 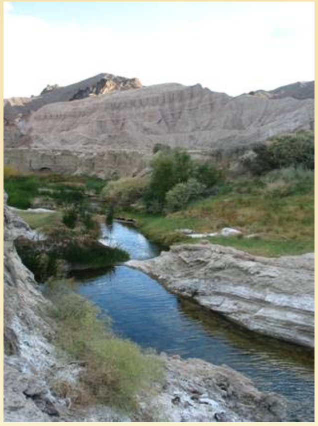 

Mojave Desert Ecoregional Assessment

 

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Version 1.1

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Executive Summary

The Mojave Desert harbors distinctive and extraordinarily rich biological diversity. Equally extraordinary is the fact that large portions of the Mojave remain mostly undisturbed by human activities and constitute one of the last great wilderness areas in the United States. The relative lack of disturbance is of great importance, because the Mojave's arid climate, delicate soils, and slow pace of ecological succession render it exceedingly fragile and slow to recover when disturbed. Protecting these intact landscapes will be essential if the full complement of native species and communities are to persist into the future. Development pressures continue to mount, however, and today the Mojave is at a crossroads. This ecoregional assessment characterizes the distribution of biodiversity conservation values across the Mojave Desert, to help inform decision making regarding regional land-use and conservation investment.

The Mojave Desert Ecoregion is home to a surprisingly diverse biota and includes one of the nation's last great wilderness areas. The California portion alone is inhabited by at least 439 species and subspecies of vertebrates including 14 endemic to the Mojave and 28 that are federally listed as threatened or endangered. The flora is similarly rich, with a large variety of shrubs and some 250 species of annual herbaceous plants, at least 80 of which are endemic. Many of these plants reveal themselves only during spring blooms following particularly heavy winter rains. With its great topographic diversity and varied geology and soils, the Mojave also supports a wide variety of plant communities and ecological systems, from rare subalpine mesic meadows and isolated mesquite bosques, to widespread creosote bush-white bursage desert scrub, patches of desert pavement, and isolated sand dunes. Perhaps most surprisingly, the ecoregion supports large numbers of aquatic animals and plants, many endemic to a single isolated system of springs. This is spectacularly illustrated at Ash Meadows in southern Nevada which features 24 animals and plants found nowhere else in the world.

Another distinctive aspect of the Mojave Desert is its land ownership pattern: a great majority of the ecoregion is in federal ownership. This poses both opportunities and challenges for conservation. Biodiversity conservation is a primary management objective of only a subset of agencies managing federal lands, and other mandates and uses of resources may not be compatible with conservation objectives. Despite substantial investments in land protection and conservation management across the Mojave, key species such as the desert tortoise continue to decline. This underscores not only the need for additional conservation commitments and actions, but also the challenges of conservation in a landscape with many competing stakeholder interests.

Recent decades have seen an intensification of pressures on the lands and waters of the Mojave Desert for residential, recreational, military, and other uses. Human land uses can have dramatic direct and indirect effects on desert ecosystems, with lasting and pervasive impacts. Conversion of native habitat to human land uses results in habitat loss, but it also fragments the remaining habitat and exposes it to factors that can degrade it, such as invasion by weeds and disruption of key ecological processes. Currently, proposals to develop the Mojave's considerable solar, wind, and geothermal energy resources are creating perhaps the most intense pressures on the ecoregion's lands and waters. Especially because the development of renewable energy generation and transmission facilities in the desert is in part motivated by a desire to reduce the threat that global climate change poses to biodiversity, it is incumbent that development not compromise the conservation values of the desert. Informed land-use decision making in the Mojave Desert requires a current and comprehensive assessment of the distribution of, and threats to, its biodiversity.

Here, we present the results of an analysis to characterize the distribution of conservation values across the Mojave Desert Ecoregion. Using an ecoregional planning approach followed worldwide by The Nature Conservancy and its partners, we identified a suite of conservation targets (521 species, 44 ecological systems, and seeps and springs are the focus of the plan) and set quantitative conservation goals for each target. We also characterized land-use impacts across the desert, such as roads, urban areas, and agricultural uses. We then used Marxan conservation planning software to help identify and map the relative conservation value of lands across the region for meeting the stated conservation goals. Marxan is designed to identify the most efficient configuration of places needed to protect a given set of conservation targets and to achieve a given set of conservation goals. It can also incorporate information on the distribution of threats to conservation targets and the relative importance of selecting sites that are clustered together to minimize the area-to-perimeter ratio, versus selecting isolated sites that contain conservation targets regardless of the resultant area-to-perimeter ratio.

Our analysis involved dividing the entire Mojave Desert Ecoregion into one-square-mile (259-hectare) planning units, synthesizing spatially-explicit information on the conservation targets and anthropogenic disturbance found in each planning unit, and then using this information to identify the relative value of each planning unit in meeting our conservation goals. High conservation value was attributed to areas with low levels of disturbance and unique conservation target occurrences or high concentrations of target occurrences.

We characterized conservation values in the Mojave Desert Ecoregion using four categories:

1. Ecologically Core: These lands of highest conservation value are largely undisturbed and un-fragmented, and support the conservation targets (species, ecological systems, springs and seeps) selected for this analysis. Their full protection is critical for long-term conservation of biodiversity in the Mojave Desert.
2. Ecologically Intact: These lands of high conservation value are largely undisturbed and unfragmented and support conservation targets. They buffer Ecologically Core lands and require levels of protection that will allow them to remain relatively undisturbed to preserve ecological processes and to provide viable habitat and connectivity for native animals, plants, and communities. Most Ecologically Intact lands are functionally equivalent to Ecologically Core lands and may contain many of the same conservation targets, including sensitive species. However, they may have been classified as Ecologically Intact because they support more widespread ecological systems, are at higher risk of degradation, or support conservation targets for which the conservation goals have already been met on Ecologically Core lands.
3. Moderately Degraded: These lands are fragmented by roads or off-road-vehicle trails, or are in close proximity to urban, agricultural, and other developments. They often maintain

ecological functionality (e.g., maintain groundwater infiltration and flow, serve as sand sources, provide connectivity) or provide habitat for native species including the conservation targets selected for this analysis.

4. Highly Converted: These urban, suburban, and agricultural lands are heavily altered. While some can support important conservation targets, their ecological context is highly compromised.

Figure 6-2 depicts the spatial distribution of land within the four conservation value categories across the entire 32.1-million-acre Mojave Desert Ecoregion. Ecologically Core lands comprise 37% of the ecoregion and Ecologically Intact lands comprise another 49%. Thus, 86% of the ecoregion retains high conservation value. Despite a long history of human occupation and use, the Mojave Desert remains one of the least disturbed ecoregions in the United States. On the other hand, Moderately Degraded lands comprise 10.4% of the ecoregion and Highly Converted lands comprise another 3.7% for a total of 14.1% of the Mojave Desert.

It is noteworthy that the Bureau of Land Management owns and manages more land classified as Ecologically Core (44.8%) and Ecologically Intact (52.7%) than any other landowner in the region. The National Park Service is second in both categories with 27.4% and 19.1%, respectively. The Department of Defense also holds more than 10% of the lands in each of the two high conservation value categories. In contrast, private landowners hold only about 8% of the lands in the highest conservation value categories, but nearly half (46.5%) of the Moderately Degraded land, and the great majority of the Highly Converted land (84.8%).

In our preliminary analysis of how well our categorization captured areas that may be of importance for the survival of species as the climate changes, we found that Ecologically Core and Ecologically Intact lands include 95% of the areas with highest landscape resilience—areas with physical features that may buffer the impacts of projected climate change and provide refuge for species. The Ecologically Core areas are particularly important because they capture 53% of the areas of highest landscape resilience while covering only 37% of the ecoregion.

This assessment identifies areas that are important for the continued survival of the full suite of the Mojave's biological diversity. As such it focuses on areas that support a broad range of rare and common species, as well as areas that remain relatively undisturbed. Given this focus, it is important to note that it is intended to complement—not replace or supersede—other biodiversity assessments and models (e.g., habitat conservation plans, recovery plans) that focus more specifically on the recovery of a single species, a more limited number of focal species, or the conservation of a smaller geographic area. Also, because of the scale and resolution of this analysis, finer-scale and site-specific assessments will be necessary for decision making regarding specific projects or site-scale planning.

Figure 6-2

Mojave Desert Conservation Value

Project Area

Mojave Desert

Conservation Value

Ecologically Core
Land with low levels of anthropogenic disturbance which support conservation targets and whose protection is critical for the long-term conservation of the ecoregion's biological diversity

Ecologically Intact
Land with low levels of anthropogenic disturbance or which supports conservation targets and which requires a level of protection that will enable it to continue to support ecological processes and provide connectivity

Moderately Degraded
Land fragmented by roads, off-road-vehicle trails or in close proximity to urban, agricultural and other developments

Highly Converted
Land in urban and agricultural areas that is fragmented and most impacted by human uses

Boundaries

State
County

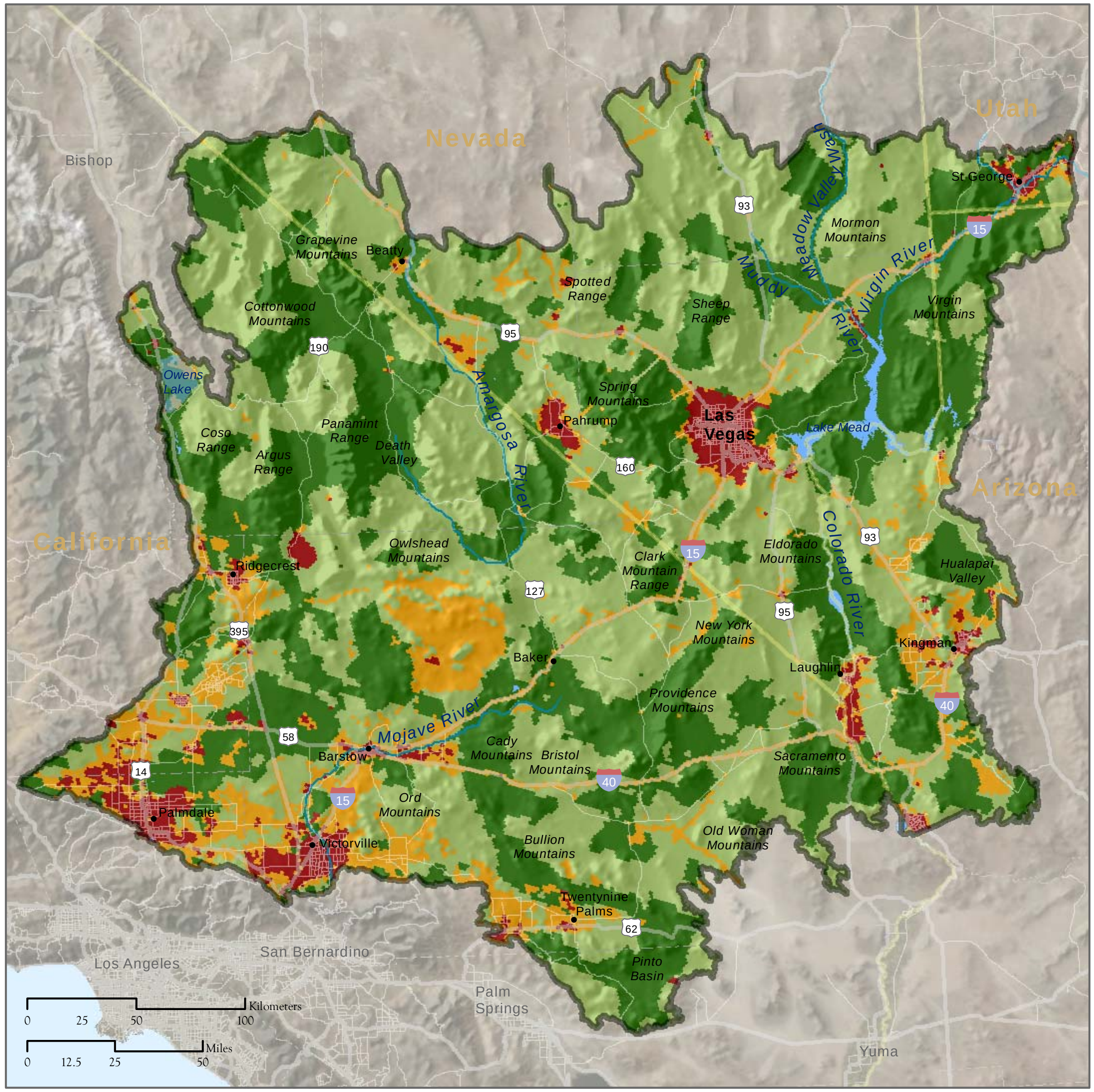
Transportation

Major Road
Other Road

Hydrology

Major River

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources



Based on our findings, we propose a vision for the Mojave Desert of enhanced protection and management that ensures the long-term viability of its native species, natural communities, and ecological processes. This vision can be realized by:

- expanding the network of core protected areas to safeguard under-protected species and systems;
- buffering this network with areas that are permeable to native plants and animals and managed sustainably;
- maintaining corridors essential to migration of wide-ranging species; and
- ensuring protection of wetlands, springs, higher-elevation lands, and other areas most likely to provide habitat to vulnerable species, especially as climates change.

In support of this vision, we propose objectives for land in each conservation value category:

- Ecologically Core: Protect the large, intact habitat blocks comprising Ecologically Core lands to conserve irreplaceable conservation targets, support the ecological processes they depend upon, and maintain habitat connectivity. Prevent fragmentation of these areas caused by development and roads, and prevent degradation caused by invasions of exotic species, uncharacteristic (frequent) fire regimes, excessive groundwater withdrawals, and other direct and indirect human impacts.
- Ecologically Intact: Promote land uses and management practices that maintain or improve landscape integrity and protect conservation targets. Promote restoration of habitat connectivity, natural vegetation communities, and ecological processes (e.g., sand transport and water-flow regimes).
- Moderately Degraded: Encourage sustainable land uses that minimize impacts to native species and communities and other natural resources, allow protection of sensitive species and isolated high value native ecosystems, and maintain landscape permeability to wildlife movement.
- Highly Converted: Encourage clustering of new land uses in areas already converted for human uses and encourage siting of developments selected to minimize impacts to conservation targets and other biological resources. Focus conservation and management efforts within Highly Converted lands on existing open spaces, riparian habitats, and canyons that support local wildlife, improve air and water quality, recharge and prevent overdrafts of groundwater aquifers, and otherwise improve human quality of life. Promote management of agricultural lands and urban landscapes that supports wildlife.

A variety of strategies may be required to meet these objectives and achieve this conservation vision. They include protecting high conservation value lands through re-designation of public lands and acquisition of private and state school lands, enhancing the management and restoration of public lands, promoting collaborative conservation among stakeholders, addressing information gaps and uncertainty, and promoting adaptive learning that puts new information to use to improve and enhance the effectiveness of all of these strategies.

The results of this assessment can help inform regional conservation and land-use planning efforts by the responsible agencies and stakeholders including industry and the conservation community. We suggest that land-use decisions adhere to the principles of the mitigation hierarchy: first, avoid harm to resources; if harm cannot be wholly avoided, damages should be minimized or resources restored or damage reduced over time; finally, compensatory mitigation for any remaining harm must then be provided. Generally, damage can be avoided by guiding potential impacts away from areas of high conservation value on Ecologically Core and Ecologically Intact lands where development is likely to cause fragmentation and other damage to conservation targets, and towards other more appropriate areas in Highly Converted lands and perhaps portions of Moderately Degraded lands. However, important conservation values may occur in these areas, so focused and finer-scale assessments are always warranted. Where damage cannot be avoided, this assessment may also have utility in helping direct compensatory mitigation funds and actions to high value landscapes and activities.

The full Mojave Desert Ecoregional Assessment report and associated Map Service products which can be used to inform decision making in a GIS environment are available at ConserveOnline: http://conserveonline.org/workspaces/mojave/documents/mojave-desert-ecoregional-2010/@@view.html.

*Joshua tree (*Yucca brevifolia*), Red Rock Canyon National Conservation Area, Nevada (Photograph by James Moore)*

1 Introduction

The Mojave Desert harbors an extraordinary variety of plants, animals, and other organisms capable of surviving some of the harshest conditions on Earth. Although portions have been degraded or converted to intensive land uses, large expanses of the 32.1-million-acre Mojave Desert Ecoregion are mostly undisturbed and constitute one of North America's last great wilderness areas. At the same time, the arid climate, delicate soils, and naturally slow pace of soil development, plant growth, and ecological succession render the Mojave Desert extremely fragile and slow to recover when it is disturbed. Even apparently minor actions can cause long-term effects on soils and ground water and long-lasting consequences for plant and animal populations and communities. This is of particular concern because habitat losses and disturbance due to human use and development have increased rapidly in recent decades and interest in developing the Mojave Desert's renewable energy resources has greatly accelerated in the past few years. This combination of biological richness, large relatively undisturbed areas, susceptibility to disturbance, and accelerating pressures for development makes conservation of the Mojave Desert both important and highly urgent.

