et al. 2015). A similar climate change sensitivity and decrease in suitable habitat may be expected for this species within the Monument.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Specific essential habitat components are unknown.	0
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes, if availability of soil moisture is a feature of the habitat.	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	*E. actoni* fruits are 4-5 mm long, flat, achenes (Shreve and Wiggins 1964). They have a pair of hairy awns at the tip, and a fringe of dense, long, trichomes around the margin. The fruits of *Encelia frutescens* are very similar in form, and are about twice the size of *E. actoni* (Clark 1998). Maddox and Carlquist (1985) note of *E. frutescens* seed: "excellent at lofting, but relatively poor at horizontal movement on a surface". This implies *Encelia frutescens* seed has the ability to readily disperse up slope by lofting, and become "lodged in crevices readily" once it has fallen to the ground (Maddox and Carlquist 1985). Considering *E. actoni* seeds are significantly smaller than those of *E. frutescens*, with the same shape, ciliate margin, and pilose surfaces, we suggest ability to disperse is comparable, if not superior.	-1

Physiology and Phenology: Encelia actoni

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	The mean annual temperature over the distribution of *E. actoni* is approximately 11-18˚C (52-64˚F; previously cited as 16-21˚C by Ehleringer and Clark 1988), with a mean annual temperature range of approx. 15-23˚C (59-73˚F; Clark 1998). The upper thermal damaging temperature for *Encelia* is approximately 45-47˚C (113-116.6˚F). If this value is increased by 3˚C over the next century, as "worst case scenario" projections predict, populations inhabiting higher elevations may avoid their thermal damaging temperature. However, populations at the lower elevations would most likely be damaged by extreme heat events. In comparison to other species of the genus, *E. actoni* occupies a fairly narrow climactic regime, limited to higher elevations and cooler mean annual temperatures than other closely related species (Clark 1998); therefore, its limiting physiological tolerances are expected to be tested.	1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Yes, a recent study of the Mojave and Sonoran desert vegetation response to drought shows that relatively small, drought deciduous shrubs, at sites located in Joshua Tree National Park, showed the greatest mortality of all perennial vegetation observed in response to a severe multi-year drought that occurred between 1998-2003 (McAuliffe and Hamerlynck 2010). As a small drought-deciduous shrub, *E. actoni* would most likely exhibit a similar response to increased episodes of prolonged drought, especially for those populations at lower elevations. The annual precipitation associated with *E. actoni*'s climactic envelope is between 50-100 mm.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Unlike many other desert species that have the ability to make metabolic adjustments to suit their environment (Berry and Bjorkman 1980 as cited in Ehleringer and Clark 1988), *Encelia spp.* can only photosynthesize under their optimal metabolic temperature. apparently between 26-28˚C (79-82˚F; Ehleringer and Clark 1988). *E. actoni* flowers between February and July (Baldwin et al. 2012, Clark 2006). The spring-restricted flowering period suggests the availability of soil moisture from winter rains is required for reproduction (Bowers and Dimmit 1994). However, other closely related species of the genus have been reported as opportunistic, exhibiting "copious flowering" under favorable soil moisture conditions throughout the year (Comstock and Ehleringer 1984). Based on this information, it appears that the phenological requirements and thresholds are broad enough to buffer for change in climate.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Yes. *E. actoni* is drought-deciduous, dropping its leaves in times of depleted soil water reserves. This causes the plant to go into a state of dormancy (Comstock and Ehleringer 1984). *E. actoni* also has a "thick reflective pubescence" which reduces leaf temperatures and prevents leaf damage when there is inadequate water for transpirational cooling (Clark 1998).	-1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Yes. At two sites in Arizona, researchers observed that the bloom of another species of the same genus, *E. farinosa*, was triggered by at least 20 mm of cool season rains followed by consistent temperatures above the threshold temperature of 50˚F (10˚C). Researchers also noted that high temperatures reached in summer months induced termination of the bloom (Bowers and Dimmitt 1994). Due to *E. actoni*'s similarity in flowering period to *E. farinosa*, we assume cues for germination are also related to temperature and moisture. In a greenhouse setting, optimal germination temperature was 15˚C (59˚F) with 65% germination; 1% germination was observed at 5˚C (41˚F); and 5% germination was observed at 25˚C (77˚F; Burgess 1977). This indicates a temperature cue for germination of *E. actoni*.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Unlike many other desert species that can make metabolic adjustments to adapt to their environment (Berry and Bjorkman 1980, as cited in Ehleringer and Clark 1988), *Encelia spp.* can only photosynthesize under their optimal metabolic temperature, apparently between 26 and 28˚C (Ehleringer and Clark 1988). In a greenhouse setting, optimal germination temperature was 15˚C, with 65% germination observed (Burgess 1977). If temperatures do increase, it is likely to have an effect on the timing of photosynthesis for this species. In a greenhouse setting, the temperature cue for germination does not seem particularly discrete, in that 47% germination occurred at 10˚C (50˚F), and 55% at 20˚C (68˚F) (Burgess 1977).	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	*E. actoni* is documented as flowering between February and July (Baldwin et al. 2012, Clark 2006). The flowering period restricted to spring suggests the availability of soil moisture from winter rains is required for reproduction (Bowers and Dimmit 1994). However, other closely related species of the genus have been reported as opportunistic, exhibiting "copious flowering" under favorable soil moisture conditions throughout the year (Comstock and Ehleringer 1984). Despite its ability to flower when temperature and soil moisture levels are less than ideal, the ability of *E. actoni* to produce viable seed at these times is unknown.	0

Biotic Interactions: Encelia actoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Unknown.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Pollination in *E. actoni* is general, involving butterflies, solitary bees, occasional honeybees and beetles (Clark 1998). Pollination is unlikely to be affected due to the generalist nature of the species. Plants have an increased likelihood of survival in the desert when arbuscular mycorrhizal (AM) fungi form associations with their roots (St. John 2000, Stutz et al. 2000 as cited by Apple et al. 2005). Colonization of AM fungi associated with other Mojavean drought deciduous shrubs have been documented fluctuating with annual precipitation patterns, and are shown to decrease significantly during periods of drought (Apple et al. 2005). In a climate with increased periods of drought, AM fungi colonization will most likely be reduced.	1
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Unknown.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Unknown.	0

Conservation Factors: Encelia actoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C2: Keystone species status	**Is this species considered a keystone species?**	Unknown.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Unknown.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. *Juniperus californica* serves as a carbon sink by fixing carbon through photosynthesis.	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	No.	0

Cultural Factors: Encelia actoni

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Unknown.	0
		Total	**6**

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California juniper

Habitat: Juniperus californica

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	The *Juniperus californica* woodland alliance is mapped as occurring at elevations between 600-2450 m throughout California (Sawyer et al. 2009). In southeastern desert California, its distributional range includes the west edge of the Colorado Desert and Joshua Tree National Park north to Kern County (Munz 1974). Associated vegetation types include cismontane and transmontane (Sawyer et al. 2009), pinyon/juniper woodland (Adams and Bartel 2012, Munz 1974), Joshua Tree woodland, and chaparral (Munz 1974). In the San Bernardino Mountains of California, this species "occurs in desert margin scrub on many of the alluvial fans immediately below the canyons" (Vasek 1966). This species distribution seems to be limited to relatively small, upper-elevation areas in the Mojave Desert (Sawyer et al. 2009). Due to climate change, it may shift further upwards in elevation. Additionally, increased fire frequency may eradicate *J. californica* stands and result in habitat conversion to open chaparral or sagebrush (Cope 1992).	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	While specific essential habitat components are unknown, preferred habitat for *J. californica* includes dry slopes, flats, ridges, slopes, valleys, alluvial fans, and valley bottoms (Adams and Bartel 2012, Sawyer et al. 2009). Preferred soils are porous, rocky, coarse, sandy or silty, and are often very shallow (Cope 1992). These physical components of *J. californica* habitat are not expected to change.	0
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Features of the habitat associated with increased survival are unknown.	0
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Birds and mammals eat the fleshy cones and disperse the scarified seeds of *Juniperus californica* (Meeuwig and Basset 1983). Considering many other desert species' seeds are light enough to be carried by wind, regardless of scarification, we rate this species' ability to disperse as moderate.	0

Physiology and Phenology: Juniperus californica

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Specific limiting physiological conditions for *J. californica* are unknown. However, the limiting factor for survival and growth of pinyon and juniper, in general, is water. Young pinyon and juniper trees can be killed by severe moisture stress, and adult trees survive with a greatly reduced growth rate (Meeuwig and Bassett 1983). Pivovaroff et al. (2015) found that *J. californica* had among the highest water transpiration among shrubs and trees studied in the desert-chaparral ecotone at Morongo Valley, southern San Bernardino County, just north of the Monument. In the presence of warmer temperatures and reduced annual precipitation (Gonzalez 2012), we expect the conditions for lowest elevation populations to exceed this species' physiological threshold.	1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	*J. californica* is fire-sensitive due to its thin epidermis and high flammability (Sawyer et al. 2009). Due to altered fire regimes resulting from increased invasive grass prevalence in the herb layer, eradication of many stands of *J. californica* is threatened from repeated moderate fire (Sawyer et al. 2009). Predicted increase in fire frequency will affect the survivorship of this species.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	There is little documentation on the phenology of this species. Growth rates in other desert junipers have been very closely tied to precipitation and soil moisture availability (Herman 1956). A decrease in soil moisture availability (Archer and Predick 2008), and a decrease in annual precipitation (Gonzalez 2012) is likely to influence phonological patterns of the genus.	1
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Growth rates in other junipers have been very closely tied to precipitation and soil moisture availability (Herman 1956). Their ability to cease growth in periods of drought and then resume growth quickly after periods of rainfall may account for their ability to survive the dry desert slopes they inhabit (Herman 1956).	-1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	This species likely uses moisture cues to initiate reproductive activity.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Unknown.	0
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	All species for this genus, which have documented flowering and seed set phenology, only reproduce once per year, at most (Bonner 2008).	1

Biotic Interactions: Juniperus californica

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Juniper mistletoe (*Phoradendron juniperinum*) can infect this and other juniper species (Cope 1992). It is unknown how this species of mistletoe will be impacted by climate change.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Plants have an increased likelihood of survival in the desert when arbuscular mycorrhizal (AM) fungi form associations with their roots (St. John 2000, Stutz et al. 2000 as cited by Apple et al. 2005). Junipers are known to have arbuscular mycorrhizal fungi associations (Haskins and Gehring 2004). Colonization of AM fungi has been documented to fluctuate with annual precipitation patterns, and are shown to decrease significantly during periods of drought (Apple et al. 2005). In a climate with increased periods of drought, AM fungi colonization will most likely be reduced.	1
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Unknown.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Fire-carrying invasive grasses have resulted in an altered fire regime in much of southern California. *J. californica* is sensitive to fire and stands of this species can be eliminated from repeated moderate fire carried by a build-up of these invasive grasses (Sawyer et al. 2009).	1

Conservation Factors: Juniperus californica

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No. This species is not protected under the Endangered Species Act. The conservation rank for the *Juniperus californica* / *Coleogyne ramosissima* association is "rare", due to the threat of eradication by fire (Sawyer et al. 2009).	0
C2: Keystone species status	**Is this species considered a keystone species?**	Unknown.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Stands of the *J. californica* woodland alliance have been extirpated in the Antelope Valley and at the base of the San Gabriel Mountains due to increased fire frequency, agricultural clearing and urban development (Sawyer et al. 2009). If anthropogenic activity persists in the small remaining patches of California Juniper habitat, the desert extent of this species' range will likely continue to decline.	1
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. *Juniperus californica* serves as a carbon sink by fixing carbon through photosynthesis. It is also utilized as shelter and forage for deer, elk, pronghorn, birds, and other animals (Cope 1992).	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Unknown.	0

Cultural Factors: Juniperus californica

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes. The berries of the California juniper were dried and pounded into flour which was then used to make mush or bread; they were also consumed after being crushed and boiled (Campbell 1999).	1
		Total	**10**

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Jeffrey pine

Habitat: Pinus jeffreyi

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Pinus jeffreyi* (Jeffrey pine) is a native, evergreen conifer. Its distribution lies mostly within California, but its range extends marginally into southwestern Oregon, western Nevada and northern Baja California (Little 1971). This species can hybridize with ponderosa pine and Coulter pine (*P. ponderosa* and *P. coulteri*, respectively; Jenkinson 1990, Zobel 1951). The elevational range of this species is 1,500-10,600 ft (457-3,230 m) in California (Gucker 2007), and 4,500-9,800 ft (1,371-2,987 m) in the Transverse and Peninsular Ranges (Lanner 1999 as cited in Gucker 2007). It is most common above the Ponderosa pine zone. Within the National Monument, Kelly and Goulden (2008) documented a 28 m increase in the elevation of *P. jeffreyi* occurrence and dieback of individuals in the lower portions of its range between 1977 and 2006-2007 due to a 0.63˚C temperature increase. It is expected that increased temperatures due to climate change will continue to cause upslope shifts into suitable *P. jeffreyi* habitat. Decreases in the extent of this species' suitable habitat may also be expected to due climate change. Based on low recruitment and high mortality at low elevation sites and high recruitment and low mortality at higher elevations, Gworek et al. (2007) demonstrate that this same shift is already occurring in *P. jeffreyi* populations in western Nevada.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Yes, if disturbance is considered a habitat component. In mixed-conifer forests, Jeffrey pine may be replaced by shade-tolerant conifers in the absence of disturbance, such as low-severity fire, which opens the canopy and increases light levels (Gucker 2007). In the San Bernardino Mountains, where fire is largely excluded, Jeffrey pine mortality is higher and adult tree density is double compared to areas where fire is not excluded (Gucker 2007). Increases in tree density may increase susceptibility of Jeffrey pine to insect infestation and drought (Savage 1997).	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. Survival of seedling Jeffrey pines is improved with increased water (Legras et al. 2010), and establishment has been correlated to El Niño conditions. Prolonged soil moisture during El Niño years ensures seedling survival by enabling roots to grow deep enough to reach bedrock water (North et al. 2005). There is no consensus regarding the projected changes to El Niño cycles due to climate alterations (Collins et al. 2010). Predictions of increased frequency and intensity of drought (Archer and Predick 2008), along with higher	1

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
		maximum temperatures have been predicted for the southwestern United States. Rapid soil drying and increased drought conditions will likely reduce seedling survival. Although an important component of this species habitat is disturbance, such as fire, the timing and severity of fires can impact survival. Fires that occur during the active growing season are more detrimental than fires during the dormant period, and high severity fires can result in complete mortality of *P. jeffreyi* stands (Azuma et al. 2004, Gucker 2007).	
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Large quantities of seed are produced within a few weeks at 2- to 8-year intervals (Jenkinson 1990). Cones are wind pollinated and produce heavy winged seeds which are wind, gravity, and animal dispersed (Gucker 2007, Vander Wall 2002). In the absence of strong winds, seeds mainly fall within 90 m of the parent tree (Lanner 1999, as cited in Gucker 2007). Winds may disperse seeds 15 times the height of the seed fall (Jenkinson 1990). This species has moderate dispersal abilities.	0

Physiology and Phenology: Pinus jeffreyi

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	This species occupies a wide elevational gradient across California (457-3,230 m; Gucker 2007), and therefore experiences a variety of climates. This species is cold-tolerant. Average January temperatures throughout its range are between -13 to 2°C (9 to 36°F) and average snowfall can range between 30 inches to more than 200 inches (Gucker 2007). Although this species' tolerances to cold are well understood, there is little information regarding its physiological tolerances to heat. This species can survive low- to moderate-intensity wildfires. Therefore, presumably increased temperatures due to climate change may still remain within physiological tolerances of Jeffrey pine. Although Jeffrey pines are moderately drought-tolerant, prolonged drought conditions, which often accompany increased temperatures, could drought stress this species.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	This species is moderately adapted to drought conditions, and can be found occupying dry, poor quality sites. However, precipitation events are expected to become more stochastic over the next century. Prolonged drought-stress may facilitate insect infestations that can lead to stand mortality. Prolonged drought periods will also decrease recruitment for Jeffrey pines. This species is long-lived (400-500 years; Jenkinson 1990), slow growing, and fire-resistant (Gucker 2007). These features will buffer it against the increased frequencies of fire predicted with climate change. Fire results in bare mineral soil and higher light levels due to canopy gaps which improve seedling establishment (Gucker 2007). Fire exclusion creates dense stands of dead fuel which can increase the intensity of fire. High-intensity fires killed 100% of Jeffrey pine trees in Oregon, whereas only a few trees were killed due to low-severity fire (Azuma et al. 2004). The combination of increased drought stress and likelihood of high-intensity fires will negatively impact Jeffrey pines survivorship.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	No limitations to this species daily activity periods or phenology are expected.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	This species is moderately drought-tolerant, and adapted to harsh conditions experienced in its current range. This ability to cope with limiting resources extends over multiple years. However, see section PS2 for discussion regarding this species' anticipated response to long-term drought conditions. The seeds of this species are long-lived in the soil seed bank. Seeds stored for 8.5 years had similar germination rates to fresh seeds (Mirov 1946, as cited in Gucker 2007).	-1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Yes. Although not necessary for germination, stratification has been shown to decrease germination time in this species. Seeds stratified at 5˚C (40˚F) reached 50% germination at 25˚C (77˚F) after 5 days versus 23 days for unstratified seeds (Stone 1957). Higher minimum winter temperatures would result in slower germination for this species. The growing season for adult individuals of this species occurring in the Stanislaus National Forest began in mid-May and averaged 78 days (Fowells 1941). Because the dormancy and growing periods are most likely cued by temperature, early onset of increased temperatures may extend the growing season and shift it to earlier in the year. An extended growing season may increase this species' exposure to drought stress. Despite elevational differences, Gworek (2007) reported no difference in timing of Jeffrey pine cone production indicating that this species is not sensitive to climate to initiate cone production. Jeffrey pines inhabiting lower elevation sites shed pollen earlier than those at high elevation sites (Gucker 2007, Duffield 1953), suggesting a temperature cue. There is the potential for a timing mismatch between cone production and pollen shedding in this species due to climate change-induced temperature increases.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Yes. Seedling survival of this species is tied to discrete peaks in available resources, namely soil moisture and precipitation, especially due to El Niño years (North et al. 2005). Alterations in amounts of seasonal moisture, such as prolonged droughts or reduce frequencies of El Niño conditions, could significantly dampen recruitment.	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	No. *P. jeffreyi* is a masting species; large seed crops are produced every 2 to 8 years, and female cones take two summers to mature after being pollinated (Jenkinson 1990). This species does not reproduce vegetatively.	1

