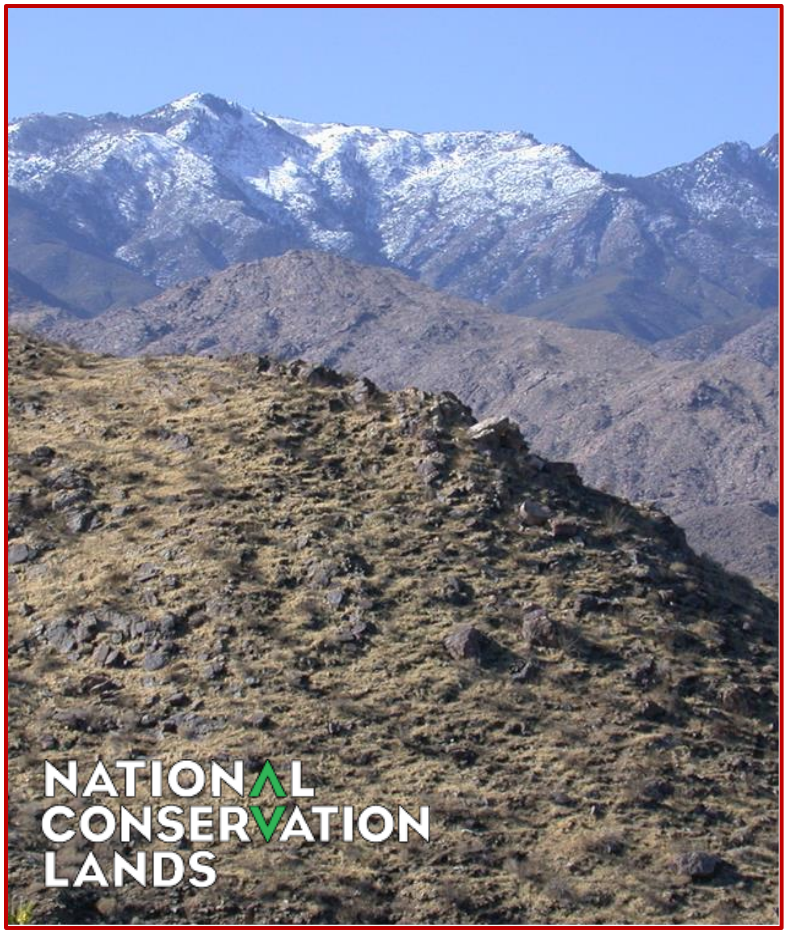
National Conservation Lands Science Plan

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
Bureau of Land Management
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

National Conservation Lands
Science Plan

for the

Santa Rosa and San Jacinto Mountains
National Monument

APPROVED:

/s/ Stephen Razo 4/19/16

Stephen Razo, Acting District Manager
California Desert District
USDI Bureau of Land Management

/s/ Jody Noiron 4/19/2016

Jody Noiron, Forest Supervisor
San Bernardino National Forest
USDA Forest Service

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EXECUTIVE SUMMARY

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.

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.

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.

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.

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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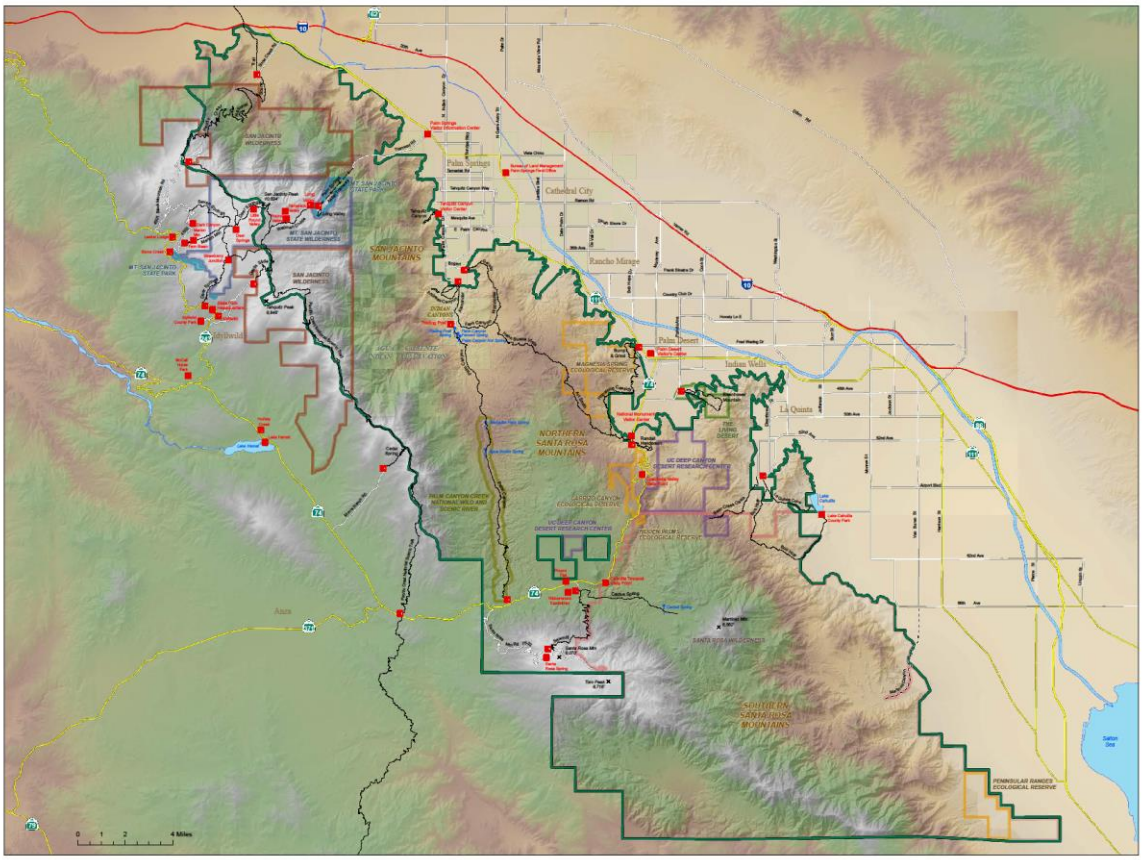
SECTION 1: INTRODUCTION

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.

  <u>Theme 1: Ensuring the Conservation, Protection, and Restoration of NLCS Values</u>

  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.

<u>Theme 1: Ensuring the Conservation, Protection, and Restoration of National Conservation Lands Values</u>

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.

<u>State Level Actions</u>:

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.

<u>State Level Actions</u>:

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.

Strategic Goal: Sustain Our Nation's Forests and Grasslands

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.

Strategic Goal: Apply Knowledge Globally

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 temperature~~s~~. 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 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 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 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.
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**.

Assessing species sensitivities to changing conditions

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.

Establishment of a database

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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