The Mojave Desert's multi-faceted conservation values include surprisingly high numbers of plant and animal species, a large subset of which are endemic—found nowhere else on earth (Section 3). Of particular note in this arid region are the numerous endemic aquatic animals and plants, many found only in a single isolated system of springs. This is spectacularly illustrated at Ash Meadows National Wildlife Refuge in Nevada, which supports 24 animals and plants found nowhere else in the world including the Devil's Hole pupfish (*Cyprinodon diabolis*), Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*), Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*), Ash Meadows naucorid, (*Ambrysus amargosus*; an aquatic beetle), and plants such as the spring loving centaury (*Centaurium namophilum*). The Mojave Desert also supports a wide variety of natural communities and ecological systems, from rare subalpine mesic meadows and isolated mesquite bosques, to widespread creosote bush-white bursage desert scrub, patches of ancient desert pavement, and isolated sand dunes. National databases (e.g. LANDFIRE and ReGAP) describe nearly a hundred different ecological systems in the Mojave Desert.

Remarkably, the Mojave Desert remains perhaps the region least fragmented by roads, urban development, and other intense land uses in the contiguous United States. According to a report on habitat loss and degradation by the World Wildlife Fund, roughly half of the Mojave Desert remains as intact habitat (Ricketts et al. 1999). Yet all of this variety and conservation value is found in what is sometimes thought of as a "desert wasteland" by people who do not realize the biological richness it actually holds.

Important conservation investments have already been made in the Mojave Desert, with an emphasis on public lands (Section 4). With over 85% of its area in non-private status, the Mojave Desert has more public land than any other ecoregion in the United States. These public lands include two large National Parks (Death Valley and Joshua Tree) and the Mojave National Preserve, plus National Wildlife Refuges, Wilderness Areas, and other specially-designated public lands dedicated at least in part to biodiversity conservation. It has also been the site of focused efforts to recover state- and federally-listed species, with the Mohave ground squirrel (*Spermophilus mohavensis* [synonym: *Xerospermophilus mohavensis*]) and desert tortoise (*Gopherus agassizii*) the most prominent. Unfortunately, these investments have not yet been enough to stave off declines of these and other species and communities, highlighting the need for additional conservation commitments and actions.

Although the Mojave Desert retains large areas of intact habitat, it has experienced a long history of human use and suffers a variety of threats to its biodiversity (Section 5). The ecoregion hosts many uses that lead to habitat loss and disturbance, including recreational off-highway vehicle (OHV) use, military testing and training, irrigated agriculture, mining, grazing, urban development, transportation infrastructure, and the generation and transmission of electrical energy. And there are growing pressures to expand the area available for many of these uses.

The past decade has seen a marked increase in understanding and concern over the projected effects of climate change in the Mojave Desert. Projections for California's deserts are severe, with the typical summer maximum temperatures by the end of the century reaching levels that are hotter than the most extreme year documented in the last 100 years. The majority of climate models also indicate that the Mojave Desert will become even more arid, with a projected mid-century decrease of an average of 1.6 inches of already sparse annual precipitation. These changes are likely to engender increases in other threats, for example promoting invasions by non-native, disturbance-tolerant, and fire-promoting plants, and increasing the frequency and intensity of wildfires in areas that have historically not experienced fire and whose species are not adapted to it.

The past decade has also seen a great surge in interest in tapping the renewable energy resources of the Mojave Desert, which receives some of the highest levels of solar radiation in the United States and offers significant wind and geothermal resources as well. This surge has been fueled in part by federal and state incentives and requirements to generate electricity from renewable sources designed to help address climate change by reducing greenhouse gas emissions. For example, the federal American Recovery and Reinvestment Act of 2009 (i.e., economic stimulus funding) provides strong economic incentives for the development of renewable energy facilities. In addition, the State of California has adopted a Renewables Portfolio Standard that requires that power companies generate 20 percent of their electricity from renewable sources by 2010, with a Governor's Executive Order to meet a goal of 33 percent by 2020. As a result, the submission of permit applications has preceded comprehensive plans for siting these new industrial facilities in locations compatible with conservation priorities. As of January 2010, permit applications, in various phases of the review process, covered over one million acres of public lands in California's portion of the Mojave and adjacent Sonoran deserts. These permit applications range in size from 2,000 to 60,000 acres for wind projects and from 3,000 to 10,000 acres for solar projects[1] capable of generating 1,000 megawatts[2]. Most solar facilities need relatively small amounts of water for periodic cleaning of their mirrors, but some solar-thermal facilities also require large amounts of

[1] The acreage identified in a permit application does not necessarily indicate the proposed footprint of a project.

[2] One megawatt provides enough power for about 400 to 900 average homes. Residential electricity consumption varies widely by region.

water for cooling. New major and minor electricity transmission lines would also be necessary for some of the proposed installations, particularly those distant from electricity demand centers (e.g. metropolitan Los Angeles and Las Vegas) and existing transmission lines with excess capacity.

Large-scale renewable energy production facilities could have significant negative impacts on desert habitats if they are inappropriately sited, place unsustainable demands on water, are located in sensitive areas, or are inadequately mitigated. Associated transmission lines and utility corridors also pose both direct and indirect threats. The access and service roads that accompany many power lines and pipeline corridors directly disturb land, may be intensively used without authorization by of OHV enthusiasts, and can facilitate the invasion of non-native plants. Transmission line towers provide platforms for native predatory birds such as ravens and hawks that use them as energy-saving vantage points for scanning the desert below for prey, allowing them to kill significantly larger numbers of small native mammals and reptiles, including juvenile desert tortoises, than would otherwise be possible.

In sum, the biodiversity of the Mojave Desert will likely be threatened by rapid climate change, and it will be important to be mindful of how land-use and management decisions can either enhance the capacity for species and systems to adapt, or undermine it. With its extraordinary solar, wind, and geothermal energy resources, the Mojave Desert could also play a role in mitigating climate change. Therein lies a conservation paradox of our day. The diversity of the Mojave is threatened by climate change, but it can also be threatened by efforts to address that change by tapping its renewable energy resources. The challenge for land-use decision-makers is to ensure that, as resources are harnessed in the desert to reduce greenhouse gas emissions, it does not come at the expense of the distinctive and important conservation values of the Mojave Desert.

1.1 Mojave Desert Ecoregional Assessment Purpose and Approach

The purpose of this assessment is to produce a current and comprehensive synthesis of the distribution of biodiversity conservation values in the Mojave Desert Ecoregion, and present a vision for the effective protection and management of those values. This information is needed for a variety of regional land-use and water-use decisions, conservation planning, and priority-setting exercises, including those aimed at ensuring that the harvest of renewable energy does not come at the expense of the Mojave Desert's biodiversity.

This assessment focuses on identifying areas that are important for the continued survival of the full array of biodiversity in the Mojave Desert, including both common and rare species. Given the sensitivity of desert ecosystems, we generally prioritize areas that are relatively undisturbed and unfragmented. This assessment is therefore designed to complement—and not replace or supersede—other biodiversity assessments and plans that have been completed or are being prepared. For example, state and federal agencies and other stakeholders have produced and continue to refine analyses and models of the ecology, distribution, and threats faced by important Mojave Desert species, such as the desert tortoise and the Mohave ground squirrel. These analyses provide more species- and/or spatially-specific information for managing population viability and recovering populations of threatened and endangered species. While this assessment may be helpful in identifying synergies between those plans and opportunities to protect the larger array of species and natural communities, even the full implementation of the conservation vision proposed here might not meet species-specific viability goals.

The Nature Conservancy and partners completed an earlier Mojave Desert Ecoregional Assessment in 2001 titled "Ecoregion-based Conservation in the Mojave Desert." [3] That assessment was conducted to help set priorities for investing scarce conservation resources and identified a portfolio of 367 sites which, if effectively conserved, would protect the full range of biodiversity in the Mojave. However, it used inputs that are no longer current, and it did not yield a comprehensive synthesis of the distribution of biodiversity conservation values across the ecoregion necessary to inform broader land- and water-use decisions as presented here.

Smoketree (Psorothamnus spinosus) Wash (Photograph by James Moore)

1.1.1 Overview of the Ecoregional Assessment Approach

We used the approach and methodology outlined in *Designing a Geography of Hope: Guidelines for Ecoregion-Based Conservation* (The Nature Conservancy 1997, 2000), described in more detail by Groves (2003) and further refined in the process of developing other regional conservation frameworks (e.g. Conservation Biology Institute 2009) in recent years. Appendix A provides a detailed description of the methods we used.

The conservation targets were selected to represent the ecoregion's biodiversity (see Table A-3 in Appendix A for a full list). They include 521 species (122 animals and 399 plants), and 44 ecological systems and community types (hereafter referred to collectively as ecological systems[4]). All seeps and springs were also selected as conservation targets because they serve both as vital habitat for many aquatic and wetland animals and plants, and as water sources critical to the survival of many upland animals in this otherwise parched environment.

Quantitative goals were set for each of these conservation targets, following guidelines established in previous ecoregional planning processes and generally based upon the global rarity of each target (Appendix A). The goal for each target should be considered an initial hypothesis of the minimum requirement to ensure the target's viability. As more detailed and specific information becomes available regarding the needs of targets, it may be necessary to adjust some of the conservation goals and to adapt the overall analysis accordingly.

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[3] The 2001 assessment, "*Ecoregion-based Conservation in the Mojave Desert*" is available for download at http://azconservation.org/downloads/multi/category/ecoregional_assessment/

[4] We selected "ecological systems" as the generic term to cover community types, land cover types, and ecological systems collectively because it can refer to systems distinguished by and named for the distinctive form of vegetation of dominant plants, as well as those distinguished based on geomorphic or edaphic characteristics, such as playas, sand dunes, and desert pavement, which are nearly devoid of macro-vegetation.

1.1.2 Distinguishing Areas of Conservation Value

We characterized the distribution of conservation values in the Mojave Desert using a four-category scheme that classifies all areas of the ecoregion as either Ecologically Core (greatest conservation value), Ecologically Intact, Moderately Degraded, or Highly Converted (Table 1-1; see Appendix A for more detail). We used Marxan conservation planning software to help inform that classification and map the relative conservation value of lands across the region for meeting the stated conservation goals. Marxan is designed to identify the most efficient configuration of places needed to encompass a given set of conservation targets and achieve a given set of conservation goals. It can also incorporate information on the distribution of threats to conservation targets and the relative importance of selecting sites that are clustered together and maximize the area-to-perimeter ratio versus selecting isolated sites that contain conservation targets regardless of the resultant area-to-perimeter ratio. Conservation areas with low area-to-perimeter ratios may be more subject to "edge" (or spill-over) effects from adjacent areas which can degrade their quality. Over the past decade, Marxan has been widely adopted for use in systematic conservation planning around the world by governments and non-governmental organizations, including The Nature Conservancy.

General Steps of this Assessment

Define Study Area, and delineate its boundaries.

Identify Targets: Identify a set of species, community types and other conservation features that represent the biodiversity of the ecoregion and that will serve as the focus of the assessment. These conservation targets were selected from a range of scales (e.g., species to communities to ecological systems) and from different taxa (e.g., fish, mammals, plants) to comprehensively inform biodiversity conservation.

Map Target Distributions: Gather data and map the distributions of the conservation targets.

Ensure Representation: Stratify, or subdivide, the region, so as to ensure representation of the important variation within and among conservation target populations and occurrences.

Set Goals: Set, for each conservation target, quantitative goals that represent the level of protection estimated to be sufficient to allow the target to maintain ecological variability, evolve, and persist within the ecoregion as conditions change over the coming decades.

Evaluate Threats: Identify and map threats to conservation targets.

Identify Conservation Values: Evaluate the distribution of conservation targets and threats to identify the conservation value of lands across the ecoregion based on their potential to contribute to the conservation goals. Use a four-category system to create a preliminary map of the distribution of conservation value.

Revise Map: Visually compare the preliminary conservation value map with recent aerial and satellite imagery to locate areas more or less disturbed than indicated in the data used in the analysis, and then update the map accordingly.

Identify Conservation Opportunities: Identify conservation objectives and opportunities for lands in each of the four conservation value categories.

Table 1-1 Conservation value categories

Category	Explanation
Ecologically Core	These lands have the highest conservation value. They are largely undisturbed and unfragmented, support conservation targets (species, ecological systems, springs and seeps), and were identified as critical to fully protect for the long-term conservation of the ecoregion's biological diversity. Despite the high inherent value of Ecologically Core lands, they do not stand alone; their conservation value is highly dependent on the connections between them and the buffering that the Ecologically Intact and even some of the Moderately Degraded lands around them provide. If significant portions of surrounding Ecologically Intact and Moderately Degraded lands are disturbed, developed, or otherwise compromised or further degraded in the future, then the conservation value of nearby Ecologically Core lands will diminish as well.
Ecologically Intact	These lands are relatively undisturbed and unfragmented and support conservation targets. They require levels of protection that will allow them to remain relatively undisturbed and to continue to support ecological processes and provide habitat and habitat connectivity for native animals, plants, and communities within and between ecoregions. The majority of Ecologically Intact lands are functionally equivalent to Ecologically Core lands and may contain many of the same conservation targets, including sensitive species. There are a number of reasons these lands may have classified as Ecologically Intact rather than Ecologically Core, including, but not limited to, the following: • Ecologically Intact lands may support more widespread ecological systems (e.g., creosote-scrub) that have lower conservation goals. • Ecologically Intact lands may be located in closer proximity to Moderately Degraded and Highly Converted lands and, therefore, are at higher risk of degradation due to edge effects or expansion of human disturbance. Areas that contain isolated conservation targets are more likely to be classified as Ecologically Core, as they are needed to attain the conservation goals.
Moderately Degraded	These are lands fragmented by roads or OHV trails, or are in close proximity to urban, agricultural and other developments. Moderately Degraded lands are partially to moderately compromised by fragmentation and other human impacts such as rural development, agriculture, OHV use, and military use. They often maintain ecological functionality (e.g., maintain groundwater infiltration and flow, serve as sand sources, provide connectivity), provide habitat for native species, or are known to have conservation target occurrences. The potential for Moderately Degraded lands to provide long-term conservation value and to be restored is greater where they are located adjacent to Ecologically Intact lands rather than Highly Converted lands. Without protection and perhaps restoration, the ability of Moderately Degraded lands to maintain functionality and sustain conservation targets will be reduced.

Table 1-1 Conservation value categories

Category	Explanation
Highly Converted	Urban, agricultural and suburban lands were classified as Highly Converted. These lands are heavily altered. Some can support important conservation targets, although the ecological context of these targets is compromised. There are a few conservation targets, such as Burrowing Owls, a variety of migratory birds, and bats that use or congregate in these heavily modified landscapes. Highly Converted lands also subsidize predatory species such as coyotes and Ravens that can have detrimental effects on conservation targets such as the desert tortoise.

Our analysis involved dividing the entire Mojave Desert planning area into one- square-mile (259 hectare), hexagonal planning units, synthesizing spatially-explicit information on the conservation targets and anthropogenic disturbance found in each planning unit, and hen using this information to identify the relative value of each planning unit in meeting the stated conservation goal. High conservation value was attributed to areas with low levels of disturbance and unique target occurrences or high concentrations of target occurrences. Appendix A provides additional information on Marxan and the analysis.

An important feature of this assessment is that, rather than identify only the highest priority areas for conservation, we categorized the entire ecoregion into one of four categories. The rationale for this approach is that the ecological context in which conservation targets are embedded matters. Good conservation reserve design requires that core areas be buffered and connected, for example. The categories of conservation value are also useful bins for categorizing threats and strategies.

Fundamental to our thinking is that large, intact landscapes are more resilient to adverse changes, maintain important ecological functions, and are easier and more efficient to manage and thus, should be the focus of protection and conservation resource investments. The more altered categories should not be misconstrued as having little or no conservation value, however. Sites in all categories, even Highly Converted lands, may have important roles to play in protecting the full suite of the Mojave Desert's diversity. For example, specific sites—especially those containing water or unique soil types—within highly impacted areas may be important for the protection of a local population of a rare plant, or for wildlife corridors between protected areas.

The categorization results are provided in Section 6, while Section 7 discusses their utility. Section 7 also presents conservation objectives for each of the four conservation value categories and a variety of strategies for realizing these objectives. In some cases, enhancing the effectiveness of conservation protection and management will rely on the independent actions of individual agencies and landowners, but in other cases, it will be best accomplished by improving coordination and collaboration among stakeholders.

1.1.3 Climate Change Adaptation Analysis

We conducted an analysis to identify sites most likely to be resilient to climate change in the Mojave Desert—that is, sites whose physical features may buffer the impacts of projected climate change locally, and thereby facilitate the ability of species that now occur in or nearby these areas to persist through the next several decades. We then evaluated whether areas of relatively high resilience were well represented in lands in the higher conservation value categories (Ecologically Core and Ecologically Intact). Section 6 presents these results, while our methods used are described in Appendix B.

1.2 Limitations on this Assessment

We encountered significant gaps in data, and inconsistencies in databases across states; the following lists some examples.