Biotic Interactions: Pinus jeffreyi

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Seeds and seedlings of *P. jeffreyi* are consumed by birds, lagomorphs, rodents, porcupines, and domestic livestock (Gworek et al. 2007, Jenkinson 1990). However, many of these seed predators are also important seed dispersers. It is difficult to generalize how climate change may impact these seed consumers and dispersers. Several insect species are known to attack Jeffrey pines, including twig and needle scales, borers, defoliators, tip moths, and seed and cone feeders (Jenkinson 1990). Many of these species may predispose Jeffrey pines to bark beetle infestations. In high densities, the Jeffrey pine bark beetle, *Dendroctonus jeffreyi*, will kill living vigorous trees as a result of mass colonization (Maloney and Rizzo 2002, Paine et al. 1997). In low densities, this beetle usually colonizes already unhealthy trees. Despite the lack of substantial scientific evidence for climate change impacts to these insect pests, we would expect that shifts in annual mean temperature causing decreased frequency of freezing temperatures will affect some life cycles, and, therefore, increase populations of associated pest insects. Drought will further stress Jeffrey pines tree, increasing their susceptibility to beetle colonization. Western dwarf mistletoe (*Arceuthobium campylopodum*) infection can cause reduced growth and lead to eventual death, especially in seedlings and saplings (Gucker 2007, Jenkinson 1990). Mistletoe was more common on *P. jeffreyi* occurring at low elevations versus mid- and high elevations in western Nevada (Gworek et al. 2007) and may expedite the decreased range extent and upslope shift of this species' distribution. Seeds from infected trees have lower germination rates (Gucker 2007). Drought stress facilitates infection and colonization of these parasites in Jeffrey pine.	1
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	This species is wind pollinated and therefore does not have a symbiotic relationship with pollinators.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Needle cast (*Elytroderma deformans*) infects Jeffrey pine and may predispose it to attack by bark beetles (Maloney and Rizzo 2002). Trees growing on poor sites can be attacked by Medusa needle blight (*Davisomycella medusa*) which reduces growth, especially after drought, and Cenangium limb canker (*Cenangium ferruginosum*) which can kill weakened branches. This species is susceptible to several types of rust, the effects of which range in severity from defoliation to death. Root fungal diseases of Jeffrey pine include annosus, armillaria, and black stain. Red rot and fungi that cause heart rot are also concerns for this species (Jenkinson 1990). It is not known how the prevalence of these diseases is expected to change in response to climate change.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Soil moisture is often limiting in the environments where *P. jeffreyi* grows, therefore competition for soil moisture with grasses, sedges, and brush can be lethal (Jenkinson 1990). These sub-canopy species will likely respond to climate change by shifting upslope. If they shift upslope at a faster rate than *P. jeffreyi*, they may outcompete Jeffrey pines. Alternatively, these species may also fuel the spread of wildfire which may have either negative or beneficial consequences for *P. jeffreyi* colonization, depending on the timing and intensity of those fires. *P. jeffreyi* is shade-intolerant and may be replaced by shade-tolerant conifers in the absence of disturbance (Gucker 2007). However, some of these competing species are less drought-tolerant than Jeffrey pine (Savage 1997). Increased densities of fire-sensitive species, such as sugar pine, white fir, and incense cedar, which may outcompete Jeffrey pine, have resulted from fire-suppression (Savage 1997). Those species are also less sensitive to pollution damage (e.g., ozone) than Jeffrey pine (Savage 1997). Overall, it is likely that populations of competing species will negatively impact *P. jeffreyi* persistence.	0

Conservation Factors: Pinus jeffreyi

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0
C2: Keystone species status	**Is this species considered a keystone species?**	Yes. Jeffrey pine habitat it utilized by a variety of wildlife, including many species of birds and small mammals, American black bears, mule deer, insects, and herpetofauna, many of	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
		which also consume Jeffrey pine seeds and seedlings and use the trees for nesting and cover (Gucker 2007). Relative to its abundance, its impact on its ecosystem is disproportionately large, thereby distinguishing it as a keystone species (Paine 1995).	
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	No, it does not appear that any anthropogenic constraints would hinder their movements in the National Monument.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. *Pinus jeffreyi* fixes atmospheric carbon and provides habitat structure. It is an important food resource for wildlife, and utilized as nesting and shelter sites.	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Not known.	0

Cultural Factors: Pinus jeffreyi

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes. Historically, the crystallized sap of this species was gathered and stored for winter use, or sold, by the northern Paiute of western Nevada (Fowler et al. 1989, as cited in Moerman 2003). The needles were used to make baskets by the Diegueno Indians (Hedges 1986, as cited in Moerman 2003).	1
		Total	**10**

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Single-leaf pinyon pine

Habitat: Pinus monophylla

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	In southern California, pinyon-juniper woodland commonly occurs between 1524-2438 m (5000-8000 ft), receiving 304-508 mm of annual precipitation, including snow (Munz 1974). Mojave Desert occurrences of the pinyon pine (*Pinus edulis*) are thought to be relic populations from the Pleistocene, and an increasingly more arid climate has restricted the species' desert distribution to only the highest elevation mountains (Wells and Berger 1967, Thorne 1986). An increasingly more arid climate will most likely continue to reduce this species' range to even higher elevations.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	This species generally occurs on pediments, ridges and slopes, on soils that are coarse textured, well drained Mollisols with surface pH usually between 6.0 and 8.0 (Meeuwig et al. 1990). This species will tolerate conditions that are more xeric than any other pine species and can withstand low levels of humidity and precipitation and high levels of evapotranspiration (Meeuwig et al. 1990).	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Habitat features associated with increased survival are unknown. However, increased soil moisture availability is reflected by increased growth and needle development (Raymond et al. 1995). Growth is dependent upon moisture stored from winter precipitation (Meeuwig et al. 1990). If the availability of soil moisture during the growing season is considered a feature of the habitat, then yes, this is expected to change (Archer and Predick 2008).	1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	The seeds of *P. monophylla* are heavy, wingless and not adapted to wind dispersal but rather fall near the parent tree. They are then disseminated locally by rodents and over larger distances by birds. These animals consume most of the seed but leave some to germinate in place or in caches, especially when seed production is above average (Meeuwig et al. 1990). In comparison to seeds of other desert plants, this species has moderate seed dispersal abilities.	0

Physiology and Phenology: Pinus monophylla

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Yes. Throughout the *Pinus monophylla* range, the average annual precipitation ranges from 200-460 mm (8-18 in.), occurring mostly during the winter months and the average annual temperature is about 10°C (50°F). Mean maximum (July) and minimum (January) temperatures are 30°C (86°F) and -6°C (21°F), respectively (Meeuwig et al 1990). It appears that most pinyon stands in Joshua Tree National Park are at their range limits for annual precipitation and maximum mean summer temperatures. If this value increases by 4˚C over the next century, as projected by IPCC in a higher emissions (A2) scenario (Gonzalez 2012), range limits for annual precipitation and maximum mean summer temperatures may be exceeded.	1
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Historic fire regimes across this species' range have varied in frequency and intensity. This species has thin bark which makes it susceptible to intense fire. Single-leaf pinyon communities in southern California typically have fire-return intervals of several hundred years (Zouhar 2001). In response to the extreme drought event of 2002, a more wide-spread species of pinyon pine (*Pinus edulis*) displayed large-scale dieoffs across the West, 40% greater than any other dominant species observed (Gitlin et al. 2006). Predictions of increased fire frequency due to invasive annuals and increased periods of prolonged and severe drought (Archer and Predick 2008) will affect the survivorship of this species in the Monument.	1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Yes. *P. monophylla* produces flowers in May, its cones ripen in August, and seed dispersal occurs from September to October (Krugman and Jenkinson 2008). Single-leaf pinyon varies growth, conductance, and transpiration rates in response to humidity, temperature, and soil water (Raymond et al. 1995). In the closely related *Pinus edulis,* precipitation and temperature influences the availability of soil moisture, which in turn, dictates productivity of phenological processes (Rich et al. 2008). The same study also documented an extreme reduction in pinyon pine productivity preceding massive regional mortality of the species in response to severe drought. Based on these findings we expect climate shifts will influence the phenology of *P. monophylla*.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	No. In an analysis of differences in physiology across an environmental gradient, it was concluded that "variation in ecophysiological response to environmental conditions does not appear to be the means by which single-leaf pinyon has succeeded in expanding over a wide range of environmental conditions in which it is found. Rather, it can be characterized as opportunistic and responds to the availability of resources and conditions that are suitable for growth" (Raymond et al. 1995).	1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Yes. The reproductive cycle of pinyon pines can take up to 3 years. Both cone development and pollen tube growth require periods of winter dormancy. Water stress during the time of strobilus initiation, or increased temperatures during pollen tube growth can negatively affect a seed crop 2 years later. Timing of pollen release is also thought to be controlled by local conditions (Keely and Zedler 1998).	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Unknown.	0
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	No. If conditions are favorable, *Pinus monophylla* flowers in May, its cones ripen in August, and seed dispersal occurs from September to October (Krugman and Jenkinson 2008). It requires two seasons to complete its reproductive cycle (Meeuwig et al. 1990).	1

Biotic Interactions: Pinus monophylla

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	There are a number of pest species related to *Pinus monophylla.* Pinyon ips, pinyon needle scale, and pinyon sawfly are all known to cause damage to the bark and needles of single-leaf pinyon. Damaging cone insects such as the moths *Eucosma bobana* and *Dioryctria albovittella,* and the beetle *Conophthorus monophyllae* are known to reduce pine nut crops substantially from year to year (Meeuwig et al. 1990). Once pine populations are weakened by other factors, such as water stress, pests can proliferate and kill trees (as cited in Meeuwig et al. 1990, Cobb et al. 1997). Pest populations in the Monument are unknown, as are effects of climate change on these populations. However, if climate change induces stress on the *Pinus monophylla* populations, they will become more susceptible to attack.	1
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Pinyon pines are known to have beneficial associations with ectomycorrhizae (EM), which help with water and nutrient uptake, especially in more stressful climates (Gehring and Whitham 1994). Reduced colonization of EM fungi has been observed under drought conditions, warmer temperatures and elevated CO_2 (Compant 2010).	1
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	*Pinus monophylla* is attacked by a number of diseases, including the fungal root disease *Verticicladiella wageneri* (Meeuwig et al. 1990). This pathogen has killed pinyon pines in the San Bernardino Mountains (as cited in Meeuwig et al. 1990). Increased climatic stress during the growing season increases susceptibility to fungal pathogens. Susceptibility is amplified by the negative impact of climate change on ectomycorrhizal associations, which help pinyons fight off fungal root disease (Lonsdale and Gibbs 1994).	1
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Stands of this species are at risk of increased fire frequency due to an increased fuel load from understory annual exotic grasses (Sawyer et al. 2009).	1

Conservation Factors: Pinus monophylla

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal**	No, this species is not protected under the Endangered Species Act.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
	Endangered Species Act?		
C2: Keystone species status	**Is this species considered a keystone species?**	Unknown.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	Unknown.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. "Most tree species support a community of other organisms, so the loss of any tree species can significantly reduce overall biodiversity" (Dale et al. 2001). Additionally, this species serves as a carbon sink by fixing carbon through photosynthesis.	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Unknown.	0

Cultural Factors: Pinus monophylla

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes, the nuts of this pine species are gathered and used by the Santa Rosa Indians (Hall 1902).	**1**
		Total	**15**

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California fan palm, Desert fan palm

Habitat: Washingtonia filifera

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Washingtonia filifera* are native primarily to perennial springs of the Colorado Desert and Baja Mexico (Parish 1930, Smith 1958, Vogl and McHargue 1966, Miller 1983, McClenaghan and Beauchamp 1986, Cornett 1986, Cornett 1988, Cornett 1993, Starr et al. 2003, Bullock and Heath 2006). Currently, this species maintains a much broader distribution because of its use in the horticultural trade (Cornett 1988, Starr et al. 2003). We anticipate the native distribution to become smaller due to pressures from ground water pumping and diminished access to surface flows. Within the National Monument this species is restricted to only a few perennial water sources. It is likely that *W. filifera* will see a reduction in habitat, assuming the climate becomes warmer and dryer.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	The distribution of *W. filifera* within its native range appears to be limited by access to surface flows, cold temperatures, and dispersal (Cornett 1993). All three of these factors combine in synergistic ways that make predictions difficult, but increased pressure on ground water in the region will likely decrease the timing and volume of surface flows necessary for *W. filifera* sustainability.	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Unknown.	0
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	This species' seeds are distributed by coyotes and other opportunistic frugivores, which provide opportunity for dispersal to new localities (Bullock 1980, DeMason 1988, Cornett 1985).	0

Physiology and Phenology: Washingtonia filifera

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Unknown. *Washingtonia filifera* is limited geographically to springs in southern California and Arizona (Cornett 1988, Cornett 1993). A loss of perennial water would be detrimental to this species. The distribution of plants may be limited by low temperatures as hot temperatures seem to have little effect (Cornett 1993).	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	No consensus. Palm oases depend on fire disturbance to reduce water competition between shade tolerant shrubs and fan palms by reducing understory growth (Laudenslayer Jr. 1988), and fire has the added benefit of increasing fan palm seed productivity. Although *W. filifera* is fire-adapted, this competitive advantage is lost when *W. filifera* must directly compete for resources with non-native, invasive species that are also fire-adapted, such as saltcedar (genus *Tamarix*).	0
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	Unknown.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Unknown.	0
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	Reproduction is tied to adequate water and precipitation (Vogl and McHargue 1966), very wet winters (Laudenslayer Jr. 1988), and the availability and frequency of which are expected to decrease. However, with an estimated lifespan of 150 years, conditions that are optimal for growth need only to occur once per century to ensure the persistence of palm oases (Vogl and McHargue 1966), in the absence of other disturbances.	1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Palm oases typically occur where a stable perennial water source exists. Therefore, their survival is not solely dependent upon discrete peaks in resources.	-1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Unknown.	0

Biotic Interactions: Washingtonia filifera

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Throughout its range *W. filifera* has a relationship with the giant palm borer (*Dinapate wrightii)*, but it is unknown what the effect of climate change on the beetle will be. Despite the lack of substantial scientific evidence for climate change impacts to this insect, we would expect that shifts in annual mean temperature causing decreased frequency of freezing temperatures will affect some life cycles and, therefore, increase population sizes. An increase in the abundance of the palm borer may cause a negative impact to the fan palm.	1
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Unknown.	0
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	Unknown.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	Invasive species, like *Tamarix* spp. (saltcedar), will directly compete with *W. filifera* for resources. Additionally, *Tamarix* is also adapted to fire, and in this regard, *W. filifera* does not have a competitive advantage.	1

Conservation Factors: Washingtonia filifera

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No, this species is not protected under the Endangered Species Act.	0
C2: Keystone species status	**Is this species considered a keystone species?**	Unknown.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	We anticipate the native distribution to become smaller due to pressures from ground water pumping and diminished access to surface flows. However, *W. filifera* may see an increase in its distribution through long-distance dispersal associated with its ornamental use in the horticultural trade (Starr et al. 2003).	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. This species serves as a carbon sink by fixing carbon through photosynthesis. The palm also provides habitat for a variety of species, including western yellow bats (*Lasiurus xanthinus*) (Ortiz and Barrows 2014).	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Yes. Palm oases have been attracting people since prehistoric times and trails leading to palm oases are often very popular with hikers. Palm oases also attract wildlife enthusiasts as these habitats are utilized by many species of birds, reptiles, and mammals.	1

Cultural Factors: Washingtonia filifera

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes, the fruit of this species has been historically roasted and eaten, or ground into flour. Fibers from the leaves have been used in basket weaving. Leaves and trunks of this species were also used to construct shelters (Sweet 1962).	1
		Total	**7**

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Catclaw acacia

Habitat: Senegalia greggii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Senegalia greggii* (*Acacia greggii*, Catclaw acacia) is a native, winter deciduous woody perennial that occurs in the deserts across southwestern United States and into northern Mexico and Baja California. It can be found along dry washes, canyons, desert flats, floodplains, riparian areas, rocky hillsides, and arroyo banks (Gucker 2005). The elevational range of this species is below 1,829m in California (Munz 1974) Packrat midden analysis has suggested that mean winter temperature has limited *S. greggii* to its current range (Holmgren 2005). Increases in mean winter temperatures may facilitate a latitudinal expansion to the north for this species in areas outside of the SRSJM National Monument. Within the National Monument, it is expected that increased temperatures due to climate change will cause upslope shifts in suitable habitat, such as was shown by Kelly and Goulden (2008) for other species. It is not known to what extent the current area this species occupies will change, although it may be restricted from currently suitable area due to drought conditions and high temperatures.	1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	Yes, if disturbance is considered a habitat component. *S. greggii* is primarily found in wash habitats where it has access to ground water and where its seeds may become scarified through sand abrasion during rainfall and flood events (Gaddis 2014). Damage or scarification of the seed is required to trigger germination. Therefore, a decrease in disturbance, such as decreased flow volumes, may prevent germination.	1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. Seedling *S greggii* require enough soil moisture post-germination to produce a tap root which will allow access to ground water before the onset of summer drought stress. Predictions of increased frequency and intensity of drought (Archer and Predick 2008), along with higher maximum temperatures have been predicted for the southwestern United States. Therefore, survival rate of seedlings is expected to become reduced. Although this species has evolved physiological drought adaptations, it is a phreatophyte and requires access to ground water to avoid drought stress. Due to reduced precipitation and snow pack melt, compounded by anthropogenic ground water pumping, ground water sources will likely be reduced in the future.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Seeds of this species may be dispersed by animals (rodents, birds, and ungulates) as well as by water transport during flood events (Gaddis 2014). Gaddis (2014) found high dispersal rates among *S. greggii* populations within the Mojave Desert National Preserve, confirming this species' high dispersal potential.	-1