- *Incomplete knowledge and data on the distribution and status of conservation targets*. Locations of all occurrences of many Mojave Desert species are not known, and many occurrences that have been recorded have not yet been uploaded into publicly available databases. In addition, spatially-explicit data on migratory routes and other movement pathways for birds were unavailable for the entire region or too coarse to be included in this analysis. Much of the Mojave Desert has been only lightly surveyed and remains incompletely known, at best. For example, it has been estimated that nearly 10% of the plant taxa in the California deserts have not yet been described and scientifically named (Andre and Hughson 2009).
- *Spatial resolution of species occurrence data differs in the four states*. In California and Nevada, occurrence records are mapped at various levels of accuracy, with less accurate records mapped as large polygons. Precise locations of species in Arizona and Utah are masked by being “fuzzed” into a blocky shape of roughly 2.2 square miles (Arizona) or roughly 100 square miles (Utah), so as to comply with state privacy protection laws.
- *Spatially-explicit data on threats such as invasive plant distribution are not available for the whole ecoregion.*
- *Spatially-explicit data on important groundwater infiltration areas and aeolian sand transport areas are not available, other than for a few, limited geographic areas.*
- *Significant inconsistencies exist in the categorization and mapping of natural communities and ecological systems by the available sources.* For example, areas mapped as Sparsely Vegetated and Barren within one data source (i.e., LANDFIRE data) are mapped in 73 different ecological systems in another (i.e., ReGAP data). In each of the available data sources we also found areas that were clearly incorrectly categorized, as discerned through inspection of available imagery.

The methods we used to overcome some of these limitations are described in Appendix A.

All of the data used in this assessment were aggregated into hexagonal planning units that were one square mile in area. Thus, the results are appropriate for viewing and analyses only at a scale of 1:250,000 or coarser. Because many gaps exist in the regional-scale data used in this assessment it is essential that site-specific assessments be conducted for all project-scale planning and land-use decisions. In many cases, state or local databases that we were unable to use because our assessment crossed these jurisdictions will be available for finer-scale assessments. For example, finer scale, spatially-explicit analyses of land ownership, landscape condition, species occurrences, key threats, and climate change refugia may reveal the sites and strategies best suited to accomplish specific conservation goals.

1.3 Products of the Mojave Desert Ecoregional Assessment

The primary products of this assessment are:

- This report, featuring:
    - A map showing the distribution conservation values across the ecoregion (Figure 6-2)
    - A vision for the effective protection and management of these values (Section 7)
    - A compilation of historic and current data on biodiversity and threats in the Mojave Desert Ecoregion (Sections 2 through 5).
- A Map Service which likewise depicts the distribution of conservation values across the Mojave Desert Ecoregion, and can be used to inform decision making in a GIS environment.

This report and the Map Service are available at ConserveOnline: http://conserveonline.org/workspaces/mojave/documents/mojave-desert-ecoregional-2010/@@view.html

Extraordinary succulent plant community on Blue Diamond Hill in Red Rock Canyon National Conservation Area, Nevada (Photograph by Bill Christian)

2 The Study Area

2.1 Ecoregion Boundaries and Subregions

The Mojave Desert as defined in this report encompasses over 32 million acres, covering a significant portion of southeastern and central California and smaller parts of southern Nevada, southwestern Utah and northwestern Arizona. It is the smallest of the four American deserts and lies within the Intermountain Semi-Desert and Desert Province as delineated by Bailey et al. (1994). The Mojave Desert Ecoregion is bounded by the Sierra Nevada Mountains to the west, the Great Basin Ecoregion to the north, the Apache Highlands Ecoregion and the Colorado Plateau Ecoregion to the east, the Sonoran Desert Ecoregion to the southeast and south, and the California South Coast Ecoregion to the southwest (Figure 2-1).

While the Mojave Desert Ecoregion covers 32.1 million acres (13,013,215 hectares), the planning area for this assessment is larger, at 32.8 million acres (13,286,509 hectares). This is because the planning area includes many individual hexagonal planning units that extend beyond the Mojave Desert Ecoregional boundary. Results reported for the assessment are based on analyses of the larger 32.8 million acre planning area.

Due to the size of the Mojave Desert and the significant vegetative, climatic (temperature and precipitation), and associated genetic and other biologically significant differences among species and natural communities across the vast reach of the ecoregion, we subdivided it into six sub-regions depicted in Figure 2-2. Appendix A outlines the rationale and the criteria for delimiting the subregions.

2.1.1 Trans-boundary Connectivity

Species movement occurs both within the Mojave Desert Ecoregion, and across its boundaries with adjacent ecoregions. Transition zones between ecoregions are often species-rich, as the plant and animal communities characteristic of each region abut one another, and species interact in novel combinations. Connectivity, both within the Mojave Desert and between ecoregions, is important in the face of global climate change, as some species may need to move in order to track shifts in the locations of areas with suitable temperature and rainfall regimes.

2.2 Ecological History and Current Vegetative Communities

Over geologic time, the Mojave Desert Ecoregion has undergone changes in climate that have strongly influenced the air temperature and the availability of water across the landscape. Plants and animals have responded to these fluctuations in climate by moving into and within the ecoregion, adapting, or going locally extinct as suitable habitat expanded, contracted, or disappeared. As a result, novel combinations of species and unique communities have emerged and dissolved within the ecoregion over time. Cooler and wetter conditions during the last ice age fostered plant communities in the valley bottoms that can only exist at higher elevations today.

Figure 2-1

Mojave Desert Ecoregion

Project Area
Mojave Desert

Boundaries
State
County

Transportation
Major Road
Other Road

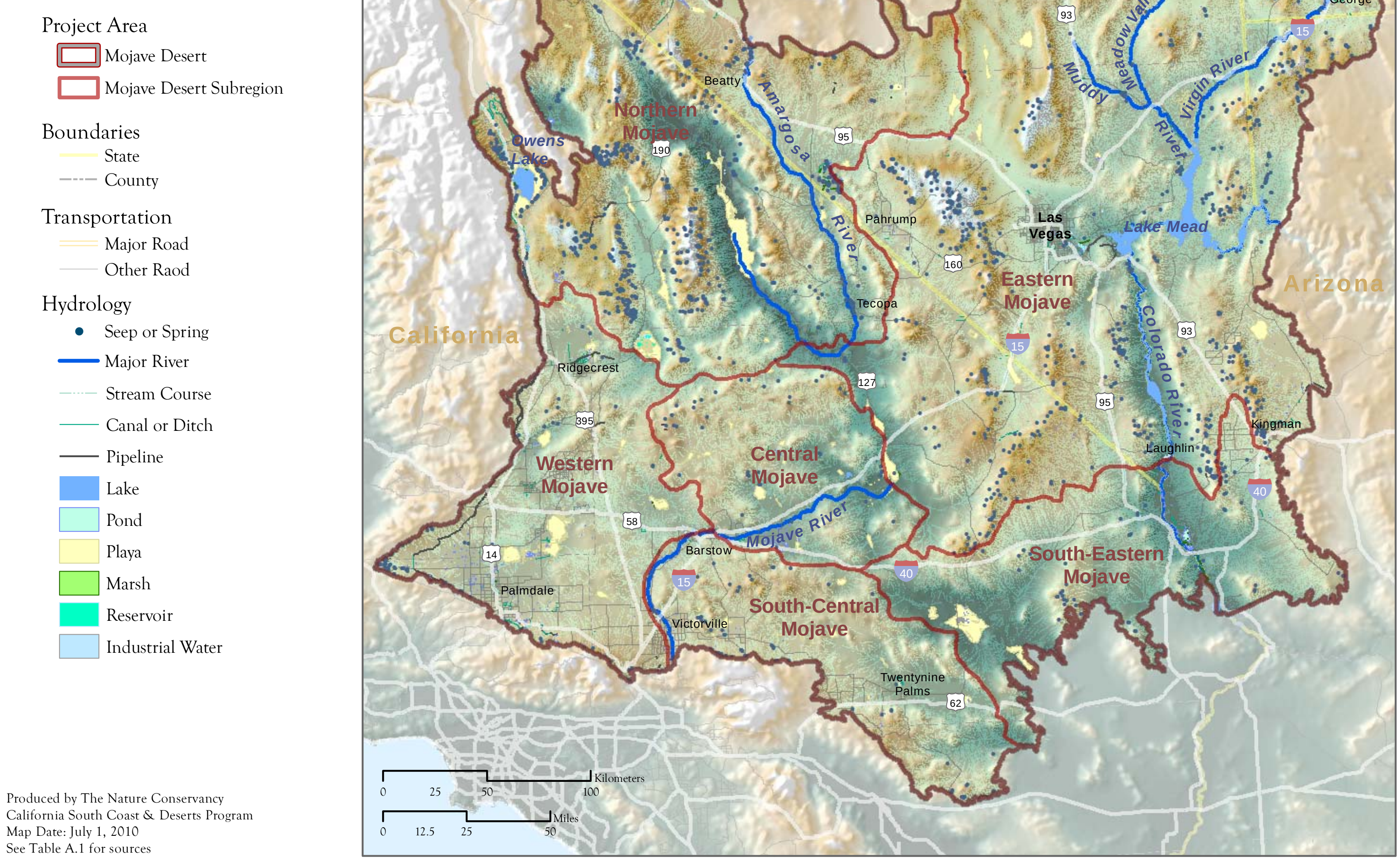
Hydrology
Major River

Elevation, meters
-75 3633

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Figure 2-2

Hydrology & Subregions



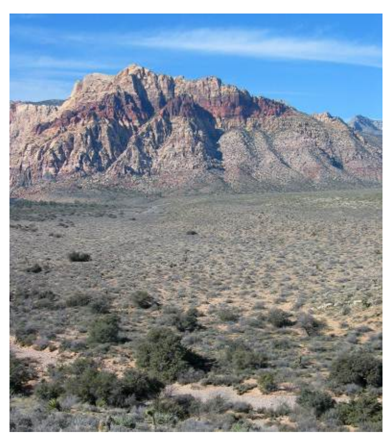
At the same time, more copious rainfall connected waterways and allowed interaction between aquatic species. This slowly gave way to isolation in more restricted streams, springs, pools, and seeps as the climate has gradually warmed since the last ice age. Geographic isolation has acted as an ecological double-edged sword in the Mojave Desert. On one hand, it has allowed for speciation and an increase in the biodiversity of the region, such as that seen by the proliferation of pupfish species in various isolated aquatic systems throughout the ecoregion. However, isolation has also made these same species vulnerable to extinction by reducing the size of the population and restricting the areas where they naturally occur.

Currently, a total of 130 natural plant alliances have been documented within the Mojave Desert (TNC 1999). Similarly, national databases (e.g., LandFire and ReGAP) describe nearly a hundred different ecological systems in the ecoregion. Creosote bush scrub, succulents, and yucca-blackbrush community types dominate the Mojave with dominant species including creosote bush (*Larrea tridentata*), white bursage (*Ambrosia dumosa)*, four-winged salt bush (*Atriplex canescens)*, Mojave yucca *(Yucca schidigera)*, blackbrush (*Coleogyne ramossissima)* and Joshua tree (*Yucca brevifolia).* Upper elevation community types occur as 'sky islands' on mountains that rise to more than 11,000 feet in elevation. These areas contain some of the ecoregion's most isolated communities and species and harbor high levels of endemism.

2.3 Geomorphology

The Mojave Desert Ecoregion overlaps two geomorphic provinces: the Basin and Range Province, and the Mojave Desert Province. The Basin and Range Province includes the northern portion of the ecoregion, and has a characteristic topography that includes steep, elongate mountain ranges interspersed by long, flat, dry desert valleys. Within the Mojave Desert Ecoregion, elevation ranges from 282 ft (86 m) *below* sea level in Death Valley to over 11,000 feet in the Spring Mountains of Nevada and Panamint Range in California. Many of these mountain ranges are oriented north-south along long faults that resulted from stretching and folding of the Earth's crust and upper mantle. As rocky mountain ranges form in the Mojave Desert, they become subject to weathering and erosion, and exposed bedrock is bombarded by liquid water, ice, wind, and large fluctuations in temperature. Eroded rocks, sand, and clay wash down mountainsides, forming large alluvial fans and bajadas and sometimes burying smaller ranges.

The Mojave Desert Geomorphic Province lies within the southern portion of the ecoregion, and includes isolated mountain ranges separated by vast expanses of desert plains. The topography of the region is controlled by two important fault trends: a dominant northwest to southeast trend, and a secondary east-west trend. The province is wedged in a sharp angle between the Garlock Fault and the San Andreas Fault, where it bends east from its northwest trend. Most of the region has interior enclosed drainages and many playas. The northern boundary of the Mojave Geomorphic Province is separated from the Basin and Range Geomorphic Province by the eastern extension of the Garlock Fault.



Red Rock Canyon NCA
(Photograph by Bill Christian)

2.4 Current Climate

The climate of the Mojave Desert Ecoregion is shaped by global weather patterns and regional topography. The ecoregion has four distinct seasons and experiences large seasonal and diurnal fluctuations in temperature. The lowest and hottest place in North America is located within the Mojave Desert: Death Valley, where the temperature can surpasses 54 °C (130 °F) in late July and early August at the lowest elevations. Low humidity throughout the ecoregion during the summer can draw moisture northward from the Gulf of Mexico, creating thunderstorms in the late summer months. Despite these isolated monsoons, rainfall in the Mojave Desert is predominantly bimodal, with most rain (82%) falling during widespread winter storms, and the small remainder falling during the summer. Rainfall during the cool season (October 15 through April 15) averages 95 mm, with a range of 27 to 249 mm/season. May and June are consistently dry, while precipitation between July 4 and October 14 averages 35 mm, with a range of 0.5 to 125 mm/season (USGS 2004).

The Sierra Nevada Mountains block coastal moisture from moving east into the region, resulting in the California portion of the Mojave Desert being the hottest and driest portion. In some of the driest sites, annual rainfall may average less than 50 mm (2 inches). Intense sunshine and high temperatures lead to rapid evaporation of this limited moisture. In the winter, temperatures can dip below -7 °C (20 °F) in the valleys, and below -18 °C (0 °F) at higher elevations. Winter storms from the northern Pacific Ocean can bring rain to the region, but the rain shadow of the Sierra Nevada often blocks the movement of moisture into the desert, resulting only in clouds and windy conditions. Rainfall tapers off through the spring, and it is rare for Pacific storms to reach the region after May. Wind is a significant and common force throughout the Mojave Desert Ecoregion, and high winds are common in mountain passes along the ecoregional boundary as cooler air from the coast pushes into the Mojave Desert. During Santa Ana wind events, the prevailing wind direction shifts, and hot air from the desert blows toward the coast.

2.5 Hydrology

Surface waters are scarce within the Mojave Desert Ecoregion, with snow and ice constituting the rarest form of water. Generally, the higher elevations of the ecoregion receive snow during infrequent winter storms, which melts quickly except on the highest mountain peaks in the region.

The majority of the water within the ecoregion exists belowground. Groundwater basins, or aquifers, hold freshwater hundreds of feet below the Earth's surface. The Mojave Desert contains several large aquifers; the Mojave River and Morongo aquifers together encompass about 2,400 square miles of the Mojave Desert in California (USGS 2009a). Limited sources of permanent surface water have led to significant groundwater pumping and artificial recharge activities, altering natural flows of ground and surface water throughout the ecoregion. Aquifers are naturally recharged when water flowing primarily from higher elevations in the mountains reaches low-elevation, alluvium-filled valleys and percolates into the ground (California State Parks 2005). When an aquifer is filled beyond its storage capacity, it overflows and creates a spring. Springs are classified according to the amount of water they discharge, their temperature, the geologic formation of the rock surrounding the water source, and the force causing the spring (gravity or artesian flow). Permanent spring oases are supported where there are fissures in the bedrock, allowing groundwater to pool near the surface. With enough flow, spring water can support a perennial stream.

Streams are fed by springs, snow melt, and rainfall. Many Mojave Desert streams are ephemeral or seasonally intermittent and flow belowground much of the time. Stream and river systems support and shape a variety of water-dependent habitats, such as riparian forests, marshes, desert washes, ephemeral playas, and even sand dunes. The rarity of surface waters underscores their importance to biodiversity within the ecoregion. Riparian and spring systems provide habitat for 75% of desert animal species, and these rare water resources allow them to use adjacent dry areas (Bunn 2007). River corridors provide not only water but rare riparian vegetation that serves as vital habitat for numerous species. The ecoregion's major river systems include the Mojave and the Amargosa rivers, which flow inland into undrained desert basins, and the Muddy River, which flowed into the Virgin River prior to the building of the Hoover Dam but now flows into Lake Mead. The Virgin River is a tributary of the Colorado River, and a portion of the river in Utah has received Wild and Scenic River designation. Due to natural interannual variability in rainfall and increasing human use of water, however, rivers in the Mojave Desert typically experience periods when they do not flow aboveground over their entire length. In the Mojave and Amargosa rivers, surface water flows down the length of the riverbed only once every 6 to 10 years, and 25 to 50 years, respectively.