Physiology and Phenology: Senegalia greggii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Projected changes in temperature will primarily remain within physiological tolerances. Other *Acacia* (*Senegalia*) species have been shown to tolerate temperatures up to 52˚C (125˚F) without visible damage (Lange 1959, as cited in Szarek and Woodhouse 1978). It is likely that *S. greggii* will have similar temperature tolerance. Physiological intolerance to low winter temperature has limited *S. greggii* to its current range, as suggested by packrat midden analysis (Holmgren 2005). Increased temperatures may release *S. greggii* from this range restriction.	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Precipitation events are expected to become more stochastic over the next century, and rainfall is an important cue for reproduction and seedling establishment. Flood events, which disperse seeds and provide scarification to the seed's thick outer coating enabling the seeds to germinate, may become more episodic due to increased variability in rainfall events. There is potential for increased flood flow volumes to undercut and erode wash habitats which may result in loss of adult *S. greggii*. This species is long-lived. Individuals in Arizona were found to be over 100 years old (Bowers et al. 1995), slow growing, and fire-tolerant. These features will buffer it against the increased frequencies of fire predicted with climate change. This species can resprout after aboveground biomass has been removed by fire, and can withstand short fire-return intervals (Gucker 2005). Decreased water flow and increased droughts will likely outweigh the benefits of this species' fire tolerance.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	This species is sensitive to temperature cues to initiate flowering. Populations at lower elevation sites will flower five days earlier than those inhabiting sites 100 m higher in elevation (Gaddis 2014). If individuals located on slopes track their climatic envelopes upwards in elevation, they may flower later than individuals in lower elevation washes. Timing of snowpack melt has been predicted to occur earlier due to temperature increases. This shift may benefit those higher elevation individuals. Although shifts in timing will likely impact this species, it is difficult todetermine the magnitude that those impacts will have on this species. It is also not known whether flowering phenology will become desynchronized with pollinator emergence.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Yes. This species has a number of strategies to cope with limiting resources. *S. greggii* is a phreatophyte, using deep roots to access ground water during periods when they would otherwise be drought stressed. Drought tolerance in this species is also achieved through low seasonal osmotic potentials, diurnal osmotic adjusting, and the ability to maintain high conductance values in the morning during summer months resulting in maximum photosynthetic leaf area (Nilsen et al. 1984).	-1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	As a phreatophytic species, *S. greggii* has access to ground water, and thus moisture cues are less important than temperature for initiating reproductive activity. Summer rains may cue a second flowering event (Turner et al. 2005).	-1
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	Yes, germination and seedling survival of this species is tied to discrete peaks in available resource supplies. Alterations in the timing of seed production and seasonal moisture for germination could significantly dampen recruitment.	1
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Yes. In most areas of its range, this species flowers in late spring-early summer, and may flower a second time in response to summer rains (Turner et al. 2005). *S. greggii* also has the ability to asexually regenerate through root crown sprouts after being top-killed (Gucker 2005).	-1

Biotic Interactions: Senegalia greggii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	Seeds of *S. greggii* are consumed by a wide variety of wildlife, including mule deer, rabbits, livestock, birds and rodents (Gucker 2005 and citations therein, Vanzant et al. 1997). Seed predation is a major factor limiting the recruitment of this species, as evidenced by the lack of a persistent seed bank despite high annual seed production (Gaddis 2014, Vanzant et al. 1997). It is difficult to generalize how climate change may impact these seed consumers. Bruchid beetles (weevils) are parasitic seed beetles whose larvae burrow into the seeds of several host species, including *S. greggii*, to pupate. Damage to the seed by this beetle may facilitate germination by scarifying the thick seed coating (Gaddis 2014). However, infestations may also deplete seed resources, facilitate fungal attack, or reduce seedling survival by facilitating germination during suboptimal precipitation conditions (Fox et al. 2012). Despite the lack of substantial scientific evidence for climate change impacts to these beetles, we would expect that shifts in annual mean temperature would result in decreased frequency of freezing and therefore increase populations of associated pest insects. Desert mistletoe (*Phoradendron californicum*) parasitizes arborescent legumes such as catclaw acacia, mesquite, and palo verde. Parasitism of palo verde host trees has been shown to cause increased mortality during extreme drought conditions in the Mojave Desert (Spurrier and Smith 2007). It is likely that *S. greggii* will respond similarly.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Pollinators include many species of bees, wasps, and butterflies. Although bees, particularly a non-native species, were observed as being the most common visitor at Mojave Desert sites (Gaddis 2014), *S. greggii* is not strictly specialized for one pollinator. Plants have an increased likelihood of survival in the desert when arbuscular mycorrhizal (AM) fungi form associations with their roots (St. John 2000, and Stutz et al. 2000, as cited by Apple et al. 2005). *S. greggii* are known to have beneficial associations with vesicular-arbuscular mycorrhizal fungi (Bethlenfalvay et al. 1984), which help with water efficiency and nutrient uptake, especially in more stressful climates. Colonization of AM fungi associated with Mojavean shrubs have been documented fluctuating with annual precipitation patterns, and are shown to decrease significantly during periods of drought (Apple et al. 2005). In a climate with increased periods of drought, mycorrhizal fungi colonization will most likely be reduced.	1
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	None known.	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	*Tamarix ramosissima* (salt cedar) is known to occur in riparian habitats similar to that of *S. greggii* and may be a direct competitor. It is not well documented the extent to which salt cedar impacts or competitively excludes *S. greggii*, nor how climate change may influence that interaction.	0

Conservation Factors: Senegalia greggii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C2: Keystone species status	**Is this species considered a keystone species?**	Yes. Catclaw acacia is important to wildlife for shelter, nesting sites and material, and food resources (Gucker 2005, and citations therein, Gaddis 2014). Relative to its abundance, its impact on its ecosystem is disproportionately large, thereby distinguishing it as a keystone species (Paine 1995).	1
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	No, it does not appear that there are any anthropogenic constraints that would hinder their movements in the National Monument.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. *Senegalia greggii* fixes atmospheric carbon and provides habitat structure. It is an important food resource for wildlife, and utilized as nesting and shelter sites.	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	Not known.	0

Cultural Factors: Senegalia greggii

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	Yes. The pods of this species have been ground by Arizona Indians for use in mush and cakes (Turner et al. 2005), and medicinal teas can be made from the roots, leaves and pods (Moore 1989, as cited in Turner et al. 2005). According to Bean and Saubel (1972, as cited in Gucker 2005), southern Californian Cahuilla Native Americans ate fresh, dried, and ground acacia beans, and used the wood for fuel.	1
		Total	**6**

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Fountain grass

Habitat: Pennisetum setaceum

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
H1: Area and distribution	**Is the area or location of the species' habitat expected to change?**	*Pennisetum setaceum* (fountain grass) is an invasive perennial grass native to Africa, western Asia and the Middle East and subsequently introduced to the United States as an ornamental plant (Halvorson and Guertin 2003, Williams et al. 1995). In California it occurs along the coast from the San Francisco Bay area south into Baja California, as well as inland in the Sacramento-San Joaquin Delta, southern San Joaquin Valley, South Coast, and Imperial County (Lovich 2000). It is found additionally in Hawaii, Arizona and Florida, Fiji, Australia, and South Africa (Lovich 2000). In California, this species is typically found below 100 m in elevation but will occur at elevations up to 610 m in the National Monument (Lovich 2000). Increases in mean winter temperatures may facilitate an expansion of this species in areas where it is currently excluded due to cold weather, such as the Eastern Sierra Nevada and Owens Valley (Sweet 2014). Within the National Monument, it is expected that increased temperatures due to climate change will cause upslope expansion in suitable habitat.	-1
H2: Habitat specialization	**Does the species require specific habitat types / habitat components?**	This species occupies a variety of habitats and has a wide elevational range (Sweet 2011, Halvorson and Guertin 2003, Williams et al. 1995). It is restricted to areas that receive less than 130 cm (50 inches) of median annual rainfall (Lovich 2000), but prefers areas that receive summer moisture (Poulin et al. 2007, Halvorson and Guertin 2003). Habitat suitability models developed using location data from Boyd Deep Canyon within the National Monument indicate fountain grass prefers northwest-facing slopes, rock outcroppings, rubble lands, and river washes, and suitability increased with slope and at elevations between 200-600 m (Sweet 2014). This suggests that habitats within the National Monument are highly suitable for this species. Additionally, this species is a habitat generalist and occurs well outside of its preferred habitats.	-1
H3: Habitat quality	**Are features of the habitat associated with increased survival expected to change?**	Yes. Projected changes are likely to positively affect habitat quality for this species. Increases in mean winter temperatures and rainfall reductions may facilitate range expansion.	-1
H4: Ability to colonize new areas	**What is the potential for this species to disperse?**	Seeds of this species may be readily dispersed by animals, wind, water, vehicles and humans (Sweet 2011, Lovich 2000). Additionally, this species is planted and cultivated as an ornamental plant which facilitates its spread.	-1

Physiology and Phenology: Pennisetum setaceum

Trait/Quality Assessed	**Question**	**Background Info and Explanation of Score**	**Score**
PS1. Physiological thresholds	**Are limiting physiological conditions expected to change?**	Projected changes in temperature will primarily remain within physiological tolerances. This species has been shown to adapt morphologically and physiologically to its environment (Williams et al. 1995, Williams and Black 1994, 1993).	0
PS2. Exposure to weather-related disturbance	**Are disturbance events (e.g., severe storms, drought, fire, floods) that affect survivorship or reproduction expected to change?**	Precipitation events are expected to become more stochastic over the next century; however, this species is drought tolerant. In a study by Poulin et al. (2007), all fountain grass plants that went experimentally unwatered survived through the experiment and were still able to produce a small but viable seed set. This species is fire adapted and will alter fire regimes by enhancing fuel loads, increasing the intensity and spread of fire, and rapidly reestablishing itself post-fire (Halvorson and Guertin 2003).	-1
PS3. Limitations to daily activity period	**Are projected climate shifts expected to influence activity patterns or phenology?**	This species is able to physiologically and morphologically adapt to its environment. For example, at higher elevations its photosynthetic rate is increased (Williams et al. 19995). This ability will be beneficial if individuals located on slopes track their climatic envelopes upwards in elevation. Phenology of this species is not likely to be impacted as it is able to flower throughout most of the year.	0
PS4. Survival during resource fluctuation	**Does this species have flexible strategies to cope with limiting resources over multiple years?**	Yes, this species has a number of strategies to cope with limiting resources. This species is drought tolerant. In response to moisture pulses, it is able to readily germinate (thus rapidly colonize; Halvorson and Guertin 2003), as well as increase its photosynthetic rates and biomass allocation (Williams and Black 1994). It has a long-lived seed bank which would allow it to persist until conditions are favorable for germination (Halvorson and Guertin 2003, and citations therein). These strategies combine to make this species extremely competitive despite limiting resources.	-1
PS5. Mismatch potential: Cues	**Does this species use temperature or moisture cues to initiate germination, hibernation or reproductive activity?**	No. This species has the ability to flower during the majority of the year and germination can occur at any time with sufficient water (Halvorson and Guertin 2003, Lovich 2000).	-1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
PS6. Mismatch potential: Event timing	**Are activities related to species' fecundity or survival tied to discrete peaks in available resources (food, temperature, moisture) that are likely to change?**	This species responds to precipitation during the warm summer months by increasing productivity and fecundity (Poulin et al. 2007). It is generally accepted that precipitation will decrease due to climate change, and summer rainfall is not anticipated to increase.	0
PS7. Resilience to timing mismatch	**Does this species have more than one opportunity to time reproduction to resource peaks?**	Yes, this species has the ability to flower during the majority of the year, but typically flowering occurs from July through October in California (Halvorson and Guertin 2003, Lovich 2000). Reproduction can occur both sexually and asexually (Halvorson and Guertin 2003).	-1

Biotic Interactions: Pennisetum setaceum

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B1. Predators/ parasites/ insect herbivores	**(e.g., bark beetles, tent caterpillars, coyotes, ravens). Are populations for these trophic levels expected to change with respect to this species?**	The occurrence of herbivory and insect damage to fountain grass is low. Goergen and Daehler (2001) observed grasshoppers consuming fountain grass inflorescences, however damage to seeds and ovules was always greater (up to 61%) on a native co-occurring grass species than on the fountain grass (never greater than 5% destruction). Livestock may graze fountain grass shoots in the spring, but it is not palatable or nutritious and is generally avoided in preference to more desirable forage (USDA 2014). It is not known how insect and/or herbivory preference for fountain grass will be impacted by climate change.	0
B2. Symbionts	**(e.g., Mycorrhizal fungi, restricted pollinators, plants that are exclusively used for nesting). Are populations of symbiont species expected to change?**	Plants have an increased likelihood of survival in the desert when arbuscular mycorrhizal (AM) fungi form associations with their roots (St. John 2000, and Stutz et al. 2000, as cited by Apple et al. 2005). *P. setaceum* are known to have beneficial associations with vesicular-arbuscular mycorrhizal fungi (Koske 1988), which help with water efficiency and nutrient uptake, especially in more stressful climates. Colonization of AM fungi associated with Mojavean shrubs has been documented fluctuating with annual precipitation patterns and decreases significantly during periods of drought (Apple et al. 2005). In a climate with increased periods of drought, mycorrhizal fungi colonization will most likely be reduced.	1

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
B3. Disease	**Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?**	There are no reported pathogens of *Pennisetum setaceum* (Goergen and Daehler 2001, Gardner and Davis 1982).	0
B4. Competitors/ invasive species	**Are populations of important competing/ invasive species expected to change?**	No. This species is considered an invasive and typically outcompetes other gramminoid and shrub species.	-1

Conservation Factors: Pennisetum setaceum

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
C1: Conservation status	**Is this species protected under the state or federal Endangered Species Act?**	No.	0
C2: Keystone species status	**Is this species considered a keystone species?**	No.	0
C3: Anthropogenic constraints to dispersal	**Are there anthropogenic constraints to this species dispersal to reach shifts in suitable habitat?**	No, it does not appear that there are any anthropogenic constraints that would hinder their movements in the National Monument. In fact, this species' spread has been facilitated in part due to anthropogenic sources.	0
C4: Essential ecosystem function	**Does this species provide an important ecosystem function (e.g., detritivore, carbon sink, pollinator)?**	Yes. *Pennisetum setaceum* fixes atmospheric carbon.	1
C5: Interest of Monument visitors	**Does this species engender interest among Monument visitors regarding its well-being?**	No.	0

Cultural Factors: Pennisetum setaceum

Trait/Quality Assessed	Question	Background Info and Explanation of Score	Score
CU1: Significant cultural resource	**Does this species have significance as a cultural resource?**	None known.	0
		Total	**-7**

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Appendix C
Habitat Suitability Models

In addition to vulnerability assessments described in **Appendix B**, another tool for projecting a species' potential response to climate change is a temperature-shifted habitat suitability model. The Mahalanobis distance statistic (*D*2) (Clark et al. 1993; Rotenberry et al. 2002, 2006; Browning et al. 2005) is one of several habitat suitability modeling tools available, and consistently ranks well in its performance compared to other methods (Griffin et al. 2010; Liang et al. 2014). The Mahalanobis statistic was used in this science plan to model the distribution of suitable habitat of selected indicator species. For any location, the Mahalanobis statistic yields an index of its habitat similarity (HSI) to the multivariate mean of the habitat characteristics at the target species location (the calibration data set). Many geographic information system (GIS) modeling approaches use only species-presence data for the dependent variable as opposed to known absences which are much more difficult to verify. But the Mahalanobis approach avoids the uncertain assumption of correct identification of unoccupied habitats (Knick and Rotenberry 1998; Rotenberry et al. 2002; Browning et al. 2005) and arguably provides a more transparent view of how individual variables influence model outcomes by being partitioned into separate components (Dunn and Duncan 2000; Rotenberry et al. 2002, 2006). Partitioning is based on a principal-components analysis of the selected model variables in the calibration data set. Each of the partitions are additive, orthogonal variable combinations that incrementally explain more variance until the final partition (the full model) captures the full range of variance exhibited in the calibration data. Mahalanobis distances and their partitions with SAS code provided in Rotenberry et al. (2006) were calculated.

Methodology

For the niche-modeling process, a GIS map of the study area was divided into 180 m × 180 m cells. Each cell was scored for underlying environmental variables. Cells containing a species observation were used to create a calibration data set from which each species' niche model was constructed. Once a model was created, it was used to calculate habitat suitability indices (HSIs) for the selected Mahalanobis distance partition for every other cell of the map data set. HSIs were rescaled to range from 0-1, with 0 being the most dissimilar and 1 being the most similar to the multivariate mean habitat characteristics based on the calibration data set, following Rotenberry et al. (2006). ArcGIS 9.3 (ESRI 2008) was used to provide a spatial model (niche map) of the similarity to the species mean for each cell. Identifying the model that best fits the distribution of observation records was a multi-step process. First, the median HSI values for each model partition were inspected to identify those partitions with the highest median values. From those partitions with the highest values, the mapped representations of the selected model partition were then examined to determine which partition best encompassed the observation points without including extensive additional areas known to be unoccupied. From these steps, the best performing current conditions niche model was selected and produced.

Habitat variables were selected based on expectations of their likely influence on the distribution of the vegetation within the Monument and surrounding region. Observations were obtained evenly across the full range of elevations and habitats that each species was known to occur based on ongoing surveys within the Monument and the surrounding landscape (C. Barrows, unpublished data sets); the more spatially unbiased and un-clustered the observations, the better the resulting model is at representing the distribution of suitable habitat (Phillips et al. 2009). Partitioned Mahalanobis *D2* models were constructed with different suites of abiotic variables derived from GIS layers readily available from internet sources in 2008: soils (Natural Resources Conservation Service 2008), ruggedness (Sappington et al. 2007; United States Geological Survey 2009), and climate (PRISM Climate Group 2004). Those variables included slope (steepness, direction, and ruggedness); rockiness; fire history; percentage of sand, clay, and silt in the soil; water holding capacity of the soil; and mean maximum summer temperatures. Rainfall and summer temperature are strongly (negatively) correlated; hence, precipitation was not included. Given the large number of observations, any combination of variables deemed appropriate could be included in each species' niche model.