Amargosa Canyon in California (Photograph by Bill Christian)

Rocks and pebbles crushed along the course of rivers create deposits that are left behind once floodwaters recede. Stratified clay, silt, sand, and salts are discharged by rivers into the lowest part of undrained desert basins to form dry, vegetation-free, flat areas known as playas. Ephemeral lakes form in these areas during wet periods, but once the lakes dry out, the sand, sediments and salts on the surface of the playa are subject to movement by wind. These playas, along with the sandy river washes that lead into them, then become a primary source of sand for dune systems throughout the desert. For example, sand from the Mojave River sink (Soda Dry Lake) is the source of the Kelso Dunes and Devils Playground in the Mojave National Preserve.

During the last glacial period, many of the areas that are now playas were lakes and marshes year-round. One of these great Pleistocene Lakes was Lake Manix, which included what are now the dry lake basins of Afton, Troy, Coyote, Harper, and Cronese. Lake Manix dried up completely 8,000 years ago. Rivers also carried more water and had perennial surface flow during the last ice age. The Mojave River, for example, at one time flowed north until it merged with the Amargosa River before draining into Lake Manley in Death Valley. Today the terminal point of the Mojave River is Soda Lake.

2.6 Land-Use History

The Mojave Desert remains one of the least populated areas of the western United States, with large contiguous areas of undisturbed, native habitat. While the majority of the landscape remains undeveloped, humans have used the region for millennia. Native American people now known as Mohave, Shoshone, Paiute, Serrano, Chemehuevi, and Kawaiisu, as well as others, occupied and used areas throughout the Mojave Desert in a variety of ways, with flexible boundaries among tribal groups. In general, these groups consisted of small, mobile social units of related families who traveled to established summer and winter locations where water and food resources were available (National Park Service 2004, Pavlik 2008).

The Old Spanish Trail that runs from Santa Fe to Los Angeles established a path for movement, however arduous, through the Mojave Desert as early as 1829-1830. The trail was used extensively by pack trains from 1830 until the mid-1850s. However, westerners avoided settling in the Mojave Desert during this time, as most viewed the inhospitable desert landscape as merely an obstacle between the established communities of northern New Mexico and southern California.

Following the discovery of gold along the Amargosa River at the foot of the Avawatz Mountains in 1849, prospectors were drawn to the Mojave Desert from around the world. Subsequent mining has extracted not only gold, but also silver, lead, copper, iron, molybdenum, lead, tungsten, zinc, borates, talc, and other materials from the region. In addition, the ecoregion contains California's largest open-pit mine, which is also the largest borax mine in the world. Both active and retired open-pit and underground mines can be found throughout the ecoregion.

Throughout the latter half of the 1800s, small numbers of livestock ranchers settled in the region, using large BLM-designated livestock allotments to graze cattle and sheep on public land. Most allotments are not actively grazed today, either due to the economics of grazing livestock in a desert, or because conservation programs for the desert tortoise have provided funds to purchase and retire the allotments from willing-seller ranchers.

Growth in the Mojave Desert Ecoregion remained slow until the late 1800s and early 1900s, when the desert became connected to other areas by road and rail. The Burlington Northern and Santa Fe Railway, completed in 1883, runs east-west along the southern boundary of what is now the Mojave National Preserve from the town of Mojave to Needles. The San Pedro, Los Angeles and Salt Lake Railroad was completed in 1905 and passed directly through what is currently the Mojave National Preserve. The Tonopah and Tidewater Railroad (T&T) was built in 1907 and extended through remote areas of the desert from Ludlow, California in the south, up through Amargosa Canyon, and terminating at the mining camps of southwestern Nevada. With the exception of the T&T, these rail lines continue to function today.

Development and extraction of local water resources, the building of aqueducts, and later, the invention of affordable and reliable air conditioning in homes, businesses, and vehicles, has changed the desert from a seasonal destination or specialized work location, to a place of year-round occupancy. Urban expansion associated with the Los Angeles Basin and Las Vegas Valley metropolitan areas has resulted in the construction of hundreds of thousands of new homes within the Mojave Desert during the past 20 years. Water availability in the Mojave Desert Ecoregion has also allowed for a continual growth in irrigated agriculture in various locations. The most common crops include alfalfa, carrots, and cotton. The Mojave Desert also contains a significant number of dairy cattle feedlots (Figure 2-3). In addition to urban growth and agriculture, other significant land uses in the Mojave Desert include military maneuvers, off-highway vehicle (OHV) recreation, tourism, and more recently, renewable energy development.

2.7 Current Land Ownership

The Mojave Desert has a large number of land owners, including federal, state, and local governments, Native American tribes, non-governmental land trusts, and numerous private entities (Table 2-1, Figure 2-4). The majority (85%) of the Mojave Desert Ecoregion is publicly owned, primarily by state and federal government. The BLM is the region's largest land manager, with about 14,647,163 acres (46% of the region; Figure 2-4). The Department of Defense (DOD)

Table 2-1 Land Ownership within the Mojave Desert Ecoregion

Type	Entity	Hectares	Acres	Percent of Total
Government	Army Corps of Engineers	5	12	<0.01
	Bureau of Indian Affairs	56,315	139,154	0.43
	Bureau of Land Management	5,927,625	14,647,163	45.55
	Bureau of Reclamation	20,510	50,681	0.16
	Los Angeles Department of Water and Power	30,500	75,366	0.23
	County-City-Regional Lands	253	624	<0.01
	County-City-Regional Parks and Preserves	369	912	<0.01
	Department of Defense[1]	1,537,509	3,799,184	11.82
	Department of Energy	173,412	428,501	1.33
	United States Fish and Wildlife Service[1]	338,900	837,422	2.60
	National Park Service	2,609,994	6,449,294	20.06
	Other State	1,136	2,807	0.01
	State Dept. of Parks and Recreation	40,389	99,800	0.31
	State DFG	4,072	10,061	0.03
	State Trust	208,071	514,143	1.60
	United States Forest Service	144,285	356,528	1.11
	Subtotal: Government	11,093,344	27,411,652	85
Private	Non-governmental organizations (NGOs)	4,146	10,245	0.03
	Private	1,915,552	4,733,330	14.72
	Subtotal: Private and NGOs	1,919,698	4,743,574	15
	Grand Total	13,013,042	32,155,227	100

[1] Acreage values were derived from BLM landstatus databases for CA, AZ, NV and UT. They assign roughly half of the 1.6 million acre Desert National Wildlife Refuge to the Department of Defense, which operates the western portion of this area as part of the Nellis Air Force Test and Training Range.

administers 3,799,184 acres (12%) including Fort Irwin, Naval Air Weapons Station China Lake, Twentynine Palms Marine Corps Base, Edwards Air Force Base, and Nellis Air Force Base. The National Park Service administers 6,449,294 acres (20%), including Death Valley National Park, Mojave National Preserve, Joshua Tree National Park, and Lake Mead National Recreation Area.

The Department of Energy administers the Nevada Test Site, which covers 428,501 acres (1.3%). The U.S. Forest Service oversees 356,528 (1.1%) acres, primarily in the Humboldt-Toiyabe National Forest in Nevada. Other federal lands are administered by the U.S. Fish and Wildlife Service and the Bureau of Reclamation. State landowners include the California Department of Parks and Recreation, the Nevada Division of State Parks, the California Department of Fish and Game, and the California State Lands Commission. Non-governmental organizations such as The Nature Conservancy and land trusts own less than 1% of the land in the ecoregion. Private lands and Native American tribal lands represent 4,743,574 (14.7%) and 139,154 (0.43%) acres of the Mojave Desert Ecoregion, respectively (Figure 2-5).

2.8 Conservation Management Status

Natural resource management and land conversion risk can be characterized within the Mojave Desert Ecoregion using the United States Geological Survey Gap Analysis Program (USGS 2008a, Figure 2-6). The GAP program uses a scale of 1 to 4 to categorize the degree of maintenance of biodiversity for each distinct land unit. A status of "1" denotes the highest, most permanent level of maintenance, while "4" represents no biodiversity protection or areas of unknown status. The GAP program generally recognizes categories 1, 2, and 3 as being under permanent protection. Our analysis recognizes the current—but not necessarily permanent—protection status granted to these primarily publicly-owned and managed landscapes with the exception of those in category 1, which are permanently protected via an official designation as National Park or Monument or Wildlife Refuge.

GAP Status Categories

Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management.

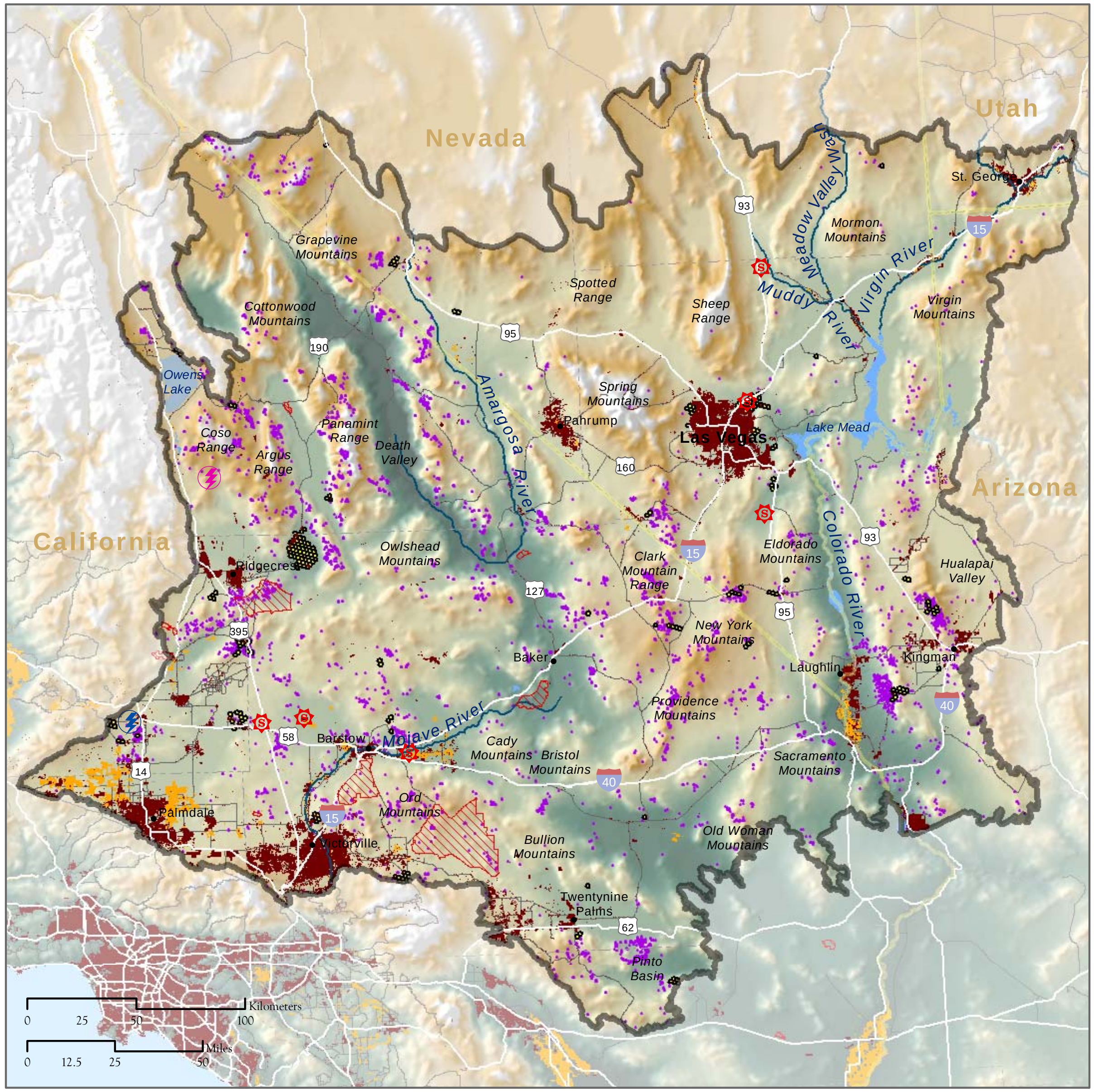
Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities.

Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area.

Status 4: Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types. Allows for intensive use throughout the tract. Also includes those tracts for which the existence of such restrictions or sufficient information to establish a higher status is unknown.

Source: http://www.gap.uidaho.edu/portal/stewardship/padus_nowater_metadata.htm (accessed August 2010)

Figure 2-3
Land Use



Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Major Road
- Other Road

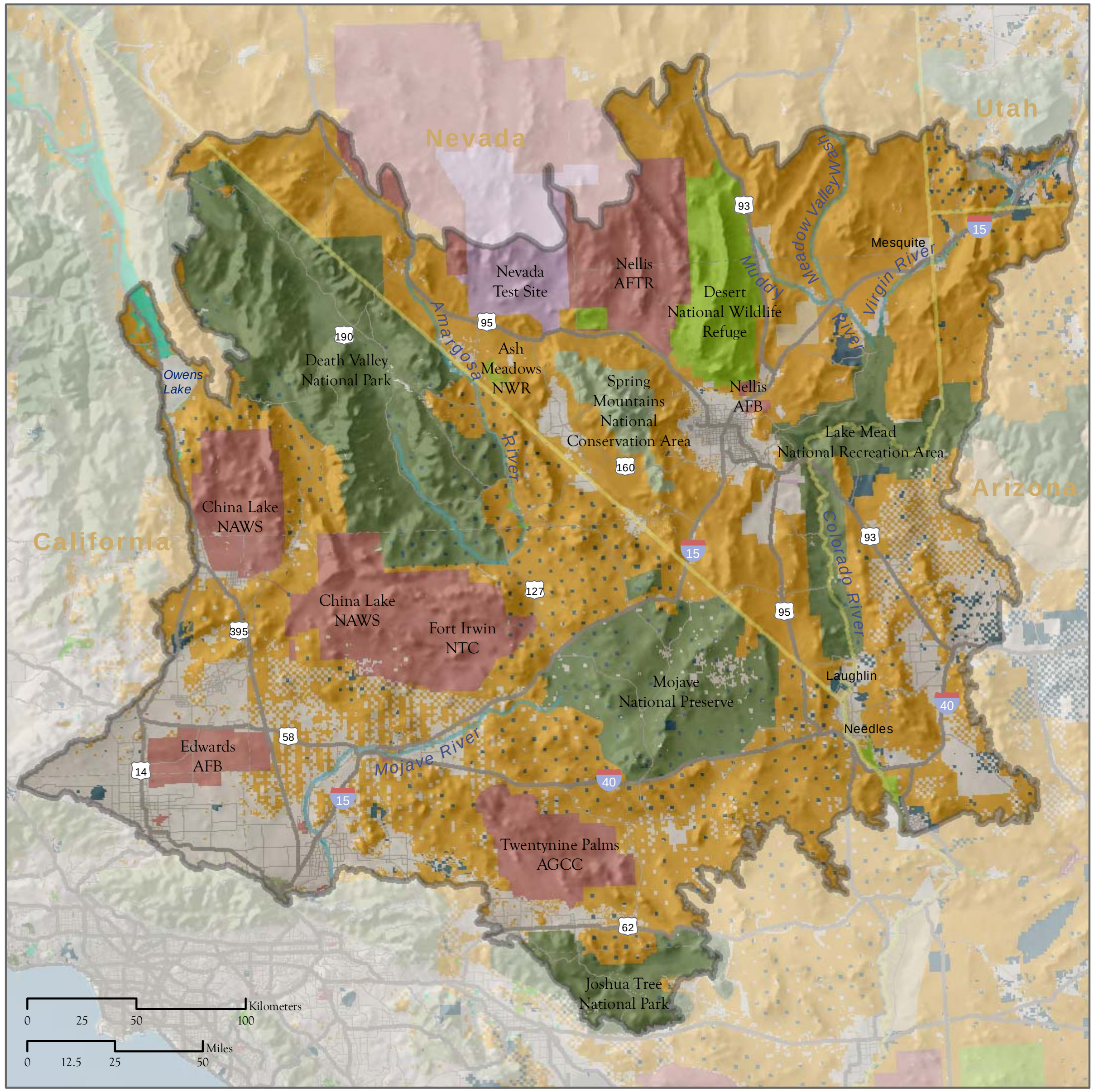
Hydrology
- Major River

Land Use
- Mining Activity
- Large Scale Mining
- Solar Facility
- Wind Facility
- Geothermal Facility
- Urban or Rural Development
- Agriculture
- Off Highway Vehicle Area

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Figure 2-4

Land Ownership



Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Major Road
- Other Road

Hydrology
- Major River

Land Ownership
- US Bureau of Land Management
- US National Park Service
- US Department of Defense
- US Fish and Wildlife Service
- US Department of Energy
- US Forest Service
- US Bureau of Indian Affairs
- State Lands
- Private Conservation
- Local Jurisdiction
- Private Land

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Figure 2-5

Lands Under Conservation Management

Project Area

- Mojave Desert

Boundaries

- State
- County

Transportation

- Major Road
- Other Road

Hydrology

- Major River

Management Status

- Wilderness
- Wilderness Study Area
- National Conservation Area
- National Monument
- National Wildlife Refuge FWS

Land Ownership of Management Areas

- US National Park Service
- US Bureau of Land Management
- US Fish and Wildlife Service
- US Department of Defense
- US Forest Service
- State Lands
- Private Conservation

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

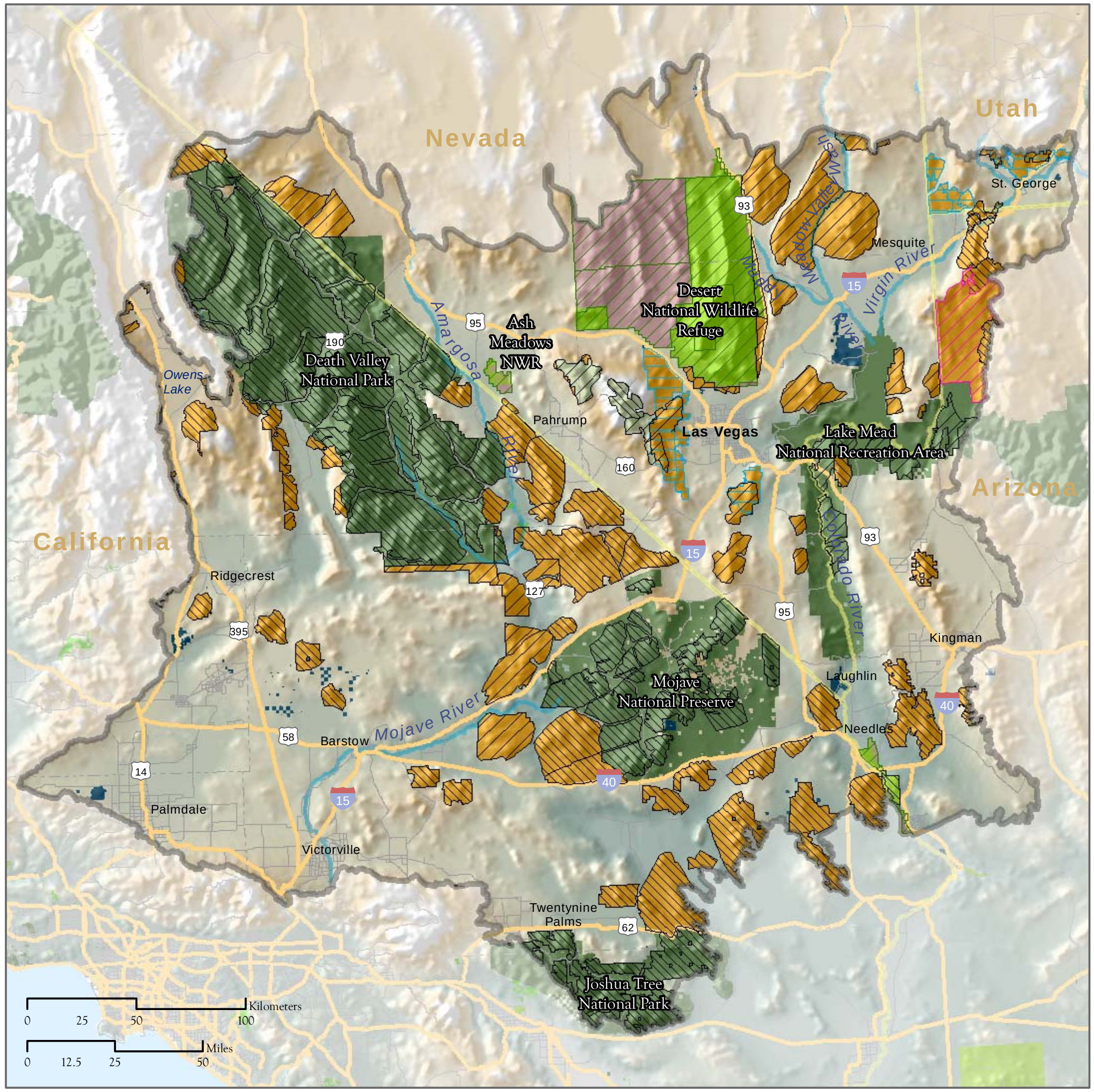


Figure 2-6

GAP Status

Project Area

Mojave Desert

Boundaries

State

County

Transportation

Major Road

Other Road

Hydrology

Major River

GAP Status

1: Permanent Protection – natural disturbance events allowed to proceed

2: Current Protection – natural disturbance events suppressed

3: Current Protection – subject to extractive (e.g. mining or logging) or OHV use

4: No known mandate for protection

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

3 Conservation Values of the Mojave Desert Ecoregion

3.1 Ecological Significance of the Mojave Desert

The Mojave Desert is known for its great variety of plants, animals and other organisms capable of surviving some of the harshest conditions on Earth. With large expanses of the landscape unfragmented and undisturbed by urban development, roads, or intensive land use, the Mojave Desert remains one of the last great wilderness areas in the 48 contiguous United States and even in the whole of the North American continent. Together, this rich biological diversity and relatively high levels of intactness comprise the conservation values of the ecoregion.

3.2 Animal Diversity and Rare and Listed Species

The Mojave Desert supports a surprisingly large variety of animals. There are 439 vertebrate species that inhabit the California portion of the Mojave Desert during at least some point in their life cycle. These include 252 species of birds, 101 mammals, 57 reptiles, 10 amphibians, and 19 fishes; 14 of these species are endemic to the Mojave Desert Ecoregion (Bunn et al. 2007) and 28 taxa are federally listed as threatened or endangered (Table 3-1). Several sites within the region have been designated as "Globally Important Bird Areas" or as "Important Bird Areas" by the American Bird Conservancy and Audubon California, respectively. Invertebrates are typically difficult to enumerate, but within the California portion of the Mojave Desert Ecoregion there are 29 invertebrate taxa that are included on the Special Animals List. This includes 19 described species of arthropods and 10 mollusks; 22 species of invertebrates are endemic to the ecoregion (Bunn et al. 2007).

Most of the animals found in the Mojave Desert have morphological, physiological, or behavioral adaptations that allow them to survive its hot, arid conditions. Some, such as desert bighorn sheep and mountain lions, range across diverse habitats in response to varying seasonal and environmental conditions, while others rely on a particular vegetation community or a narrow set of environmental parameters. For example, yucca night lizards (*Xantusia vigilis vigilis*) live in the thatch along the trunks of living and dead Joshua trees, while fringe-toed l*izards* (*Uma inornata*) are restricted to sand dunes. Some branchiopods (e.g., fairy shrimp) and desert pupfish are even further limited in their distribution by aquatic characteristics (e.g., water quality, quantity, and temporal availability) of their unique habitats (ephemeral playas and permanent pools, respectively). Many sand dunes, including the Kelso Dunes of the Mojave National Preserve, support a number of endemic invertebrate species, including the Kelso Dunes giant sand treader (*Macrobaenetes kelsoensis*), the Kelso Dunes Jerusalem cricket (*Ammopelmatus kelsoensis*), a giant mydid fly (*Rhaphiomidas tarsalis*), and the Kelso Dunes shieldback katydid (*Eremopedes kelsoensis*).

Mojave desert tortoise in Bird Springs Valley, Nevada (Photograph by James Moore)

Table 3-1 Federally-listed Threatened and Endangered Animals in the Mojave Desert Ecoregion

Scientific name	Common name	Threatened (T) or Endangered (E)
Bufo microscaphus californicus	arroyo toad	E
Crenichthys baileyi baileyi	White River springfish	E
Crenichthys baileyi grandis	Hiko White River springfish	E
Cyprinodon diabolis	Devils Hole pupfish	E
Cyprinodon nevadensis mionectes	Ash Meadows Amargosa pupfish	E
Cyprinodon nevadensis pectoralis	Warm Springs Amargosa pupfish	E
Cyprinodon radiosus	Owens pupfish	E
Empetrichthys latos latos	Pahrump poolfish	E
Empidonax traillii extimus	Southwestern Willow Flycatcher	E
Falco peregrinus	Peregrine Falcon	E
Gila bicolor mohavensis	Mohave tui chub	E
Gila bicolor snyderi	Owens tui chub	E
Gila cypha	humpback chub	E
Gila elegans	bonytail	E
Gila robusta jordani	Pahranagat roundtail chub	E
Gila seminuda	Virgin River chub	E
Gopherus agassizii	Mojave desert tortoise	T
Microtus californicus scirpensis	Amargosa vole	E
Microtus mexicanus hualpaiensis	Hualapai Mexican vole	E
Moapa coriacea	Moapa dace	E
Pipilo crissalis eremophilus	Inyo California Towhee	T
Plagopterus argentissimus	woundfin	E
Rallus longirostris yumanensis	Yuma Clapper Rail	E
Rana aurora draytonii	California red-legged frog	T
Rhinichthys osculus nevadensis	Nevada speckled dace	E
Strix occidentalis lucida	Mexican Spotted Owl	T
Vireo bellii pusillus	Least Bell's Vireo	E
Xyrauchen texanus	razorback sucker	E

3.3 Plant Diversity and Rare and Listed Species

The Mojave Desert, which is one of the most arid habitats on Earth (Section 2.4), presents plants with unique survival challenges that have resulted in a diversity of forms and life history strategies. Nonetheless, the ecoregion has a rich flora. For example, although the California portions of the Mojave and Sonoran deserts collectively make up 28% of California's landmass, they contain a disproportionate 37% of its native plant taxa (Andre and Hughson 2009). Some of the mid-elevation areas in the eastern Mojave support 60 to 70 species of shrubs per hectare, placing them among the highest shrub diversity areas in North America (Andre and Hughson 2009). The ecoregion is even richer in herbaceous annual plants, most of which reveal themselves only during spring blooms (or following rainfall in other times of year) in years of suitable precipitation and temperature conditions. Shreve and Wiggins (1964) reported that the Mojave Desert contains 250 ephemeral plants, approximately 80-90 of which are endemic. During favorable years, the report continues, the region supports more endemic plants per square meter than any other location in the United States.

In addition, the wide variety of habitat types and microclimates, including shifting sand dunes, streambeds and flood-prone washes, intermittently flooded playas, natural desert pavement, marshes, canyon bottoms and adjacent terraces, seeps and springs, rocky mountain slopes, and sky islands have resulted in a wide variety of vegetation types.

Mojave yucca on desert pavement (Photograph by James Moore)

Endemic plants are found throughout the Mojave Desert Ecoregion and most are tightly associated with specific substrates such as alkaline flats (e.g., *Nitrophylla mojavensis*), limestone cliff faces (e.g., *Mimulus mojavensis*), exposed gypsum outcrops (e.g., *Arctomecon californica*), rhyolite beds (e.g., *Astragalus funereus*), sand dunes (e.g., *Penstemon albomarginatus*), and playa edges (e.g., *Phacelia parishii*) (Table 3-2, Figure 3-1).

Table 3-2 Federally-listed Threatened and Endangered Plants in the Mojave Desert Ecoregion

Scientific name	Common name	Threatened (T) or Endangered (E)
Arctomecon humilis	dwarf bearpaw-poppy	E
Astragalus albens	Cushenbury milkvetch	E
Astragalus ampullarioides	Shivwits milkvetch	E
Astragalus holmgreniorum	Holmgren milkvetch	E
Astragalus tricarinatus	triple-ribbed milkvetch	E
Centaurium namophilum	spring-loving centaury	T
Enceliopsis nudicaulis var. *corrugata*	Ash Meadows sunray	T
Erigeron parishii	Parish's daisy	T
Grindelia fraxino-pratensis	Ash Meadows gumplant	T
Ivesia kingii var. *eremica*	Ash Meadows ivesia	T
Mentzelia leucophylla	Ash Meadows blazingstar	T
Nitrophila mohavensis	Amargosa nitrophila	E
Oenothera caespitosa ssp. *crinite*	caespitose evening primrose	E
Pediocactus sileri	Siler pincushion cactus	T
Phacelia anelsonii	Aven Nelson's phacelia	E
Swallenia alexandrae	Eureka Valley dune grass	E

Figure 3-1
Rare or Threatened Plant Species Distribution

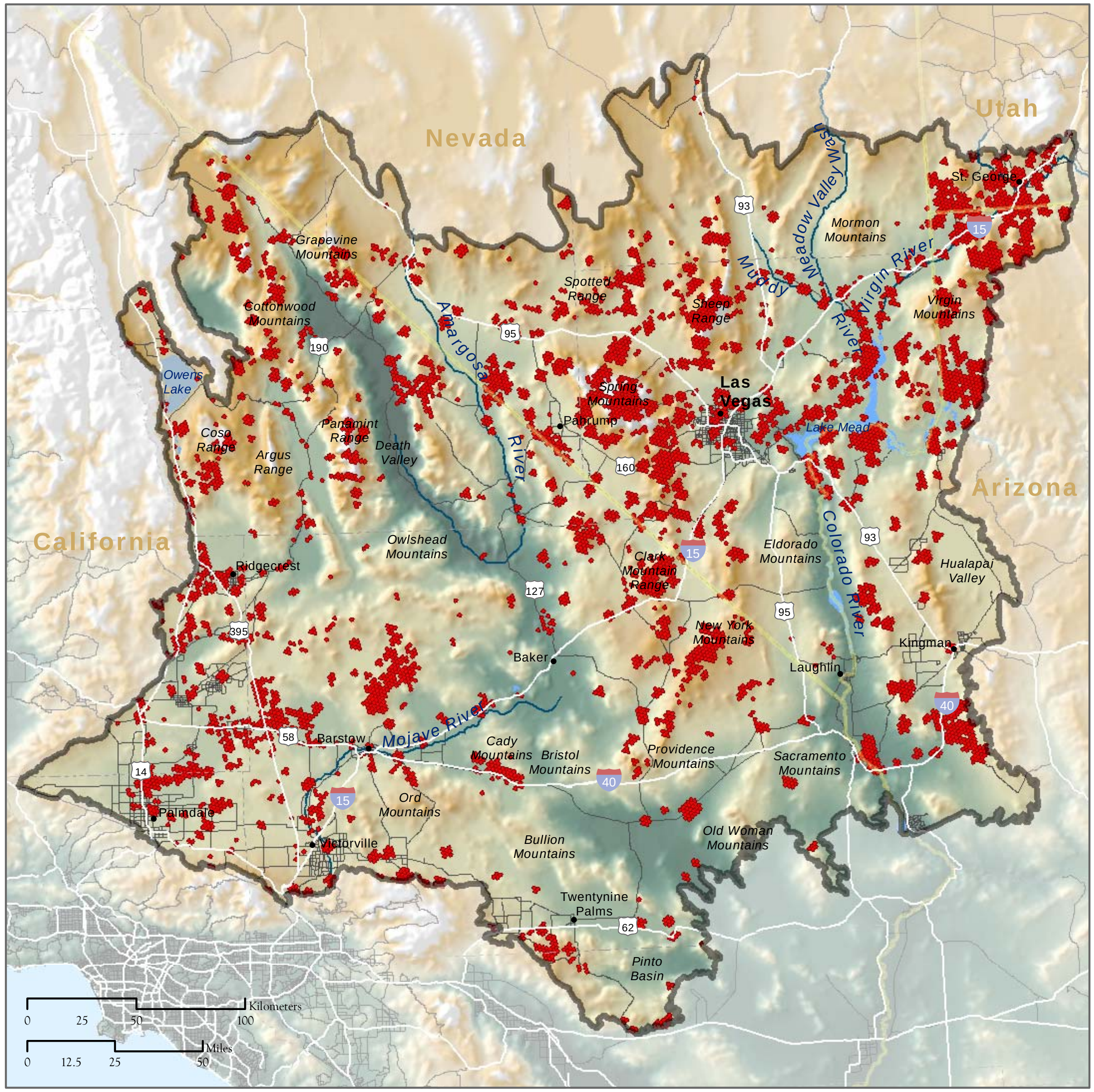
Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Major Road
- Other Road

Hydrology
- Major River

Species Distribution
- Planning Unit that contains a recorded Rare or Threatened plant species occurrence



Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

3.4 Soil Biota and the Vital Importance of Soil Integrity

The integrity of soils is critical to the maintenance of biodiversity in the Mojave Desert. Protecting soils and allowing them to retain their natural characteristics ensures the survival of plant and animal species throughout the ecoregion. In many desert habitats, soil integrity relies on soils staying in place. Fragile soil biological crusts constitute the protective skin, binding particles of mineral soil together to create a thin, cohesive horizontal layer along the surface of the ground (Bowker et al. 2007). These crusts include mosses, lichens, liverworts, cyanobacteria, and other organisms. By holding soil particles together and moderating water run-off, fertility, and soil temperatures, biological soil crusts enhance soil quality and integrity (Evans and Ehleringer 1993, Lange et al.1994, Kidron and Yair 1997). The measured annual rates of net ecosystem CO_2 uptake in the Mojave Desert, which rival those of forest or grassland ecosystems, have been attributed to the carbon fixation activity of biological soil crusts (Wohlfahrt et al. 2008). Given that deserts and arid lands cover 40% of the Earth's land surface, this finding suggests that crusts are crucial components of ecosystem health and have global importance.

In contrast to systems where soil biological crusts provide the basis for soil integrity, other systems such as sand dunes require a reliable source of sand and uninterrupted wind-born transit to the dune. These systems are discussed in detail in Section 3.6.3.