Using the best performing niche model based on current or recent environmental conditions, the model was then fitted onto new map data sets with shifted map-point values for summer maximum temperature and mean annual precipitation. Rather than use a downscaled Global Circulation Model (GCM) with uncertain error when applied to a complex topographic unit such as the Monument, a temperature gradient approach (Barrows and Murphy-Mariscal 2012) was used. To simplify the presentation of analyses here, only the 3°C shifted models are compared to the constructed current conditions models rather than showing the incremental increases of maximum summer temperatures by 1, 2 and 3°C. A +3°C shift approximates a maximum expected change from current conditions over this century (IPCC 2007) and so represents a potential "worst case" from which to assess the sensitivity of species to climate change. If the climate doesn't heat to a "worst case" scenario, shifts in suitable habitat, and so impacts to species, will likely be incrementally less than predicted for the modeled +3°C shift. For each model, the area of suitable habitat in hectares for HSI values ≥ 0.7 was calculated and the distribution of that suitable habitat was mapped. The selection of HSI values of ≥ 0.7 for model comparisons, while arbitrary, correspond to visually close fits between location data and niche model distributions.

For prioritizing species' risks using HSMs, two criteria were identified: 1) the proportional loss of each species' suitable habitat expected with a 3°C increase in a summer maximum-temperatures scenario, and 2) how much of the species' current habitat will continue to be suitable under that scenario. This second criterion addresses uncertainty associated with the ability of a species to shift its distribution at the same pace as the climate shifts. The current increasingly more rapid rate of climate change has been contrasted with what was thought to be more gradual rates during the past, which may have allowed species many generations to shift their distributions as they tracked preferred climate envelopes. A summary of the proportional loss of suitable habitat and the amount of climate refugia for each modeled species is shown below in **Table C1**. Habitat suitability models (maps) for individual species are also provided below. It is important to reiterate that these models are hypotheses that need to be validated or refuted, and improved as more data are collected.

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Table C1

Summary statistics for the 24 habitat suitability models constructed for selected species occurring within the Monument.[1]

Reptiles

	current elevation (m)	3C+ modeled elevation (m)	current modeled habitat extent (ha)	3C+ modeled habitat extent (ha)	% change	climate refugia extent (ha)	refugia as a % of 3C+ extent
Banded rock lizard	595 ± 175	980 ± 182	17383	14029	19%	3245	24%
Chuckwalla	530 ± 267	894 ± 263	213600	111816	48%	59415	53%
Granite spiny lizard	1082 ± 340	1340 ± 311	56959	35970	39%	27912	78%
Western fence lizard	1260 ± 297	1681 ± 353	150867	62804	58%	43860	70%
Southern sagebrush lizard	2187 ± 246	2511 ± 205	18993	8206	57%	4620	56%
Desert spiny lizard	726 ± 315	1086 ± 295	243240	99782	59%	83589	84%
Yucca night lizard (spp complex)	993 ± 212	1195 ± 163	156051	86100	45%	45590	53%
Coast horned lizard	1188 ± 246	1515 ± 184	106505	38618	64%	8359	22%
Desert horned lizard	367 ± 258	646 ± 201	425470	244150	43%	192738	79%
Mojave desert tortoise	601 ± 212	876 ± 218	208089	54095	74%	40364	0

Plants

	current elevation (m)	3C+ modeled elevation (m)	current modeled habitat extent (ha)	3C+ modeled habitat extent (ha)	% change	climate refugia extent (ha)	refugia as a % of 3C+ extent
Desert agave	731 ± 259	1015 ± 250	10822	7633	29%	4140	54%
Ocotillo	521 ± 173	930 ± 179	98859	63277	36%	12730	20%
Single-leaf pinyon pine	1335 ± 177	1459 ± 272	21449	9185	57%	269	3%
California barrel cactus	595 ± 193	924 ± 207	33780	20198	40%	6007	30%
White bursage	581 ± 289	918 ± 269	327655	164877	50%	86579	52%
Brittlebush	451 ± 281	703 ± 203	335207	140891	58%	85857	61%
Acton encelia	1076 ± 228	1271 ± 183	65545	30822	53%	1869	6%

	current elevation (m)	3C+ modeled elevation (m)	current modeled habitat extent (ha)	3C+ modeled habitat extent (ha)	% change	climate refugia extent (ha)	refugia as a % of 3C+ extent
Creosote bush	486 ± 354	654 ± 287	475658	266765	44%	237638	89%
Muller's oak	1331 ± 196	1480 ± 193	74474	15912	79%	6273	39%
Jojoba	881 ± 194	1055 ± 165	106103	67392	37%	22025	33%
California juniper	1167 ± 190	1350 ± 144	71329	38990	45%	11602	30%
Red shank	1389 ± 194	1779 ± 195	31240	7105	77%	2031	28%
Jeffrey pine	2050 ± 366	2417 ± 293	15429	6172	60%	2553	41%
Catclaw acacia	650 ± 225	934 ± 265	147316	93665	37%	61482	66%

[1]Species highlighted in red are those shown to be more at risk from projected levels of climate change as measured by the small percentage (≤ 30%) of their current suitable habitat that will remain as a climate refugia and a ≥ 50% decline in the amount of total future suitable habitat. For the desert tortoise, the calculation of refugia as a percentage of the future extent of suitable habitat is for the Monument only. Other desert tortoise refugia exist on lands to the north, such as in Joshua Tree National Park.

As indicated in **Appendix B**, results reveal strong parallels for those species for which both vulnerability assessments and habitat suitability models were prepared—models for pinyons, red shank, coast horned lizards, and desert tortoises all indicate high-risk levels. Taken together, based on vulnerability assessments and habitat suitability models, additional species at higher risk include Peninsular bighorn sheep, Acton brittlebush, and bigberry manzanita.

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Reptiles

Coast horned lizard, *Phrynosoma blainvillii*

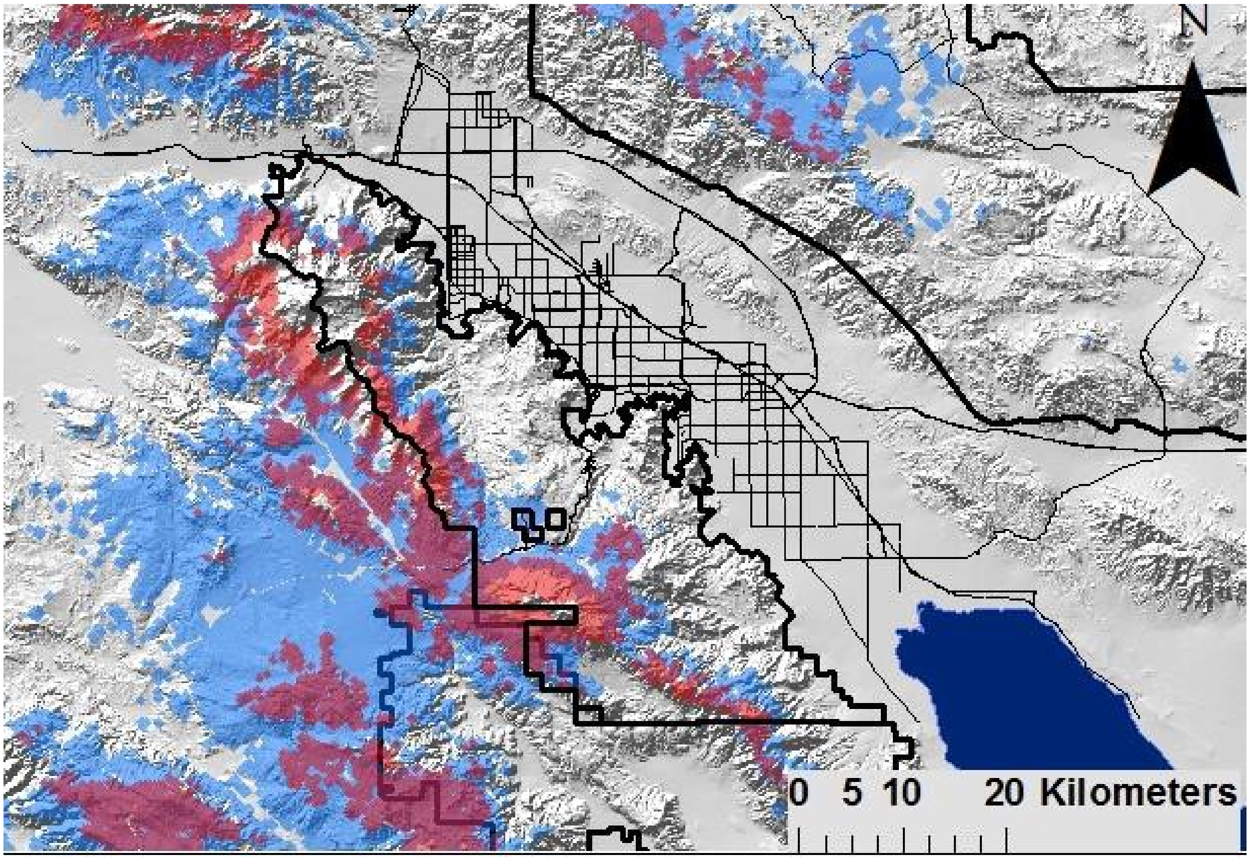

Figure 1. Habitat suitability model for coast horned lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Desert horned lizard, *Phyrnosoma platyrhinos*

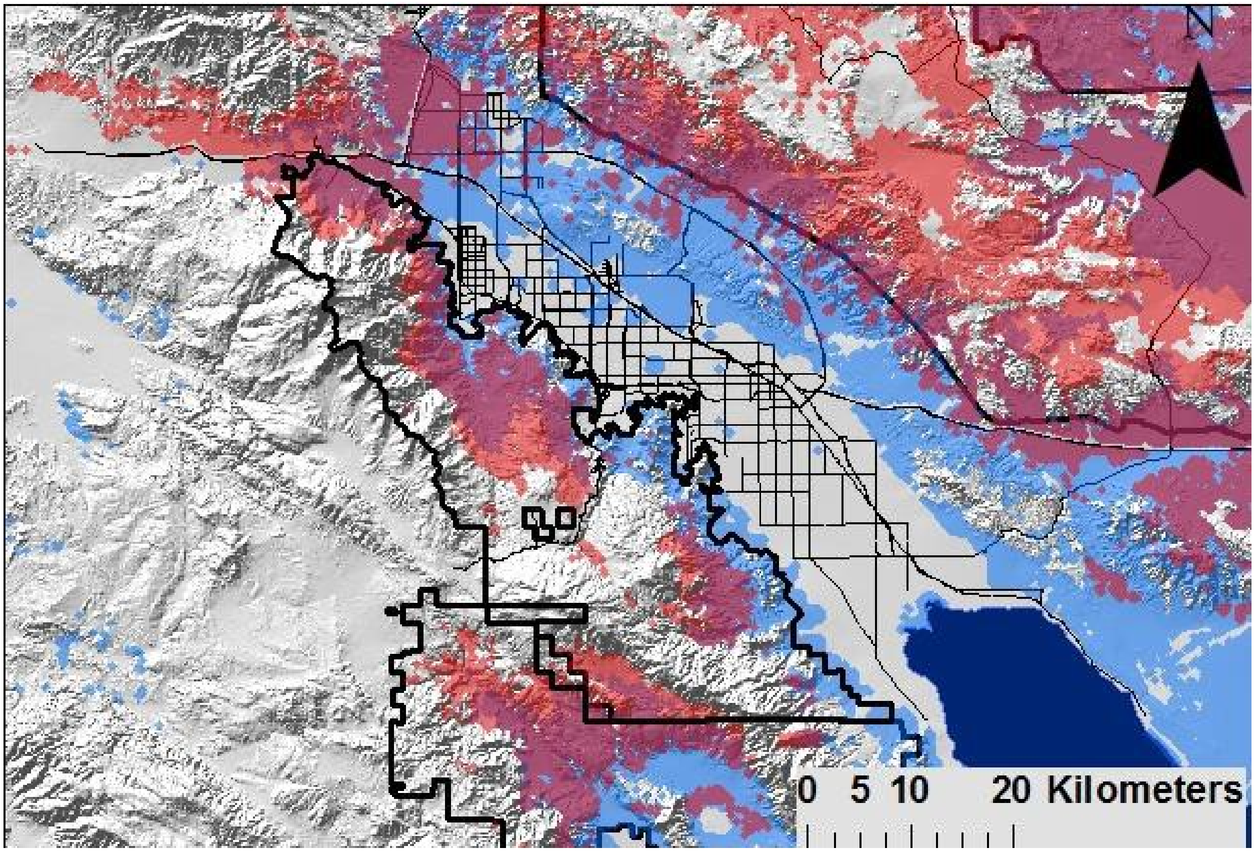

Figure 2. Habitat suitability model for desert horned lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Banded rock lizard, *Petrosaurus mearnsi*

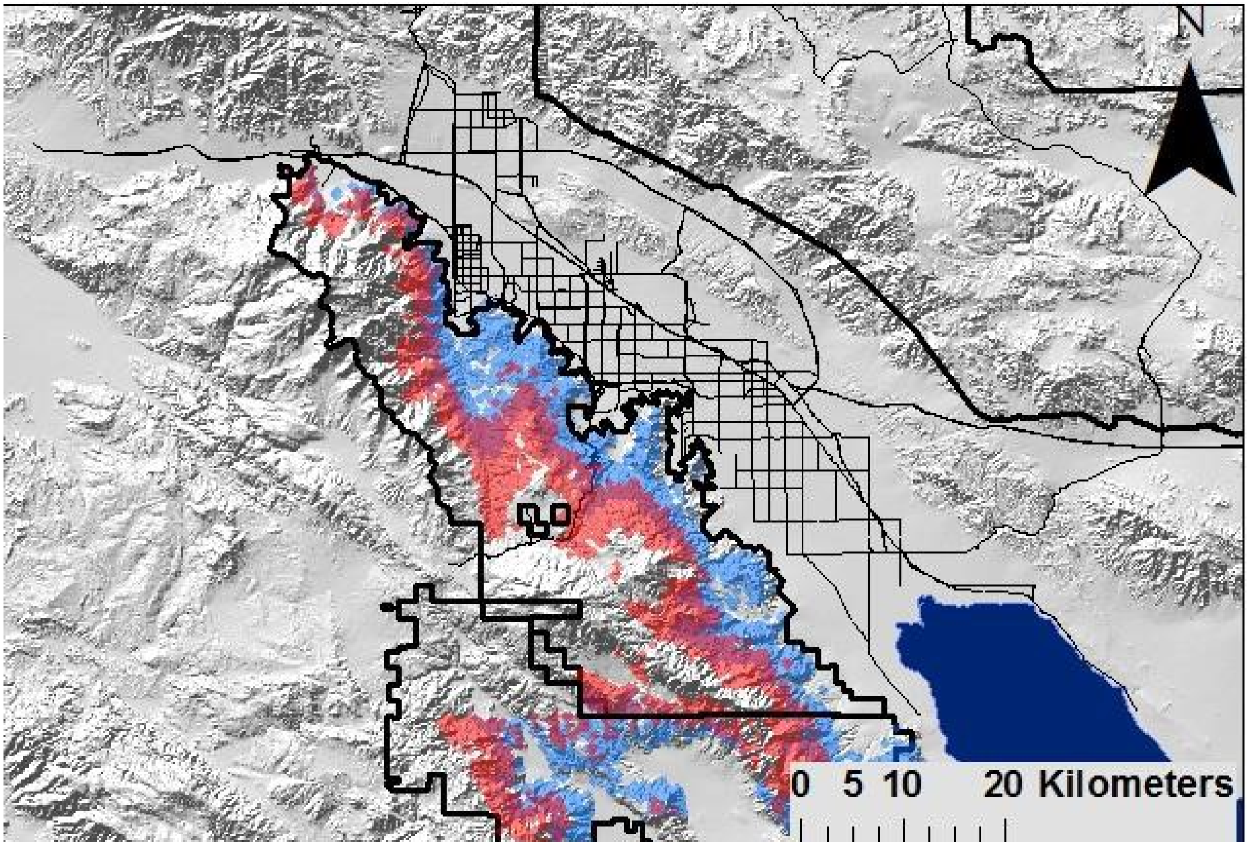

Figure 3. Habitat suitability model for banded rock lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Chuckwalla, *Sauromalus ater*