Soil integrity can be degraded by a variety of human activities. The use of OHVs, livestock grazing, and any change in land use that involves disturbance of the soil leads to the degradation and destruction of soil biological crusts and a loss of soil integrity (Section 5). The integrity of dune soils can be compromised by human-induced stabilization of wind-blown sand or the creation of barriers that prevent natural aeolian processes. Following soil disturbances or the disruption of natural processes that maintain soils, desert ecosystems are prone to invasion by non-native species, loss of fertile topsoil, reduced infiltration of rare precipitation, increases in fire frequency, and loss of native plant and animal species. These effects in turn lead to a decline in native biodiversity. Thus, intact and functional soils underlie the conservation value of the Mojave Desert Ecoregion and become the indicator by which ecosystem health can be evaluated.

3.5 Landscape Context

3.5.1 Intactness vs. Fragmentation

Levels of fragmentation, and of its inverse, intactness, vary across the Mojave Desert. Large portions of the Mojave Desert remain relatively intact, with few roads, human developments, or other land uses that fragment and degrade habitat. The ecoregion retains some of the largest blocks of unfragmented land in the contiguous United States. According to a report on habitat loss and degradation by the World Wildlife Fund, roughly half of the Mojave Desert remains as intact habitat (Ricketts et al. 1999). Notable blocks of relatively intact habitat include the eastern portion of the Mojave Desert within California from Death Valley past the southern edge of the ecoregion south of the Mojave National Preserve, and the northeast corner of the ecoregion in Nevada[5].

Other portions of the ecoregion are much more fragmented. Habitat loss has primarily resulted from urban and suburban expansion and proliferation northward and eastward from Los Angeles into the western Mojave and around Las Vegas in the central Mojave, as well as the increasing demand for landfill space, agricultural development along the Colorado River, grazing, off-road vehicles, and military activities (Ricketts et al. 1999). Some of the most impacted areas include Antelope Valley in the West Mojave, the area between Lancaster and Victorville along the north slope of the San Gabriel Mountains, the area around Barstow, and the Las Vegas urban/suburban complex.

3.5.2 Climate Change Adaptation

Species affected by climate change that have the ability to disperse at, or faster than, the rate of change may adapt in this way if there are large intact and interconnected landscapes. However, such species will be at increased risk of extinction if their movements are blocked by fragmenting factors. Because large areas of the Mojave Desert remain relatively intact, this ecoregion has the potential to provide species and communities with the space and interconnectedness they may need to adapt to climate change. Depending on how the climatic zones of North America shift in the future, the intactness of the Mojave Desert Ecoregion may allow for large-scale shifts in species ranges and habitats. Meso- and micro-habitat features of these landscapes may also provide critical climate refugia for some species adapted to cooler conditions.

3.6 Landscape-scale Ecological Processes

A number of ecological processes shape the physical conditions of the Mojave Desert Ecoregion and thus are integral to maintaining its vegetation communities and species. Conservation and management efforts must therefore recognize that functional, landscape-scale processes transcend jurisdictional and ownership boundaries as well as physiographic features. Indeed, maintaining the integrity of this landscape, both within the desert itself and through connections to adjacent areas, is critical for long-term survival of the ecosystem.

3.6.1 Ecological Integrity, Connectivity, and Ecosystem Services

Landscapes with high ecological integrity (i.e., low habitat fragmentation), may be better able to maintain intact ecosystem services, which include provision of clean air and water, regulation of carbon sequestration, maintenance of scenic and recreational resources, and preservation of biodiversity. They may also be more resilient to disturbance events and surrounding land-use changes, and better able to accommodate long-term changes such as those associated with climate change.

[5] The intactness or low fragmentation evaluated here does not necessarily equate to a healthy native ecosystem, as the same northeast Nevada portion of the ecoregion is heavily compromised by invasive non-native grasses such as red brome, and as such has burned extensively in recent years.

Because habitat patch size suitability varies among species, it is important to maintain landscape integrity at multiple scales. For example, bighorn sheep live primarily in habitat "islands" of mountainous terrain surrounded by flat terrain. Fringe-toed lizards occupy patches of sand dunes. Least Bell's Vireo (*Vireo bellii pusillus*) and other rare and endangered birds occupy patches of riparian habitat surrounded by arid lands, and pupfish survive in isolated pools in various locations throughout the ecoregion. Conserving connections between these species' preferred habitats allows individual movements and multi-generational dispersal, thereby increasing long-term species viability. For species that are not able to move far, such as pupfish or narrowly endemic plants, protecting adjacent habitat can be critical to their survival because activities on surrounding lands can disrupt or alter the ecosystem processes that support them.

Maintaining landscape integrity across elevational gradients and transition zones, such as where the desert merges with montane communities of the Sierra Nevada or Transverse Ranges, also increases the ecosystem's resilience to long-term environmental changes, such as changing temperatures and precipitation levels. Conserving wide swaths of protected areas that span the complete range of elevations will allow some desert species to shift their distributions in response to a changing climate (Pitelka et al. 1997, Warren et al. 2001).

3.6.2 Water, Watersheds, and Groundwater to Surface Water Linkages

Surface and groundwater shape desert communities in many ways, including some that are not immediately apparent. For example, sand dunes are indirectly dependent on water when their sand source is a river bed. Mesquite bosques are sometimes located miles from surface water and entirely dependent on subsurface water. Smoke trees and other inhabitants of desert dry wash woodlands are dependent on periodic flooding and scouring for recruitment of new individuals.

Numerous aquatic habitats, such as pupfish ponds and ciénagas, are dependent on intact groundwater systems. Resources in California's Mojave Desert are adapted to the unique hydrologic regimes of the area, and natural hydrologic processes are associated with high integrity watersheds (Poff et al. 1997). In addition, desert communities rely on intact watersheds and groundwater basins for clean and adequate water supplies. Therefore, maintaining the integrity of watersheds is critical to effective conservation of all aquatic and semi-aquatic habitats and the isolated species that inhabit them.

3.6.3 Aeolian Processes, Sand Sources, and Sand Deposition

The Mojave Desert Ecoregion contains several areas that satisfy the prerequisites for dune formation: 1) a source of sand, often from a dry lake or river bed devoid of vegetation, 2) wind that can lift and transport this sand, and 3) an area where the wind loses momentum due to topography or some other obstacle, causing the sand particles to settle, collect, and form sand dunes. Active sand dunes are dynamic; their shapes and locations are continually changing as a result of a continuous sand source and reliable wind patterns. Other dunes accumulated during past climates, where and when water sources dried out and exposed sediments to wind erosion. Sand dune characteristics depend on the geology of the sand source, as this determines the size, shape, and color of the sand particles, and on the speed and direction of the wind. They are thus a direct product of the aeolian system that created them and their existence depends on replenishment of wind-blown sand. So-called "star dunes" have three or more directional sources of sand and thus are more resilient to disruption of any one directional source.

Big Dune in Amargosa Valley
(Photograph courtesy of Basinandrangewatch.org)

Sand dune areas are scattered throughout the Mojave Desert. Some are already protected, such as the Kelso Dunes within the Mojave National Preserve, and the Eureka, Panamint, and Mesquite Flat Dunes in Death Valley National Park. The Kelso Dunes, which rise more than 600 feet above the desert floor, are one of the largest sand dunes remaining in the United States and the largest field of aeolian sand deposits in the Mojave Desert Ecoregion. Sand dunes account for only 6% of the surface area of North American deserts but they provide habitat for a number of uniquely-adapted plant and animal species found nowhere else on Earth (Sections 3.3 and 3.4).

3.6.4 Fire Regimes

Fires were historically infrequent and small in the desert Southwest (Humphrey 1949, Rogers 1986, Brown and Minnich 1986). The occurrence of fire in the Mojave Desert is largely controlled by fuel continuity, fuel type, and ignition sources (Brooks and Minnich 2006). Fires cannot spread far beyond their ignition points if fuels are discontinuous or do not burn readily, and most of the native vegetation types found within the Mojave Desert Ecoregion produce fuels that fit into one or both of these categories.

While the desert lacks trees with fire scars or suitable lakes with charcoal deposits that researchers can use to reconstruct the past, prehistoric fire regimes of the Mojave Desert can be inferred indirectly from studies of vegetation (Brooks and Minnich 2006). Fossil packrat middens also contain a wealth of information about the vegetation found in the Mojave since the beginning of the Holocene epoch (~10,000 years ago). It appears that during this period, the ecoregion's vegetation has remained relatively static, with pinyon juniper woodlands at higher elevations and scrub and/or perennial grasslands at lower elevations (Van Devender and Spaulding 1979, Koehler et al. 2005). This suggests that, throughout the Holocene epoch, the Mojave Desert has had long fire intervals and low-intensity, patchy fires in the low-elevation valleys where fuels are sparse. Middle to high elevation zones could have supported enough vegetation to allow stand-replacing fires, as occur in pinyon-juniper woodlands today. The current climate conditions found in the Mojave Desert have remained constant since about 1,440 years ago (Koehler et al. 2005), lending further support to the idea that fire regimes changed little in the region until the late 1800s, which brought sweeping changes in human land use and invasion by non-native annual grasses such as bromes (*Bromus* spp.) and fluff-grass (*Erioneuron pulchella*).

Grazing by cattle and sheep may have reduced vegetation cover and prevented fires in the early days of livestock operations in the Mojave Desert, but deliberately-set fires were likely used to promote the growth of native grasses as forage during this time as well (Brooks et al. 2003). Periodic fires occurred in the area that is now Joshua Tree National Park between the late 1880s and 1942 (Minnich 2003, Hereford et al. 2006). A mid-century drought resulted in a reduction in fires between 1942 and 1977 (Brooks and Minnich 2006). After 1977, fires became larger and more frequent, and their spread was facilitated by the non-native annual grasses red brome (*Bromus rubens*) and cheat grass (*Bromus tectorum*). Analysis of fire agency data from 1980 to 1995 demonstrates that, throughout the Mojave Desert, increased fire frequency is due to an increase in human-caused fires, since the number of fires ignited by lightning strikes has remained constant (Brooks and Esque 2002). Another probable contributing factor was the above-average rainfall that occurred throughout the Mojave Desert Ecoregion between 1976 and 1998 (Hereford et al. 2006) which, coupled with soil disturbances associated with past livestock operations, likely furthered the spread of fine fuels in the form of non-native annual grasses.

Today, invasions of non-native plant species often result in a continuous blanket of fuel within native desert plant communities, allowing fires to spread more readily and contributing to type conversion from shrub communities to grass-dominated communities (Sections 5.2 and 5.4). Increased ignition rates and fuels have also resulted in more frequent and more extensive fires (Section 5.4). The high rainfall totals of the 2004-2005 wet season were followed by the largest fires on record within the Mojave Desert Ecoregion. Nearly a million acres burned in the Mojave Desert during the summer of 2005; 92% of the area burned was in Nevada, Arizona, and Utah (Brooks and Minnich 2006).

Burned landscape with succulents in Red Rock Canyon NCA showing red brome invasion one year post-fire. (Photograph by James Moore)

It has been suggested that desert plants are not fire-adapted (Rogers 1986), and that even rare fires may have long-term impacts on the structure and composition of communities such as creosote bush scrub and the succulent communities (Brown and Minnich 1986). Several studies have demonstrated that recovery may depend on fire intensity and season (e.g., Rogers and Steele 1980, O'Leary and Minnich 1981, Brown and Minnich 1986). For example, mortality and re-sprouting rates among creosote bush appears to be related to fire intensity, duration, and season of burning (Brown and Minnich 1986). In general, however, long-lived perennials such as creosote bush, catclaw acacia, teddy-bear cholla, and Joshua tree recover slowly (or not at all) while short-lived shrubs such as brittle-bush may recover more quickly and persist following fire (Brown and Minnich 1986). Vegetation communities such as chaparral and forest communities found at the

Burned Joshua tree and scorched landscape in Red Rock Canyon NCA, Nevada (Photograph by James Moore)

edges of the desert appear to be more fire adapted than true desert communities (Brown and Minnich 1986). Historically, fires moving through these communities would stop when they reached desert communities such as creosote bush scrub, presumably due to limited fuels, with the possible exception of years following high rainfall and high biomass production by annuals (Brown and Minnich 1986). This resulted in long fire-free periods in these communities, permitting the re-establishment of long-lived perennials (Brown and Minnich 1986).

3.7 Cultural Resources

Although this report focuses on the natural biodiversity of the Mojave Desert, it is important to acknowledge the rich cultural resources that exist in this region. Humans have lived in this region for centuries, calling it home and making use of its many natural resources. People have also influenced and manipulated the desert in a variety of ways (Section 2.6). Many historical and archeological sites, such as Native American village sites and traditional areas important to Native Americans, are found in association with the natural resources that are the focus of this report, reflecting the close ties that Native American cultures had with the desert and its natural communities. Because of the close geographic association of cultural sites with conservation targets chosen for our assessment, conservation efforts intended to protect natural resources may also help protect culturally important sites.

Origin of the Word "Mojave"

The word **Mojave** (or Mohave) is derived from the Native American phrase ***Aha macave***. The word *aha* means "water", and *macave* means "along or beside". The Mojave people refer to themselves as *Aha macave*-- people who live along the water (or river). They are the northernmost of three culturally related groups historically residing along the lower Colorado River (Sherer 1967).

4 Existing Management and Conservation Efforts

More than 85% of the Mojave Desert Ecoregion is in public ownership, administered and managed by a diverse set of government agencies carrying out a varied array of land-use mandates, conservation efforts, and management protocols (Table 2-1, Section 2.7). Private individuals, corporations and organizations own and manage much of the remaining land. This diversity of land ownership has the potential to fragment the landscape, and produce management inefficiencies or conflicts detrimental to the regional conservation values. Understanding how the various land-governing entities work together is essential to establishing an effective conservation and management framework for the Mojave Desert. In this section, we outline the varied conservation goals and approaches of these public and private entities to document the existing management and conservation landscape in the Mojave Desert Ecoregion.

4.1 Federal Lands

The majority of federal lands in the study area are administered by the Bureau of Land Management (BLM), while other federal land managers include the Department of Defense (DOD), National Park Service (NPS), the U.S. Forest Service (USFS), and the Fish and Wildlife Service (USFWS). Each of these agencies has a unique mission or mandate in relation to desert conservation (Table 4-1). Other Federal agencies responsible for management and conservation of lands in this region include the Bureau of Reclamation and the Bureau of Indian Affairs. The U.S. Geological Survey collects and provides environmental data to guide management of public lands.

Federal lands managed primarily for conservation values in the study area are administered by BLM, NPS, USFS, and USFWS. Lands with the highest levels of protection include Wilderness Areas, Wilderness Study Areas, Areas of Critical Environmental Concern (ACEC), National Parks and Monuments, and National Wildlife Refuges (Section 2.7). The remaining federally-administered lands outside of these designations have varying levels of natural resource protection but the land-use mandates for some of them may be incompatible with the protection of biological diversity and conservation values.

4.2 State Lands

The Mojave Desert Ecoregion extends into four states—Arizona, California, Nevada, and Utah—and the mandates and goals governing land management differ from state to state. Table 4-2 provides examples of California agency mandates, while Table 2-1 (Section 2.7) lists the amount of land held and managed by each agency within the ecoregion.

Some conservation goals, such as maintaining connectivity throughout the region, are complicated by the different land-use policies of the different states. State lands with the highest levels of protection include Wilderness Areas, Natural Reserves, Ecological Reserves, and State Wildlife Areas. The remaining state-owned lands have varying levels of natural resources protection, and various land-use mandates that do not necessarily focus on natural resources protection.

Table 4-1 Federal Agency Mandates

Agency	Mission, Stated Purpose, or Goals
Bureau of Land Management	According to the Federal Land Policy and Management Act of 1976, the U.S. Congress declared that "it is the policy of the United States that the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use." The California Desert Conservation Area (CDCA) Plan directs BLM 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" (BLM 1999).
National Park Service	The National Park Service (NPS) is "dedicated to conserving, unimpaired, the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations. The Service is also responsible for managing a great variety of national and international programs designed to help extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world" (NPS 2007). Each NPS unit within the Mojave Desert has a unique mission: "Death Valley National Park dedicates itself to protecting significant desert features that provide world class scenic, scientific, and educational opportunities for visitors and academics to explore and study" (NPS 2002). "The National Park Service at Joshua Tree National Park preserves and protects a representative area of the Colorado and Mojave deserts and the natural and cultural resources for the benefit and enjoyment of present and future generations. The park strives to maintain its rich biological and geological diversity, cultural history, recreational resources, and outstanding opportunities for scientific study". (NPS 2001). The "Mojave National Preserve was created to protect the area's diverse natural and cultural resources and to perpetuate the sense of discovery, solitude, and adventure that has existed for generations" (NPS 2007a). The mission of the Lake Mead National Recreation Area is to "provide diverse inland water recreational opportunities in a spectacular desert setting for present and future generations" (NPS 2007b).
Forest Service	The Forest Service's mission, "... to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations", is now carried through with a renewed emphasis on *condition of the land* rather than *outputs of the land* (USFS 2005).
Department of Defense	The mission of the U. S. Department of Defense (DOD) is "to provide the military forces needed to deter war and to protect the security of the United States" (DOD 2010). While the DOD's primary goal is military readiness, its long-term management goals also include safeguarding native environments and species that rely on them.
Fish and Wildlife Service	The mission of the U.S. Fish and Wildlife Service: working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

Table 4-2 California State Agency Mandates

Agency	Mission, Stated Purpose, or Goals
California Department of Parks and Recreation (CDPR)	The mission of the CDPR is to provide for the health, inspiration, and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.
California Department of Fish and Game (CDFG)	The mission of the CDFG is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.
California State Lands Commission	The California State Lands Commission's mission is to manage approximately 4.5 million acres (1.8 million hectares) of land held in trust for the people of California. The Commission manages 469,250 acres of School Lands held in fee ownership by the State, and the reserved mineral interests on approximately 790,000 acres of School Lands where the surface estate has been sold. The vast majority of these lands are located in the desert. The State holds these lands "for all the peoples of the State for the public trust purposes of water related commerce, navigation, fisheries, recreation, and open space". The Public Trust Doctrine originally required that land and water be maintained for "commerce, navigation, and fisheries". Subsequent revisions added hunting, fishing, swimming, recreational boating, and "preservation of those lands in their natural state" in order to protect scenic and wildlife habitat values to the list of requirements (California State Lands Commission 2008).