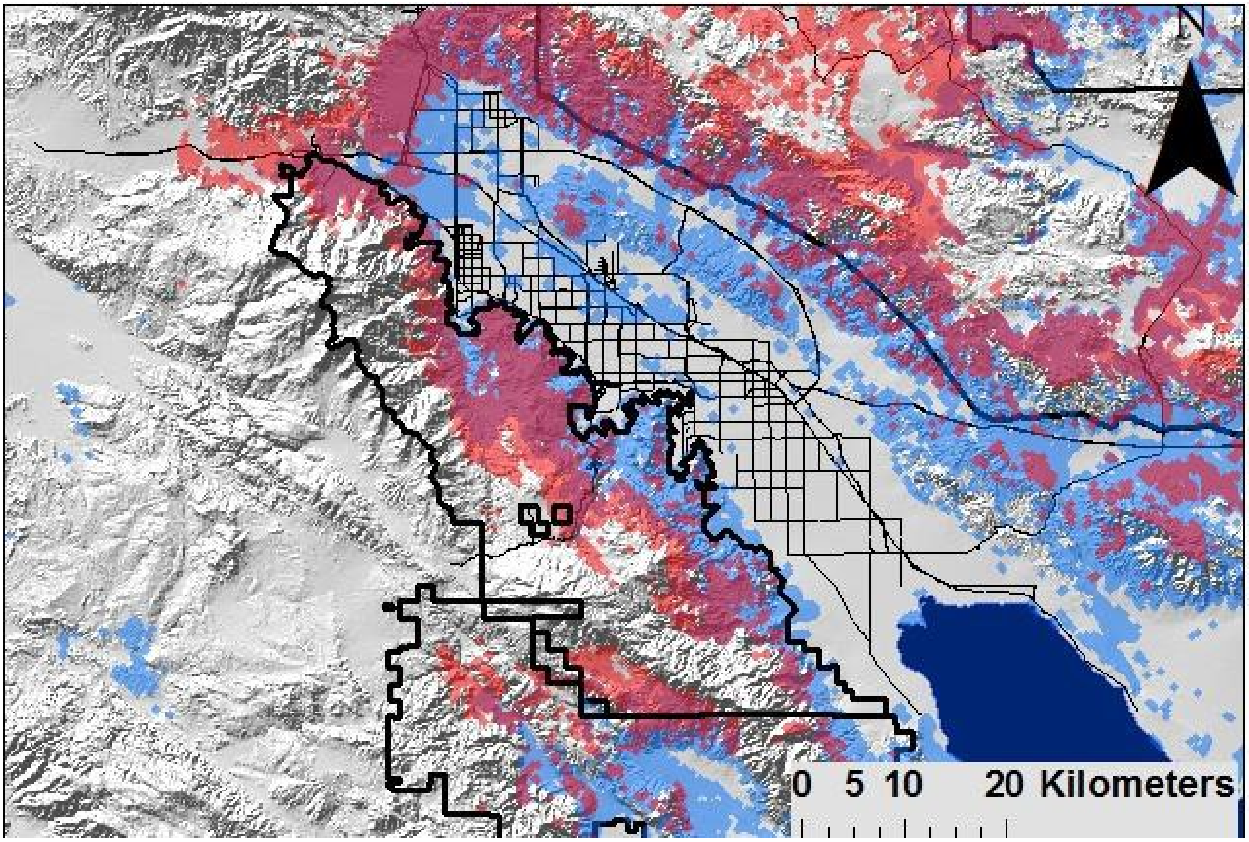

Figure 4. Habitat suitability model for chuckwallas within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Granite spiny lizard, *Sceloporus orcuttii*

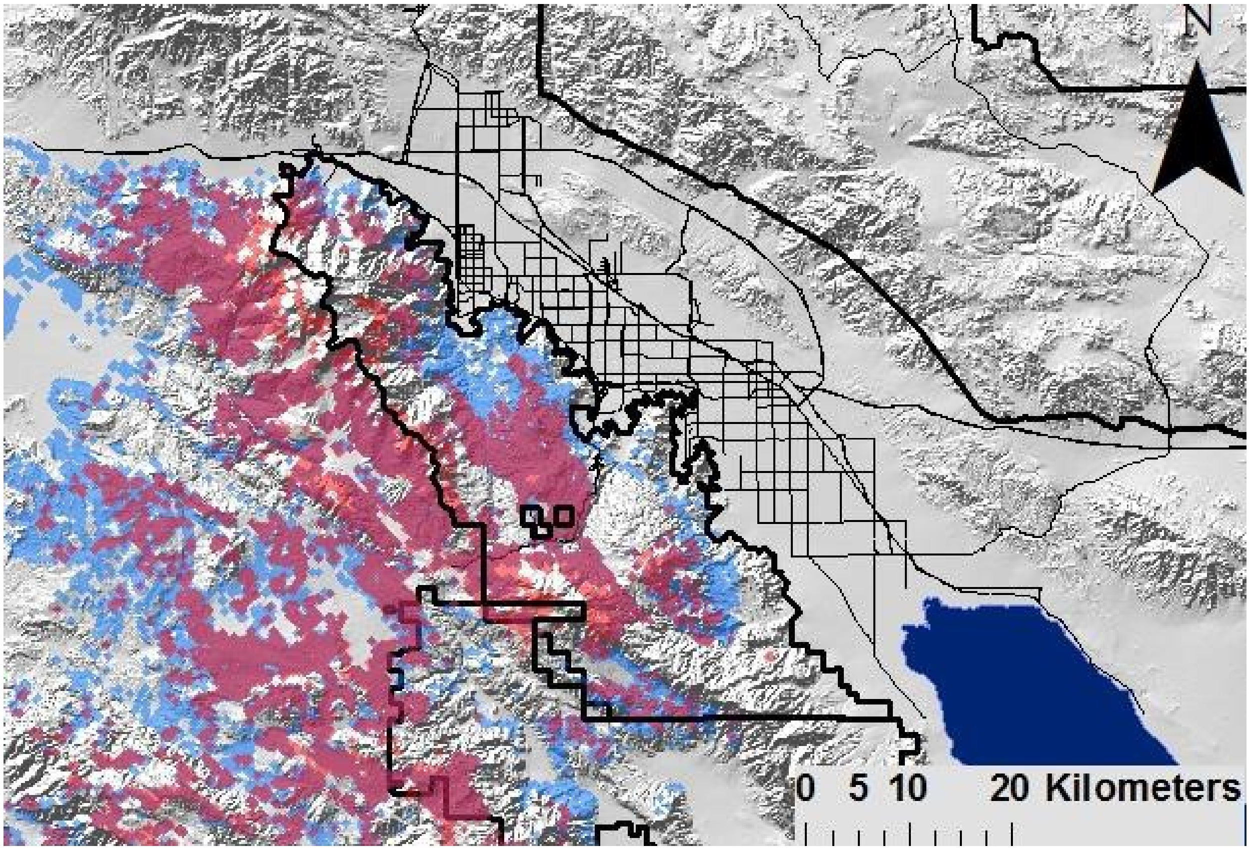

Figure 5. Habitat suitability model for granite spiny lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Western fence lizard, *Sceloporus occidentalis*

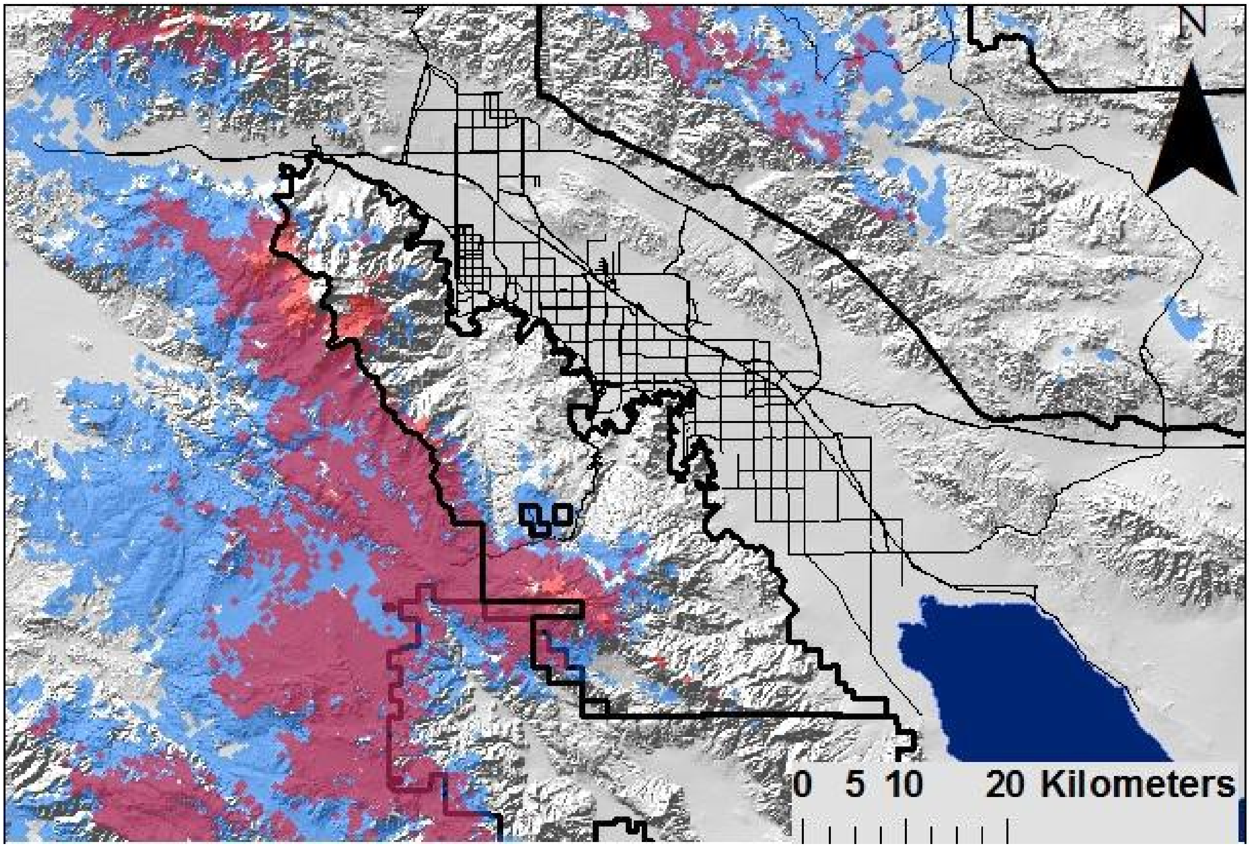

Figure 6. Habitat suitability model for western fence lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Desert spiny lizard, *Sceloporus magister*

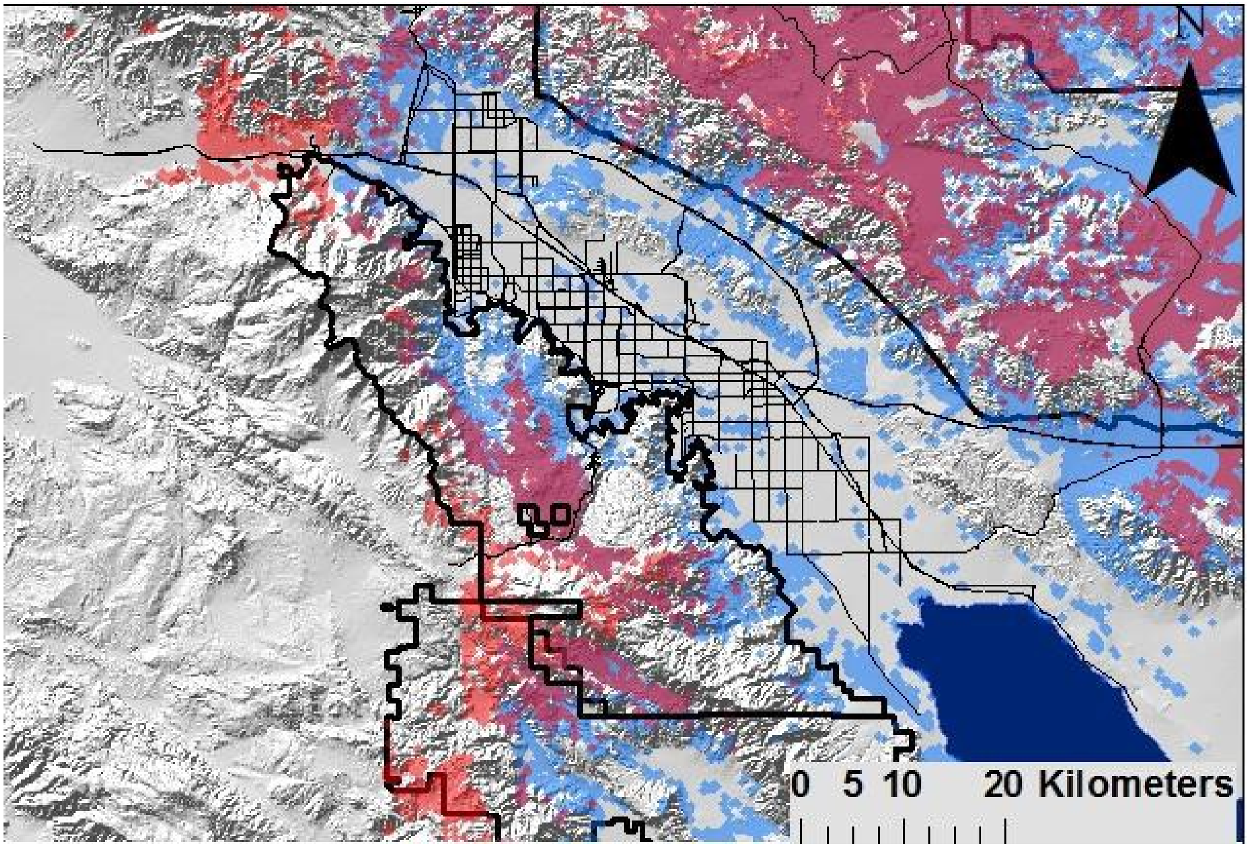

Figure 7. Habitat suitability model for desert spiny lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Southern sagebrush lizard, *Sceloporus vandenburgianus*

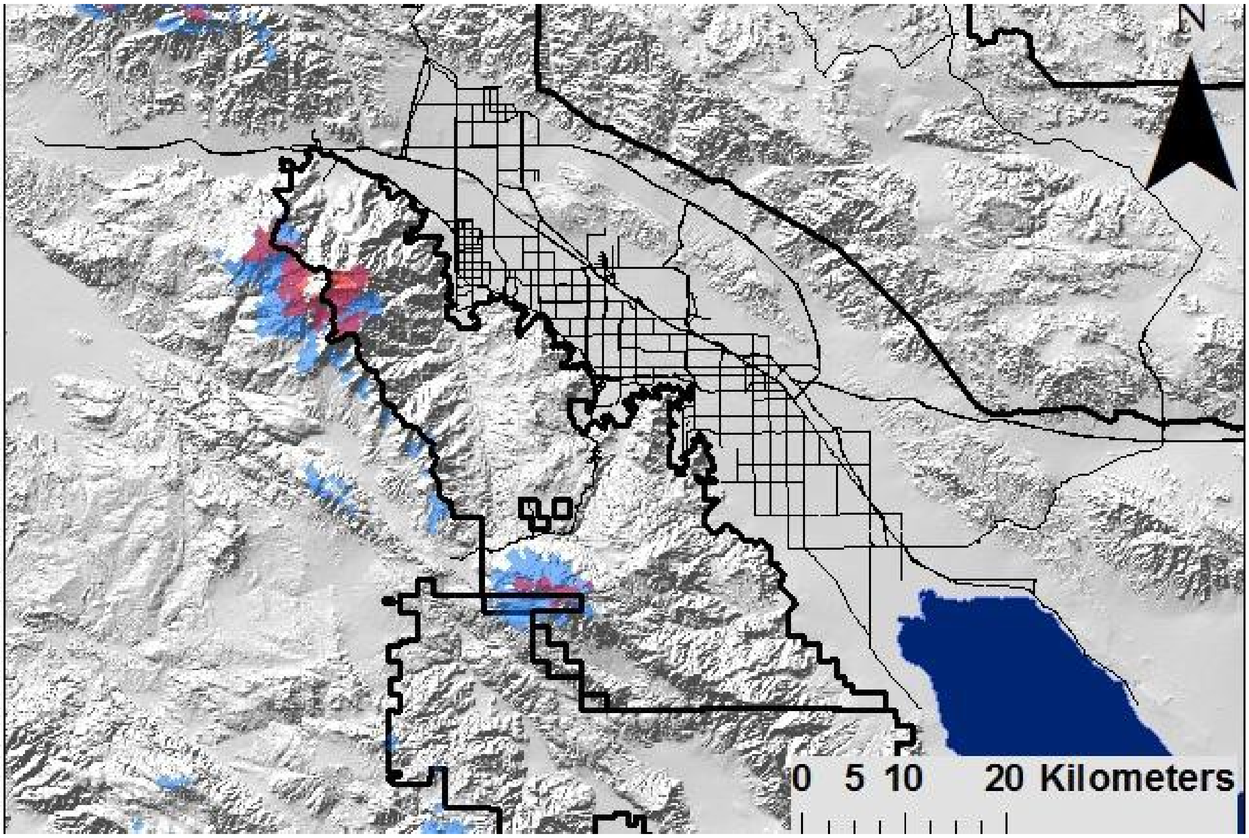

Figure 8. Habitat suitability model for southern sagebrush lizards within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Desert night lizard species complex, *Xantusia* spp.

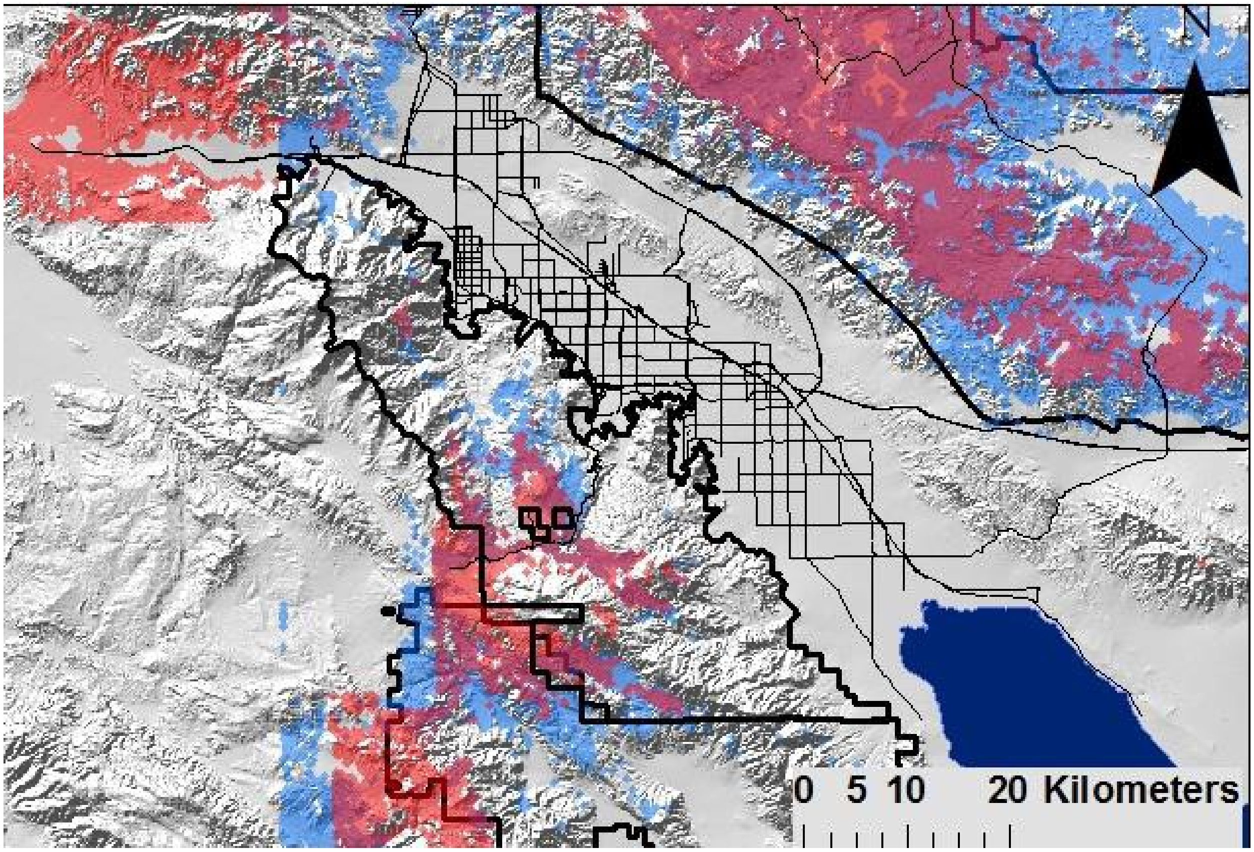

Figure 9. Habitat suitability model for the desert night lizard species complex within the project area. Within this modeled area, distributions for *Xantusia vigilis*, *X. wigginsii*, and up to one or more other, yet undescribed species are included. *X. vigilis* is generally restricted to the north of the Coachella Valley. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Mojave desert tortoise, *Gopherus agassizi*

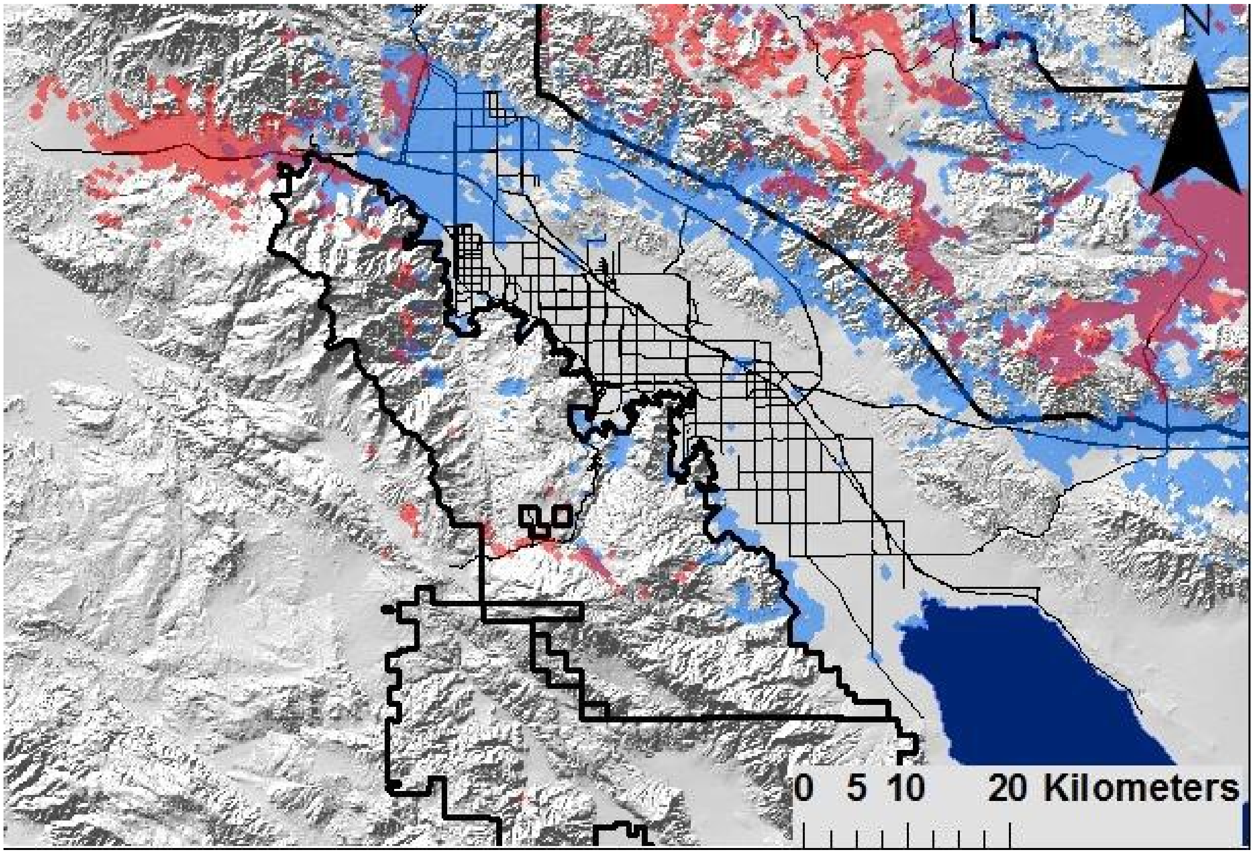

Figure 10. Habitat suitability model for desert tortoises within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Perennial/Woody Vegetation

Creosote bush, *Larrea tridentate*

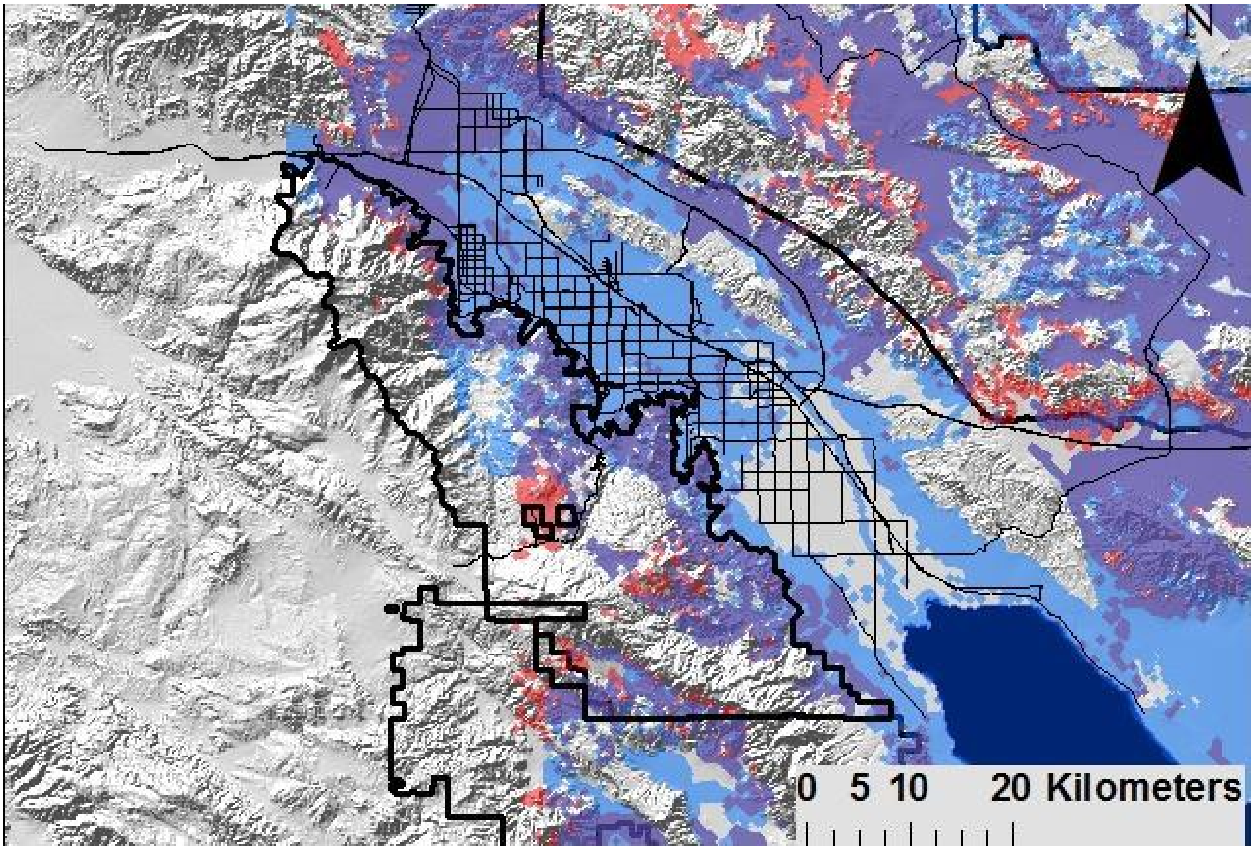

Figure 11. Habitat suitability model for creosote bush within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Jojoba, *Simmondsia chinensis*

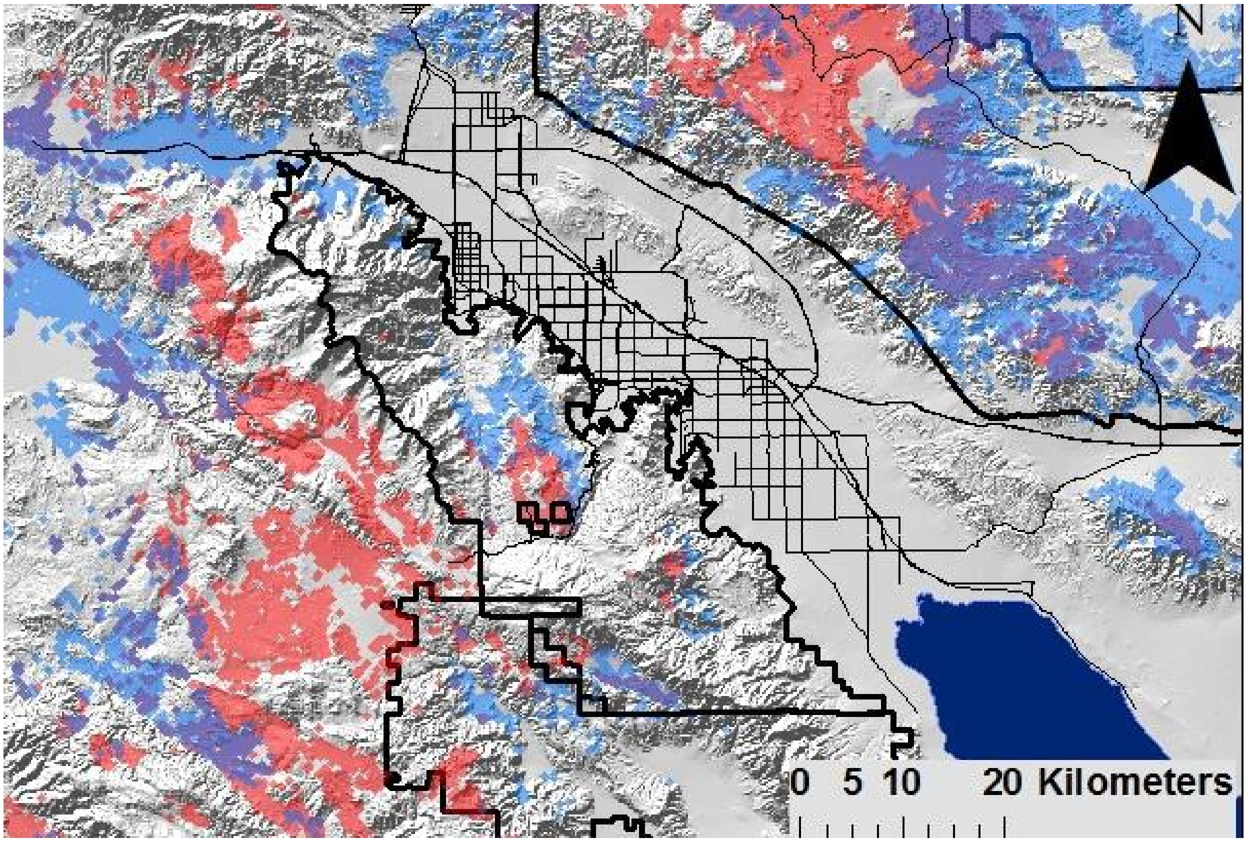

Figure 12. Habitat suitability model for jojoba within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Muller's oak, *Quercus cornelius-mulleri*

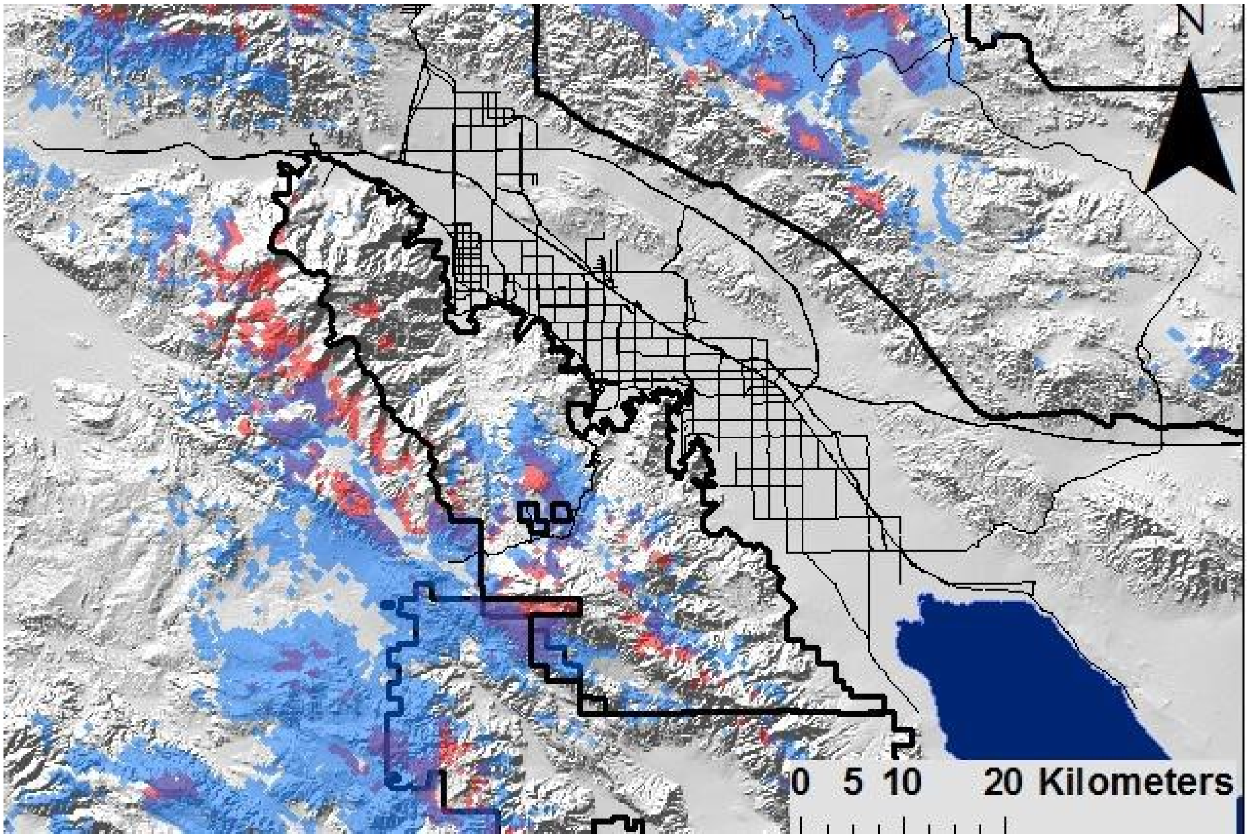

Figure 13. Habitat suitability model for Muller's oak within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

California juniper, *Juniperus californica*

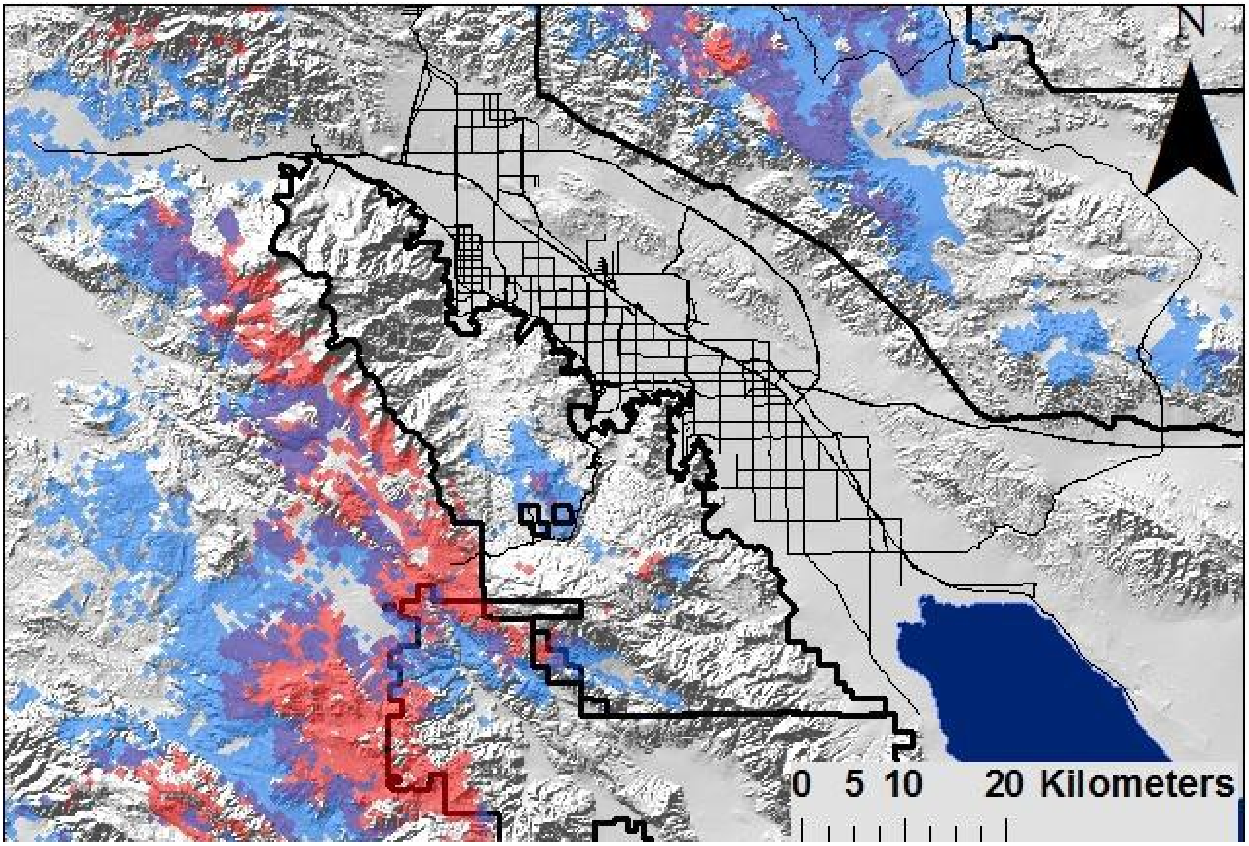

Figure 14. Habitat suitability model for California juniper within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