4.3 Native American Lands

The Mojave Desert Ecoregion includes the ancestral and present-day homes of a number of Native American tribes. The Federal Government maintains a special trust relationship with the tribes, as a result of various treaties, statutes, Executive Orders, judicial decisions, and other legal instruments (USFWS 2008). This relationship creates an enforceable fiduciary responsibility to Indian tribes to protect their lands and resources. These lands are, however, not federal public lands or part of the public domain, and are therefore not directly subject to federal public land laws (USFWS 2008). The Bureau of Indian Affairs (BIA), within the U.S. Department of the Interior, is responsible for the administration and management of land held in trust by the U.S. government for Native American Indians. Land protection related to development on forests and rangelands, leasing assets on these lands, protection of water and land rights, and direction of agricultural programs are components of the Bureau's responsibilities. Although Indian lands are exempt from a number of laws, involvement by the BIA in such land management situations triggers selected Federal laws such as the National Environmental Policy Act (NEPA). Within the framework of applicable laws, Native American lands are managed by individual tribes according to their goals and objectives (USFWS 2008), such that management may differ from tribe to tribe.

4.4 Regional Conservation Plans

In addition to Federal and state lands, the Mojave Desert Ecoregion includes land held by a large number of jurisdictions at the city and county level, resulting in a diverse set of land-use plans and management goals. In some cases, planning is coordinated among jurisdictions to address long-term habitat and species recovery goals and land management strategies.

A number of regional-scale planning efforts have been completed or are currently underway (Figure 4-1). For California, pursuant to a statutory directive of the Federal Land Policy and Management Act (FLMPA) in 1976, BLM prepared a California Desert Conservation Area (CDCA) Plan, which was adopted in 1980. That plan has been amended by the adoption of subsequent regional desert conservation plans, driven by litigation over the agency's treatment of listed species. Each of these planning efforts proposes specific actions and adopts land management decisions to satisfy the NEPA, the mandates of the Endangered Species Act, and other statutory obligations of the agency. The three CDCA plans are the West Mojave Plan (WEMO), the Northern and Eastern Mojave Plan (NEMO), which covers 3.3 million acres and was approved in 2002, and the Northern and Eastern Colorado Plan (NECO), which covers over 5 million acres and was also approved in 2002. Each plan consists of two components: a federal component that amends the CDCA Plan, and a proposed Habitat Conservation Plan (HCP) that, once approved, enables development to occur on lands owned by private parties or state and local governments under Section 10(a)1(B) of the Endangered Species Act.

Outside of California, planning efforts include the Lower Colorado River Multiple Species Conservation Program (LCRMSCP), the Washington County Habitat Conservation Plan (WCHCP), and the Clark County Multiple Species Habitat Conservation Plan (CCMSHCP). In addition, a BLM planning effort is currently underway in Utah to create plans for the Red Cliffs National Conservation Area (NCA) and the Beaver Dam Wash NCA, which were Congressionally-designated in 2009 and feature high desert tortoise densities. Each plan must demonstrate on-the-ground conservation benefits to minimize and mitigate the incidental habitat loss they are proposing for the listed species. Each plan must also demonstrate adequate funding to accomplish the conservation goals and adequate safeguards built into the programs to respond to unforeseen changes.

For the regional desert tortoise planning efforts (WEMO, NEMO, NECO, WCHCP, CCMSHCP) a two-decade-long process of defining critical habitat, recovery areas, and lead management entities has resulted in mixed results with regard to on-the-ground conservation achievements. However, processes are in place that would allow these planning efforts to integrate substantially with many of the conservation goals presented in this Mojave Desert Ecoregional Assessment. For instance, Clark County, Nevada developed a 30-year Multiple Species HCP (beginning in 2001), which covers many of the conservation targets found in the Eastern Subregion of this assessment. This program will provide funding for conservation actions benefiting the 79 species in addition to the desert tortoise, covered by incidental take permits and pre-listing agreements.

Figure 4-1

Existing Multiple Species Habitat Conservation Plans/Programs & RMPs

Project Area

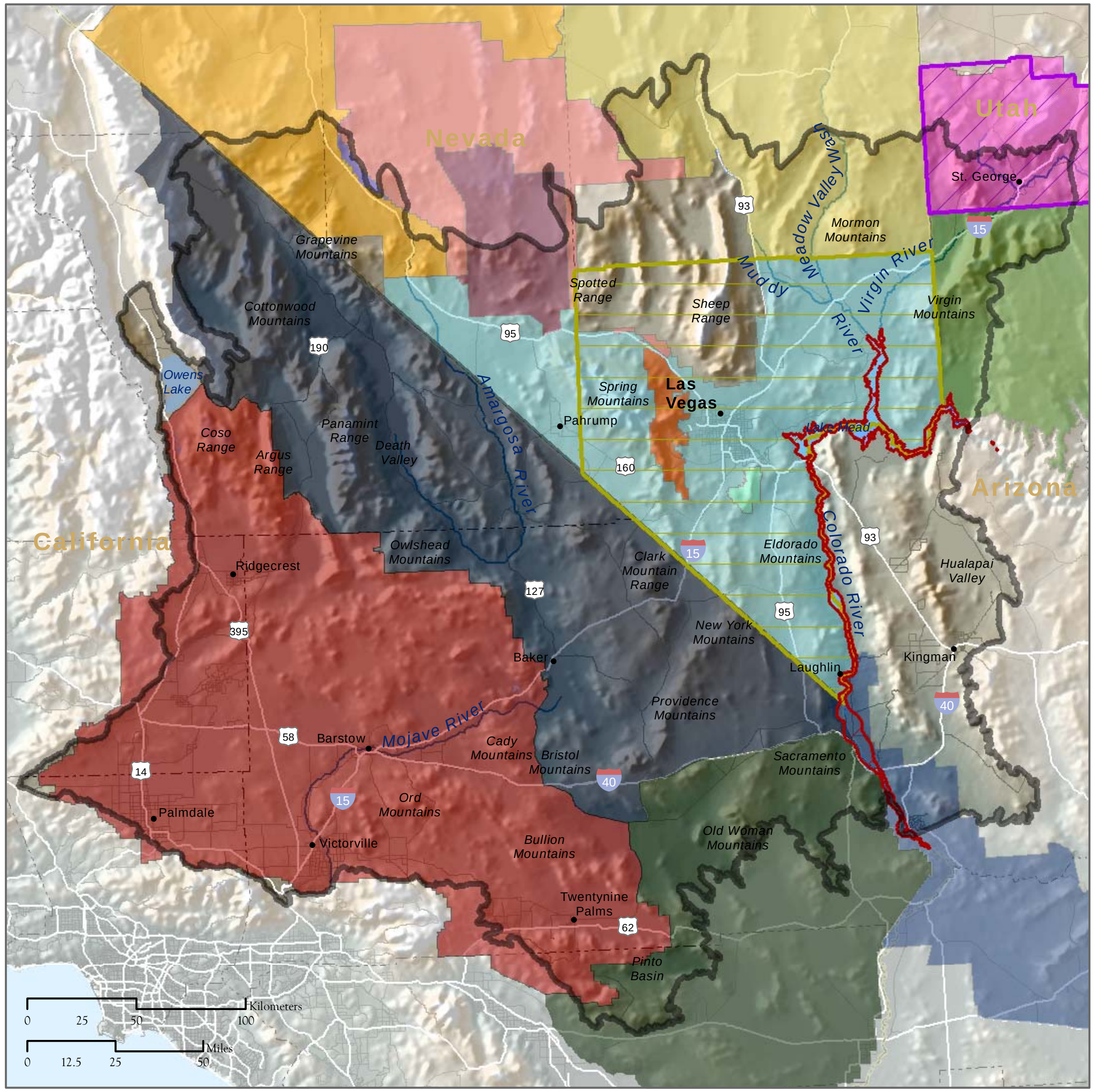
- Mojave Desert

Habitat Conservation Plans/Programs

- Lower Colorado MSCP
- Washington County HCP
- Clark County MSHCP

BLM Resource Management Plans

- Northern and Eastern Mojave
- West Mojave
- Northern and Eastern Colorado
- DOE PLAN
- Ely RMP
- Las Vegas RMP
- Nellis (NTTR) RMP
- Nellis Non-renewal Area
- Red Rock Canyon RMP
- Sloan Canyon NCA RMP
- Tonopah RMP
- Lake Havasu Field Office RMP
- Arizona Strip RMP
- St. George RMP



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California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Within southern Nevada, the BLM is currently revising Resource Management Plans (RMPs) for lands managed from both the Pahrump and Las Vegas field offices. Similar RMPs exist for lands managed in the Arizona portion of the Mojave Desert Ecoregion, and the St. George, Utah field office.

In addition to the above planning efforts, each county within the Mojave Desert has a general plan which addresses land-use issues, including protection of natural resources, and numerous cities have their own environmental goals and plans.

4.5 Non-governmental Organization Lands

A number of non-governmental organizations (NGOs) are dedicated to the protection of open space, natural habitats, and biodiversity in the Mojave Desert Ecoregion. Although not all of these entities are long-term land stewards, all work to acquire or otherwise protect natural area lands for the purpose of protecting sensitive and rare habitats and species, and for maintaining linkages between ecological preserves, parks, and other wildlife refuges.

Non-Governmental Organization Landowners

California Wilderness Coalition

Mojave Desert Land Trust

The Amargosa Conservancy

The Antelope Valley Conservancy

The Desert Tortoise Preserve Committee

The Transition Habitat Conservancy

The Nature Conservancy

The Wilderness Land Trust

The Wildlands Conservancy

4.6 Private Lands

Approximately 4,743,574 acres of the Mojave Desert are in private ownership (Table 2-1, Figure 2-4: Section 2.7). Private lands have no formal protection status and management of privately-owned land is diverse and unpredictable. The type of use may range from a highly managed status on a voluntary basis to high-density industrial, agricultural, and urban development. As described in Section 2.6, land-use patterns in the Mojave Desert have evolved towards increased intensity of use, primarily as a result of water importation and the construction of an ever-lengthening network of roads in the region. As the human population of the Southwest United States grows, it is likely that greater demands will be placed on the Mojave Desert Ecoregion for development, agriculture, recreation, and electrical power production and transport.

Many private lands do, however, support conservation values, and they can be managed to protect natural desert habitats and to provide benefits to wildlife. Conservation management can be accomplished via the volunteer efforts of private land owners, either individually or through collaborative efforts, conservation dedications via mitigation programs, or through financial incentives such as purchase of development rights or dedication of conservation easements for tax benefits. Private land does not necessarily have to be maintained in a natural state to support important conservation values. Beneficial management of private lands may include protection of important natural areas or buffers on portions of the property, low intensity land uses that provide permeability to wildlife and maintain habitat connectivity, and working landscapes that support wildlife habitats. An important example of the latter is the management of agricultural lands in the west Mojave to provide vital foraging and roosting areas for bird species (Section 5.1.5).

4.7 Conservation Management Challenges

Although many conservation efforts are underway in the Mojave Desert Ecoregion, and a large number of agencies and organizations are involved in protecting biodiversity of the ecoregion, there are a number of management challenges that currently hinder the full potential of these collective efforts.

4.7.1 Multiple Mandates and Constraints

The entities managing lands in the Mojave Desert each have their own mission and set of mandates (Tables 4-1 and 4-2). Although conservation efforts would be most effective if coordinated among agencies and organizations, divergent missions and mandates often create a different set of long-term goals and on-the-ground management strategies. For example, while one agency might be mandated to provide for recreational opportunities or extraction of resources, another may be required to provide complete protection of native ecosystems. This difference in mission constrains how closely management strategies can be coordinated. Similarly, even slight differences in missions can result in divergent management protocols, such as with fire management policies.

4.7.2 Lack of Coordinated Management

Management strategies are frequently not coordinated among agencies and organizations, which can hinder effective conservation management. For example, when a watershed is owned and managed by multiple agencies and private owners, a land manager with a conservation emphasis can be adversely affected by an upstream land manager with a resource extraction emphasis. Agency mandates to provide intensive recreational opportunities may adversely affect adjacent lands managed to protect high conservation values. Lack of coordination is often related to the various mandates of the agencies and organizations, and a lack of time and resources available for coordination. In addition, different regional field offices within the same agency often have different management priorities and interests, further resulting in inconsistent administration and enforcement of land uses.

Designation of the CDCA provided a geographic delineation for a coordinated conservation effort extending to the Mojave Desert within California. Currently, however, only the BLM is mandated to manage their lands as part of this conservation area (BLM 1999). Although the missions and mandates of multiple governmental agencies and non-governmental organizations promote conservation of this area, there is no mandate requiring them to work in a coordinated fashion within the CDCA.

Creation of the Desert Managers Group (DMG), an interagency group formed in 1994 to jointly address desert-wide conservation, visitor services, and public safety efforts (DMG 2007), has increased coordination by facilitating communication and providing a forum for sharing information and discussion of issues of common concern. The DMG is involved in collaborative activities such as weed management, and has a number of working groups with varying levels of activity that jointly address a wide range of conservation issues, including:

- Conservation Land Acquisition Work Group
- Desert Tortoise Information and Education Work Group
- Desert Lands Restoration Work Group
- Hazardous Materials Work Group
- Mohave Ground Squirrel Working Group
- Paleontology and Cultural Resources Work Group
- Raven Management Work Group

Similar to the DMG, the Southern Nevada Agency Partnership (SNAP) is a group of stewardship professionals from the BLM, NPS, USFWS, and the USDA who are focused on the portion of the Mojave Desert within Nevada.

4.7.3 Single-Species Focus

Many conservation efforts have traditionally focused on protecting single species, and planning for the recovery of species that have special status as threatened or endangered under state or federal law significantly drives agency programs and policy. In many cases, funding and laws necessary to advance conservation objectives are often tied to a particular listed species. In the Mojave Desert, recovery of the desert tortoise has absorbed much of the conservation effort and resources on the part of state and federal agencies. However, current practitioners recognize that large-scale processes support biodiversity, and that protecting entire ecosystems or landscapes often results in a better outcome than narrowly-focused, single-species conservation (Society for Conservation Biology 2010).

4.7.4 Knowledge Gaps and Public Misconceptions

The ability to effectively manage and conserve the Mojave Desert is often hindered by a lack of information. In addition to numerous information gaps, the Mojave Desert suffers from a public image problem. Common misconceptions about the desert have limited the public's understanding its inherent conservation value. In part due to scarce water resources, deserts in general are typically perceived as wastelands—lands of little to no value. This limits acceptance of the need to conserve desert landscapes. Wealth extracted from the desert through mining or grazing, for example, often imposes few costs or obligations on the pursuer and the activity is viewed as purely additive. Habitat destruction caused through extraction is often ignored and left unremediated where habitat values are perceived to be non-existent or negligible.

4.8 Restoration Efforts

Active restoration of native plant communities has been attempted at various locations throughout the Mojave Desert. On the whole, these efforts have been costly and have resulted in only slow ecological recovery where they have been successful at all. Soil biological crusts, which are essential to the growth and survival of many plant species and the maintenance of ecosystem processes (Section 3.4), have unassisted recovery times estimated between several years (Belnap and Eldridge 2003) to millennia (Belnap and Warren 1998) depending on a variety of factors. While assisted recovery may occur more rapidly (Bowker 2007), many native Mojave Desert plants, such as creosote bush (*Larrea tridentata*) and blackbrush (*Coleogyne ramossissima*), are so long-lived and slow-growing that restoring a community to a pre-disturbance condition can take decades to centuries, if it is possible at all. Active restoration projects that focus on early-successional and/or post-disturbance native species such as saltbush (*Atriplex sp.*), have met with more success, but these species are often not representative of the original plant community at locations that land managers would like to restore.