California barrel cactus, *Ferocactus cylindraceus*

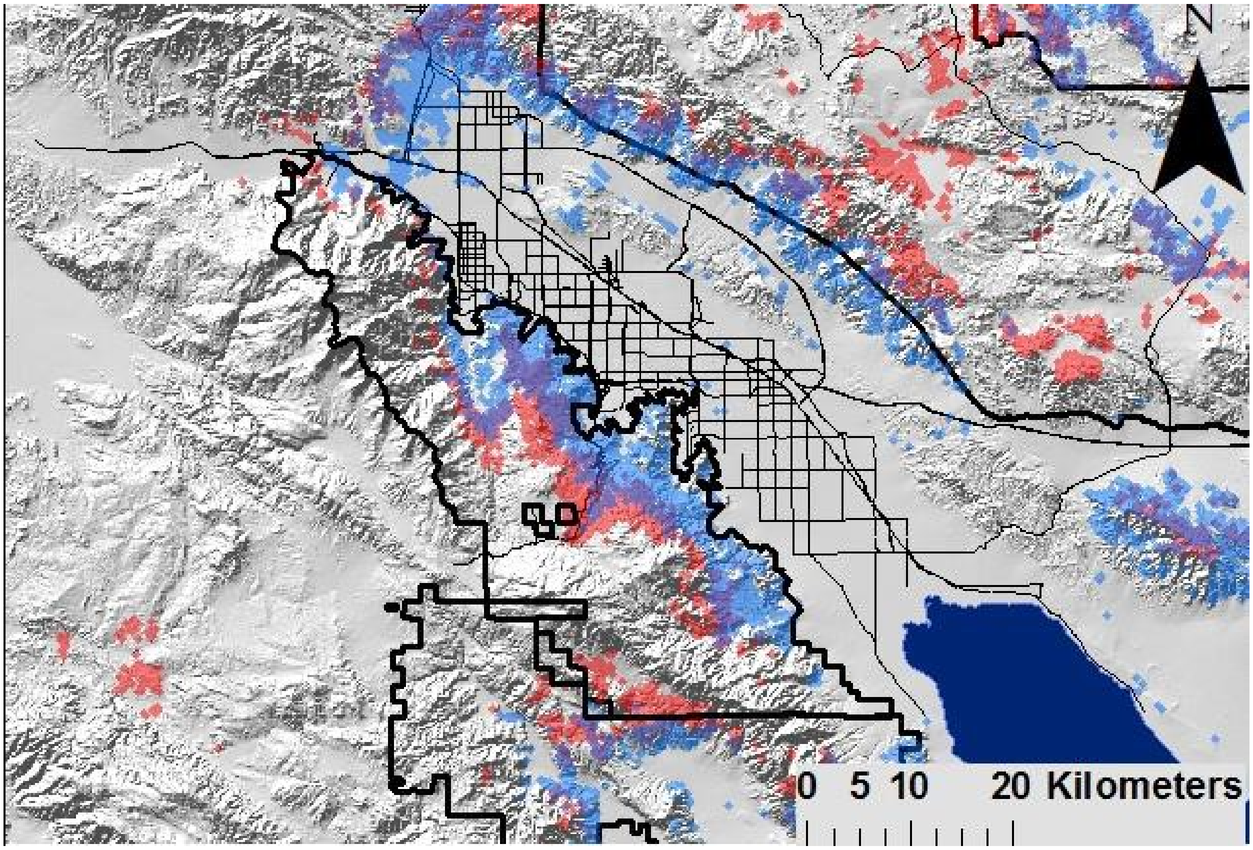

Figure 15. Habitat suitability model for California barrel cactus within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Single-leaf pinyon pine, *Pinus monophylla*

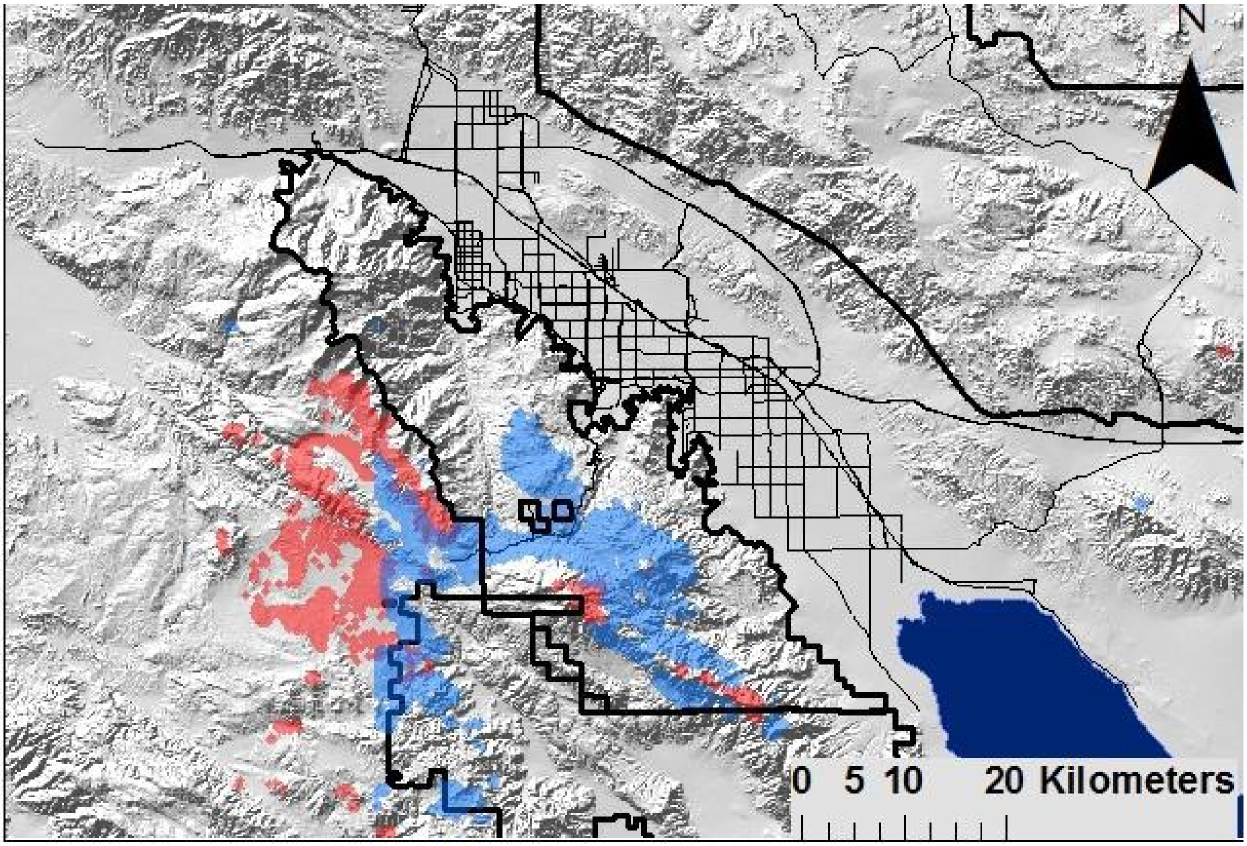

Figure 16. Habitat suitability model for single-leaf pinyon pines within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Ocotillo, *Fouquieria spledens*

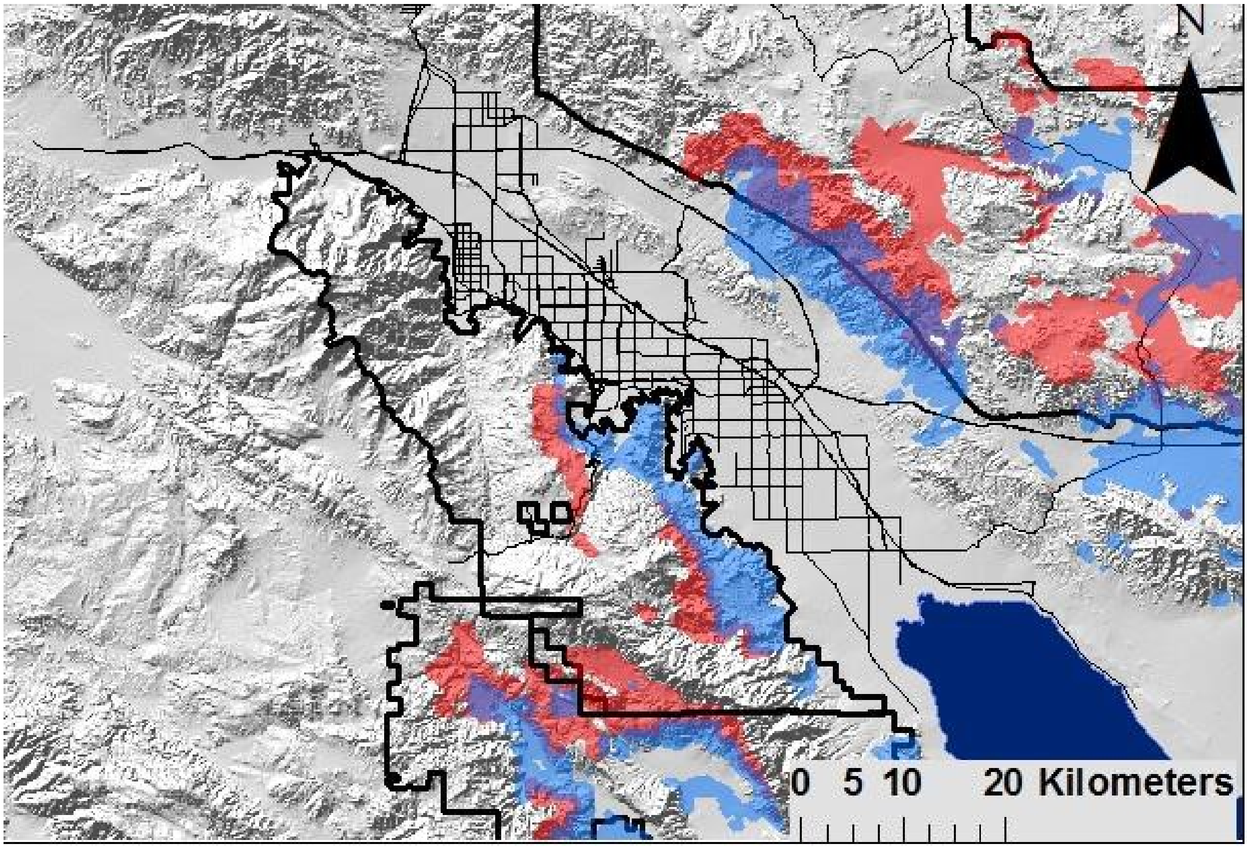

Figure 17. Habitat suitability model for ocotillo within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Desert agave, *Agave deserti*

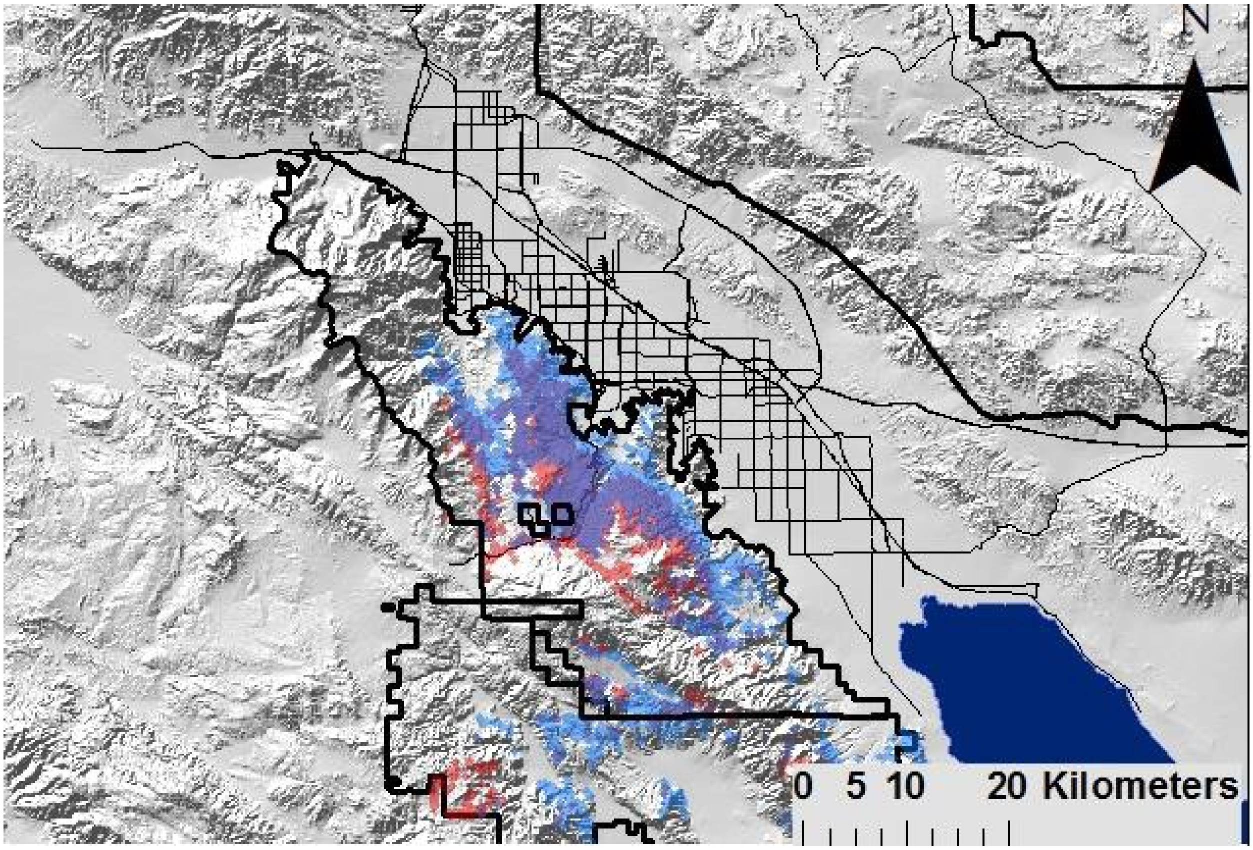

Figure 18. Habitat suitability model for desert agave within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Red shank, *Adenostoma sparsifolium*

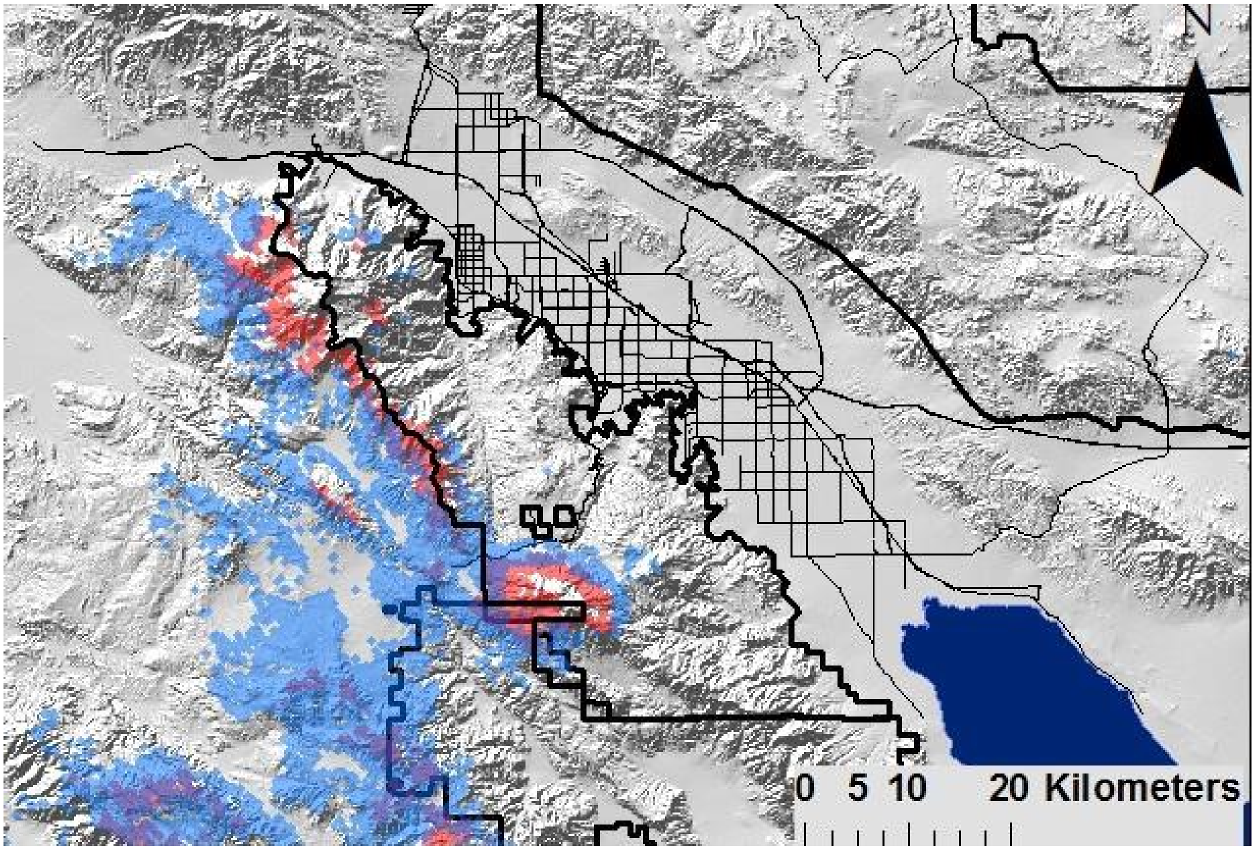

Figure 19. Habitat suitability model for red shank/ribbonwood within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Jeffrey pine, *Pinus jeffreyi*

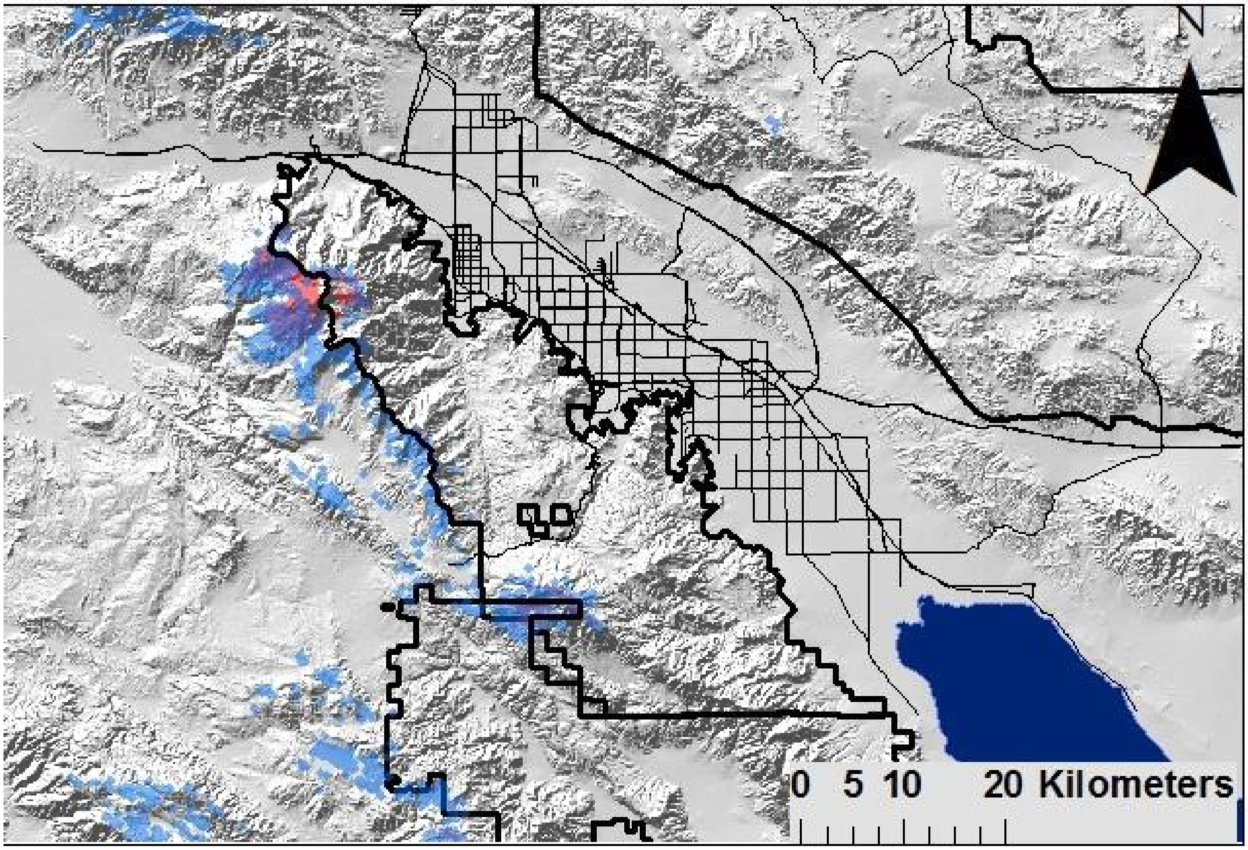

Figure 20. Habitat suitability model for Jeffrey pine within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Catclaw acacia, *Senegalia greggii*

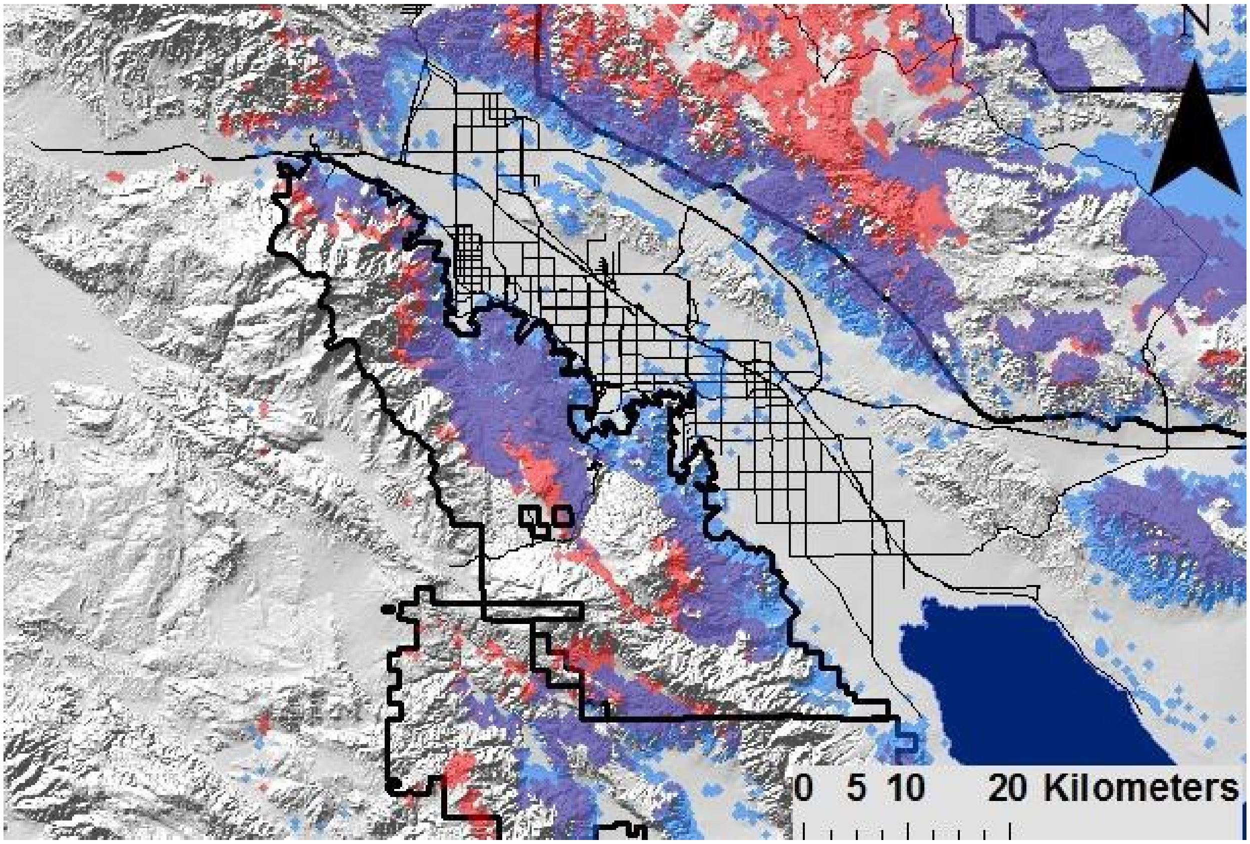

Figure 21. Habitat suitability model for catclaw acacia within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

White bursage, *Ambrosia dumosa*

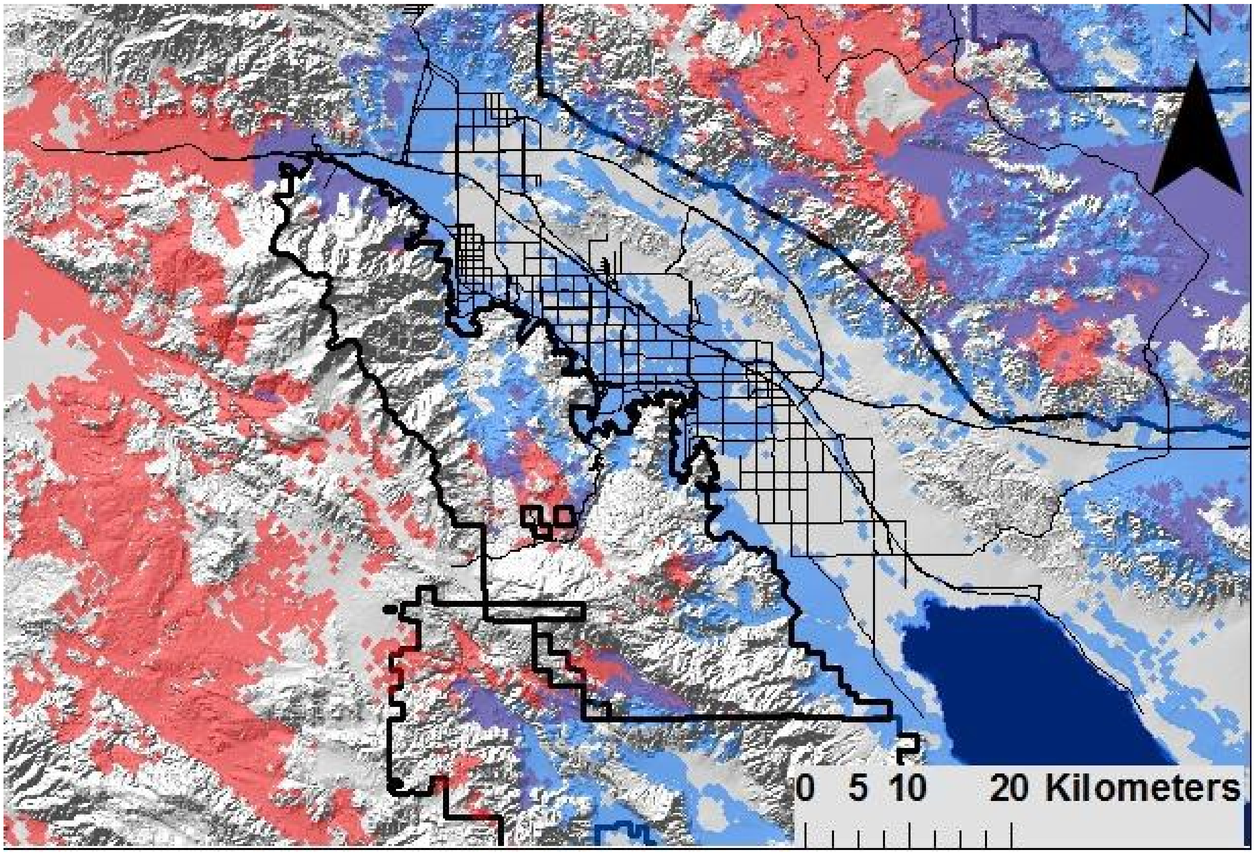

Figure 22. Habitat suitability model for white bursage/burro bush within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Acton encelia, *Encelia actonii*

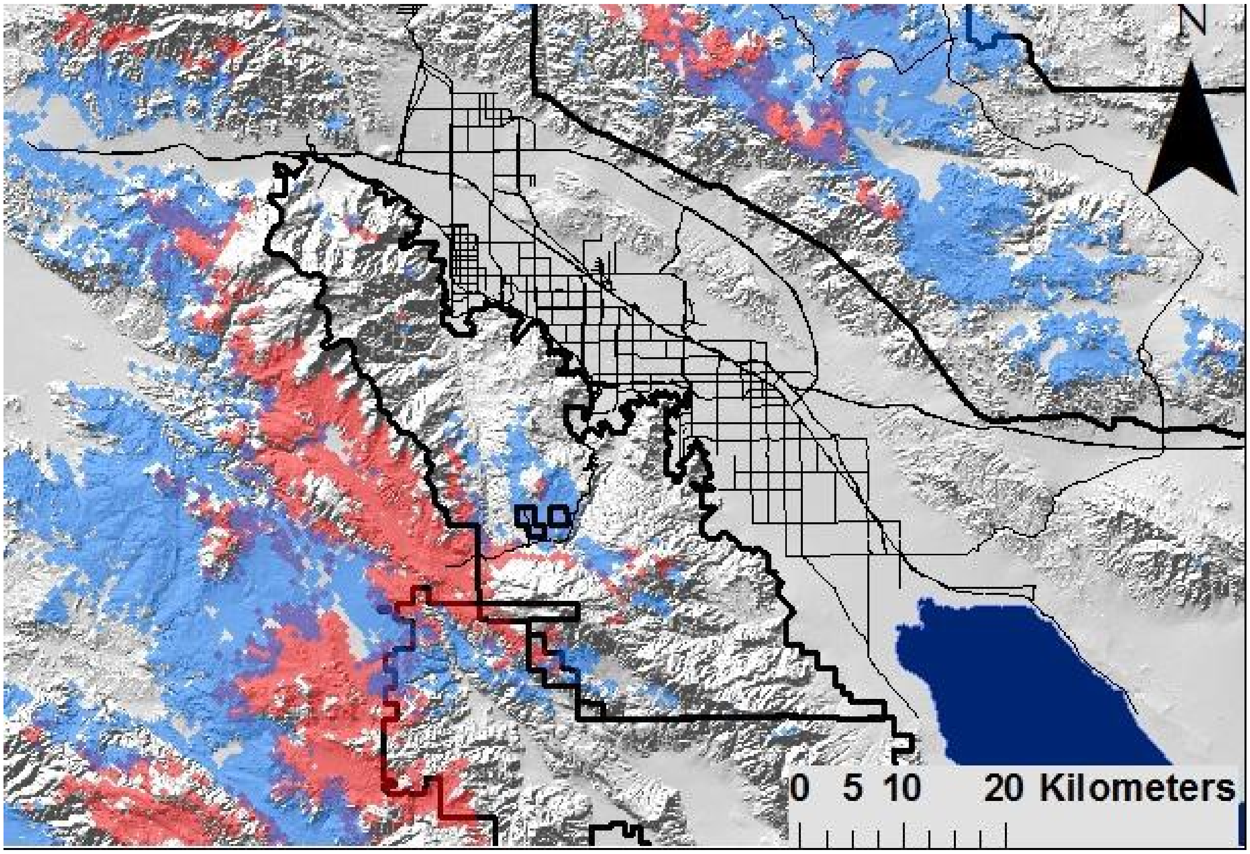

Figure 23. Habitat suitability model for Acton encelia within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

Brittlebush, *Encelia farinose*

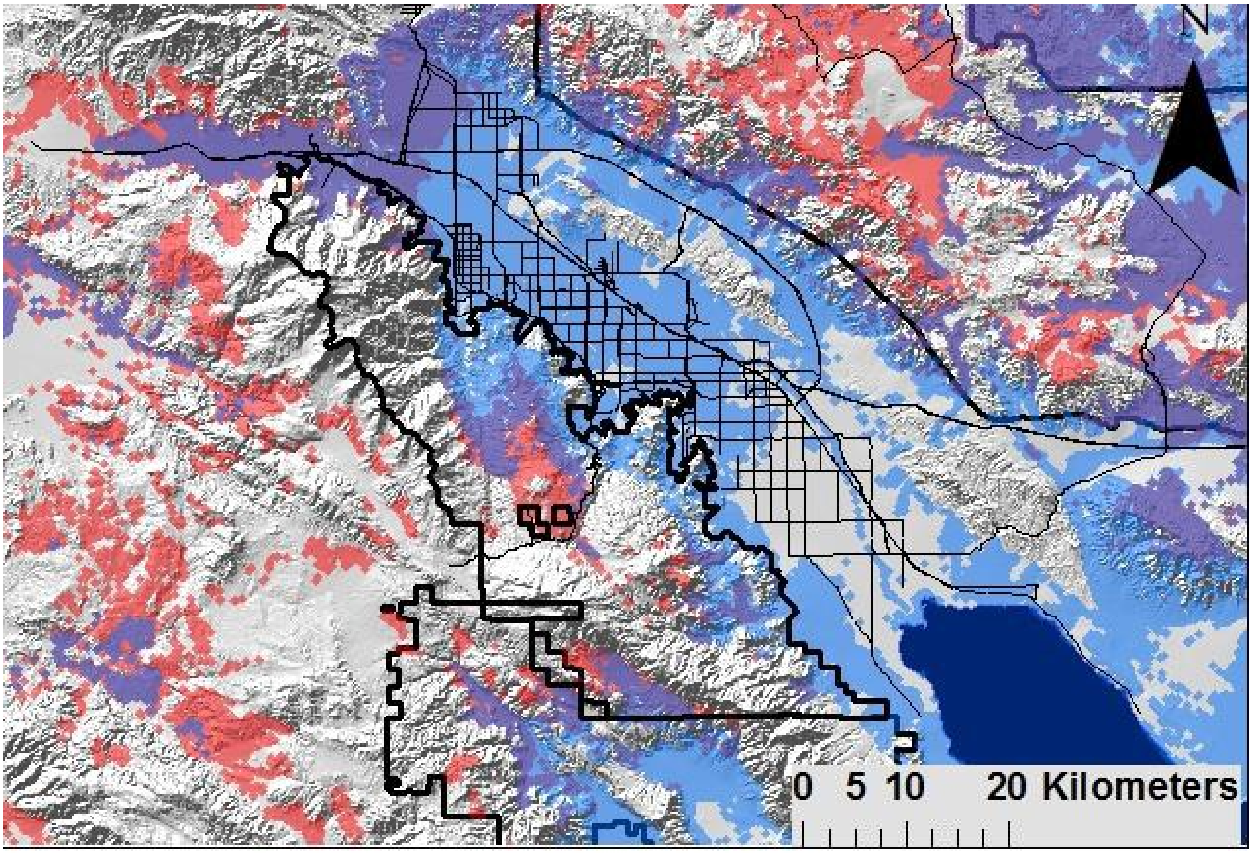

Figure 24. Habitat suitability model for brittlebush within the project area. Blue shaded areas represent modeled suitable habitat under current or recent historic conditions. Red shaded areas represent modeled suitable habitat under a summer temperature increase of 3°C. Purple shaded areas indicate where the two models overlap and so constitute areas of climate refugia for this species.

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