Gaps Hindering Effective Conservation in the Mojave Desert Ecoregion

- Incomplete location data and inventories on sensitive species and communities
- Incomplete inventories of land-use threats and/or digital data across the ecoregion
- Incomplete understanding of the quantitative interaction of threats for cumulative impacts analyses
- Incomplete knowledge regarding control of invasive plant species
- Incomplete knowledge regarding control and the indirect impacts of invasive animal species
- Incomplete understanding of future climate change
- Incomplete understanding of groundwater systems
- Lack of successful restoration protocols
- Incomplete understanding of the inter-relationships between nitrogen deposition, fire, and invasive plants
- A lack of linkage (habitat connectivity) planning in the Mojave Desert
- Incomplete understanding of the direct and indirect impacts of large-scale development of renewable energy facilities

Ultimately, the success or failure of a restoration project can only be judged against the original goals established by entities leading the project. Typical goals for the recovery of disturbed lands include visual erasure of disturbance, recovery of site stability and soil structure, recovery of vegetation cover or composition, return of native animals, or recovery of ecosystem processes (Belnap 2004). Several agencies, such as the National Park Service, have active restoration programs for disturbed lands. For example, volunteers working for the American Conservation Experience program and AmeriCorps have worked to restore desert tortoise habitat in the Lake Mead National Recreation Area. Post-fire restoration research by USGS and others has been conducted in several locations, including the Pakoon Basin of Arizona and Joshua Tree National Park. Abandoned mines are restored by closing adits (horizontal mine shafts) and leveling spoil piles through the joint efforts of a many federal and state agencies and their partners (AML 2010); however, true restoration of desert habitats is not often pursued.

4.9 Mitigation Programs

A variety of generic and specific mitigation programs currently exist in the Mojave Desert. Most mitigation obligations arise out of permitted uses of public land that disturb habitat or adversely affect other resources. Mitigation requirements follow a hierarchy: first avoid harm, then minimize adverse effects, and then compensate for any remaining harm. One specific example of a large-scale compensatory mitigation program comes from Nevada. In 1999, Congress passed what is known as the Southern Nevada Public Lands Management Act (SNPLMA), which allows for the expenditure of 85% of the proceeds of public lands in and around Las Vegas to be expended on the purchase of environmentally sensitive lands in Southern Nevada, with an emphasis on Clark County. Estimates of income that may be generated by these sales, based upon the current land market values and the amount of public land identified for disposal under the PLMA, range from $650 million to $1 billion. These figures rival the amount allocated by Congress under the Federal Land and Water Conservation Fund (LWCF). Criteria similar to those used by the LWCF were initially employed during the process of decision-making regarding the expenditure of funds from this program. However, effectiveness of implementation of the SNPLMA mitigation program has been uneven in recent years. Involvement of multiple agency staff in the selection of projects, combined with the timing and availability of qualifying acquisitions, has resulted in only a few, high-value projects.

Amargosa Canyon near China Ranch (Photograph by Bill Christian)

5 Threats and Conservation Challenges

The Mojave Desert has experienced a long history of human use and abuse (Rowlands 1995). Many of the threats that plague the ecoregion are familiar and shared with other systems, but a few are especially severe and broad in scope in the Mojave Desert. The arid climate, delicate soils, and naturally slow pace of ecological succession render the Mojave Desert fragile and vulnerable to disturbance; even subtle actions can have long-lasting consequences for the ecoregion's plant and animal communities. Exploitative use of the desert continues to intensify as the human population grows and society grapples with solutions for persistent, global environmental problems. The contemporary intensification of old threats is coupled with the emergence of newer threats, leading to interactions that are difficult to address without the involvement of multiple agencies, land owners, and a diverse and often conflicting array of interest groups. The ecoregion is further plagued by a deep-seated lack of cultural understanding and appreciation of its importance as a vital, living ecosystem worthy of protection. Without successful, wide-spread amelioration of the threats described in this section, much of the Mojave Desert's conservation value may be lost in the years to come.

Habitat loss and degradation are the top threats to biodiversity conservation within the Mojave Desert Ecoregion. The Mojave Desert is included as one of the national hotspots of native species endangerment (Flather et al. 1998), with residential and industrial development cited as top causes of harm to biodiversity within the region. Habitat loss, degradation, and fragmentation occur through a variety of mechanisms, including both direct land conversion and slow degradation due to dispersed, persistent uses. The expansion of cities, including Victorville and Lancaster in California and Las Vegas and Pahrump in Nevada, is a familiar threat spurred by population growth and cheaper housing options available at the edge of large urban areas. From 2006 to 2007, Victorville experienced the second-highest population growth rate in the country according to the U.S. Census Bureau. In addition, recent efforts to rapidly site and construct industrial-scale electrical solar power plants threaten to obliterate tens of thousands of acres of native vegetation and wildlife habitat in desert valleys, while wind energy development is occurring along ridge tops.

In addition to habitat loss and degradation, habitat fragmentation in the Mojave Desert has occurred as a result of physical barriers such as urban development, highways, rail lines, dams, and fences. Habitat connectivity and integrity are vital for long-term survival of species and the functionality of ecological processes. Barriers restrict the movement of species, limit gene flow, and prevent natural dispersal. Fragmentation along an elevational or latitudinal gradient could prevent species from moving to a more suitable habitat in response to a changing climate. Barriers can also impact ecological processes such as sand deposition (Bunn et al. 2007), or fragment aquatic habitats leaving populations isolated from one another (Martin and Wilcox 2004). In addition to blocking movement, roads, rail lines, utility corridors, and other agents of fragmentation can serve as vectors for invasive species and disease, increase mortality rates for numerous ground-dwelling species, and spread pollution.

Every natural system is subject to disturbances. In this assessment, only human caused destruction, degradation, and/or impairment of conservation targets are considered threats. Threats are collectively comprised of both stresses and sources of stress. The Nature Conservancy uses the word "stress" to refer to impairment or degradation of natural systems, communities, or populations. An example of a stress would be low population size or reduced extent of a particular plant community type. For each stress present within the Mojave Desert Ecoregion, there are one or more causes or sources. Sources of stress (also known as direct threats) are the proximate activities or processes that have caused, are causing, or may cause the stresses. Examples of sources of stress include incompatible management practices or land development. Sources of stress are limited to human activities. Here we present the sources of stress that contribute to habitat destruction, degradation, and other forms of impairment to natural systems, communities, and species in the Mojave Desert Ecoregion.

5.1 Land-Use Changes

5.1.1 Urban Expansion and Proliferation

There are about one million people residing within the California portion of the Mojave Desert Ecoregion (Hunter et al. 2001), and over 1.8 million within Clark County, Nevada alone (U.S. Census Bureau 2009 estimate). Many of the cities in the Mojave have doubled in size in recent years, though the recession that began in 2008 has slowed the rampant growth in many locations. The built urban environment of cities in the desert includes many components, including most notably housing, commercial development, and transportation and utilities infrastructure.

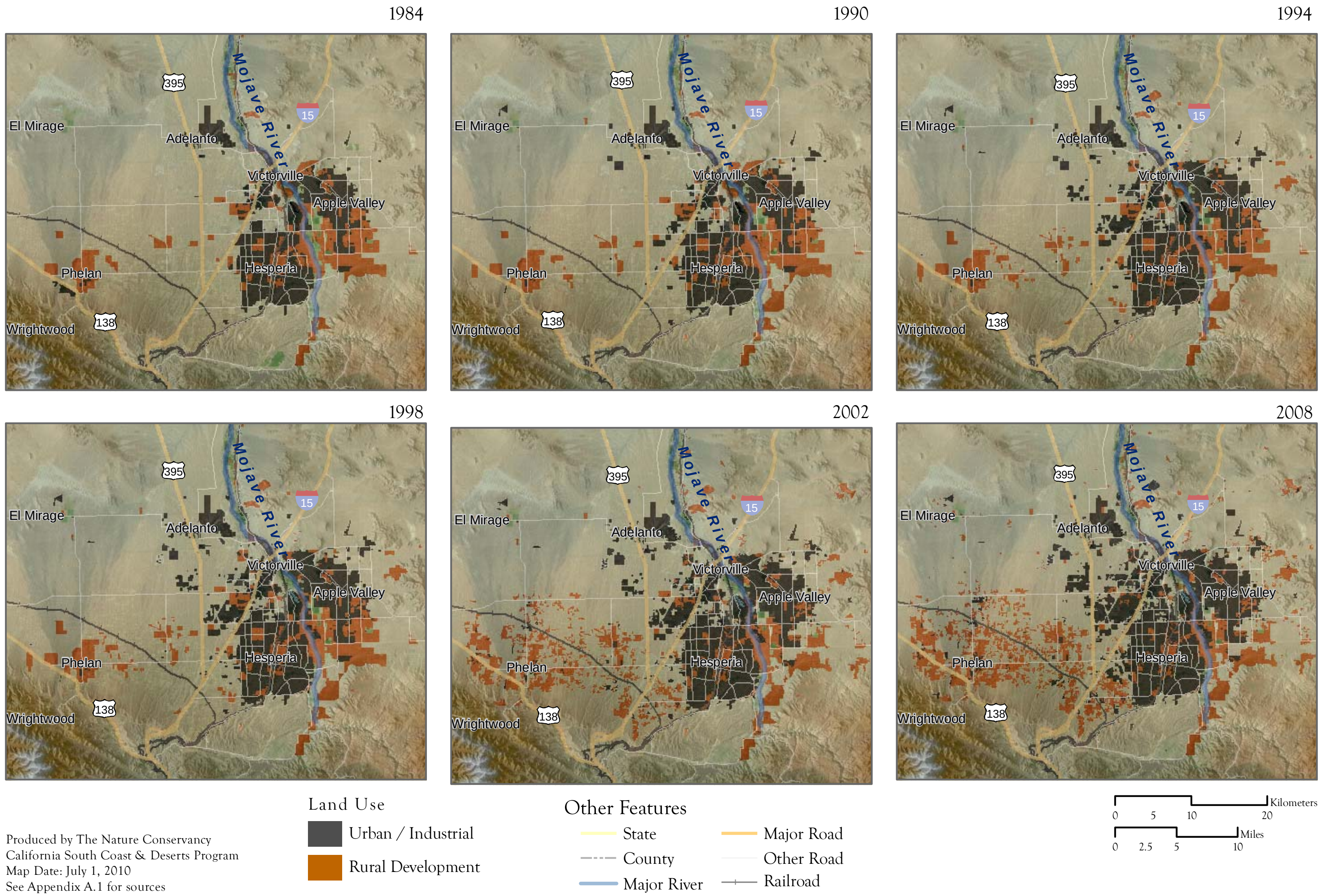
5.1.1.1 Housing and Commercial Development

Over the past two decades, a housing boom has occurred in communities that were once small, remote Mojave Desert towns such as Lancaster, Palmdale, Victorville, Barstow, Ridgecrest, Las Vegas, Pahrump, Mesquite, Kingman, and St. George (Figure 5-1). Even the large planned community of California City, which initially failed to draw a substantial population, grew from 3,200 people in 1985 to over 14,000 in 2009. The Mojave Desert, once a landscape that most people entered only temporarily, is now the year-round home to more people than ever before.

Residential development, which has expanded existing urban areas and spurred the incorporation of new communities across the ecoregion, has been fueled by many factors including: a warm and dry climate, available inexpensive land, seemingly adequate supplies of water supplemented by projects that deliver water (e.g., from the Bay Delta and the Colorado River) via aqueducts, recreational opportunities, and favorable economic conditions. Construction jobs draw people to the region, creating a housing boom. The building of homes necessitates commercial development and other infrastructure, as discussed below. Urban development threatens the conservation value of the Mojave Desert directly by causing direct habitat loss, degradation, and fragmentation.

Figure 5-1

Urban and Rural Expansion



5.1.1.2 Transportation Infrastructure

The rapid influx of new human residents into the Mojave Desert necessitates not only the building of houses and businesses, but also the expansion of delivery systems for all services and utilities demanded by modern cities. Water pipelines, electric power lines, communications infrastructure including towers and cable lines, and facilities for storage and containment of trash are all part of the built environment in cities. Roads are bulldozed and paved to accommodate construction activities and provide for vehicle traffic. Major highways connect large population centers, and a network of smaller paved and unpaved roads crisscrosses the Mojave Desert. This road network, which is surprisingly large given the amount of open space in the ecoregion, results from a relative ease of road construction, lack of regional planning, and permanence of even unpaved roads due to the arid climate and slow growth of native vegetation (Figure 5-2). New highways are planned in several locations to accommodate the growing human population.

While most new human communities in the Mojave Desert have limited or no local public transit, there are plans for a high-speed rail line to connect Victorville to Las Vegas and another from Orange County to Las Vegas. Rail lines have existed in the Mojave for over a century (Section 2.6). Early on, they were employed in the movement of mining materials; now they are used for the long-distance movement of freight and soon they will be used for passengers. The ecoregion also has several small municipal airports, a number of military airstrips, and a larger international airport at Las Vegas. Another major airport is currently has been planned in Primm, Nevada near the California/Nevada state line to service the Las Vegas area; however, recent economic conditions have delayed or cancelled those plans.

Taken alone, any one of these infrastructure developments could have an impact on certain vulnerable species in a particular geographic area. All developments associated with urban expansion and proliferation cause direct loss of habitat, and the grading of areas for development disturbs and destabilizes soils by destroying sensitive soil biological crusts. Roads, highways, and railways create new paths for the invasion of non-native invasive species, and lead to direct mortality of terrestrial species through direct strikes. Because some reptiles such as snakes and lizards take advantage of the heat radiating from paved roads at night, they are particularly vulnerable to being hit by vehicles. The desert tortoise is also affected by roads. Studies on the impact of highways on the species indicate that there is a "dead zone" that extends up to 1.5 miles on either side of heavily travelled roads (Hoff and Marlow 1993). This results in a significant loss of potential habitat for this threatened species throughout the Mojave Desert. However, fencing can prevent some of the negative impacts of roads on the tortoise, and studies have shown that coupled with underpasses, fencing along roadways can decrease vertebrate deaths by 98% (Boarman 1991, 1992), and allows the dead zone to be recolonized by desert tortoises.

Together, the multiple threats associated with urban expansion and proliferation constitute a significant impact on conservation targets in the Mojave Desert by destroying existing habitat, fragmenting and degrading remaining habitat, and using large amounts of a water. In addition, the expenditure of large amounts of energy is required to transport additional water to the region.

Figure 5-2

Roads & Railroads

Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Highway or Main Road
- Local Road
- Minor Road / Dirt Road*
- Railroad

* Does not include most OHV routes.

Hydrology
- Major River

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California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

5.1.2 Electrical Generation and Transmission

Cognizant of the nation's ever-growing demand for electricity, the desire to reduce the country's dependence on foreign sources of energy, and the desire to reduce CO_2 emissions to help address climate change, many government leaders have increasingly voiced support for using publicly-owned land to site large power plants that use the sun, wind, or geothermal energy to generate electricity. Legislators, power companies, investors, environmentalists, and the general public have become increasingly interested in the development of renewable alternatives to fossil fuel-driven electrical production. The searing sunshine, strong winds, and geothermal resources present in the desert Southwest have captured the attention of those looking to solve a range of problems related to the production of electricity within the United States. In addition to addressing issues related to demand for electricity, reducing foreign fuel dependence, and increasing employment opportunities, proponents of industrial-scale electrical power generation in the desert argue that these new developments will contribute to solving the problem of global climate change.

In response to the surge in applications by energy companies to develop public land, the BLM and the Department of Energy (DOE) are preparing a Solar Energy Development Programmatic Environmental Impact Statement (PEIS) to evaluate potential impacts of utility-scale solar energy development on BLM-administered lands in seven western states (Figure 5-3). However, BLM will also review and make determinations on many applications for proposed renewable energy facilities prior to the completion of the PEIS, as the time-limited availability of federal stimulus funding and state renewable portfolio standards have placed considerable pressure on the regulatory agencies to quickly review these project proposals.

In light of the potential long-term benefits that renewable energy could provide, many are impatient with the permit review process, which weighs those potential benefits against the real threats inherent in the construction and operation of industrial-scale electrical power generating facilities. However, the impacts of this type of development are significant and potentially devastating. If poorly sited, these facilities and their associated transmission corridors can destroy, damage, and fragment important habitat for desert plants and animals and exacerbate other threats such as the spread of invasive plants and associated wildfires. Consideration of landscape connectivity is critical when siting facilities, as power plants might not only restrict seasonal movement of wildlife, but also prevent some species from moving to adapt to future climate change over longer timeframes. Grading of natural areas for development disturbs fragile soils, and energy production that requires water can lead to groundwater overdraft, causing degradation of fragile aquatic habitats on which many desert species depend.

5.1.2.1 Differences in Impacts of Proposed Technologies

Solar, wind, and geothermal technologies are similar to other methods of industrial-scale electricity generation in that each has notable advantages and disadvantages, and some technologies are better suited to a given location than others. Solar photovoltaic (PV) panels convert sunlight into electrical energy without using an intermediate step of a steam turbine. The technology they contain is proven and simple, but they require more land to generate a given amount of electricity

Figure 5-3
Proposed Electricity Generation

Project Area
- Mojave Desert

Proposed Electricity Generation
- Solar
- Wind

Includes footprint of BLM right-ofway applications for CA and AZ, point locations for NV, CA, and AZ.
CA locations accessed 9/13/10.

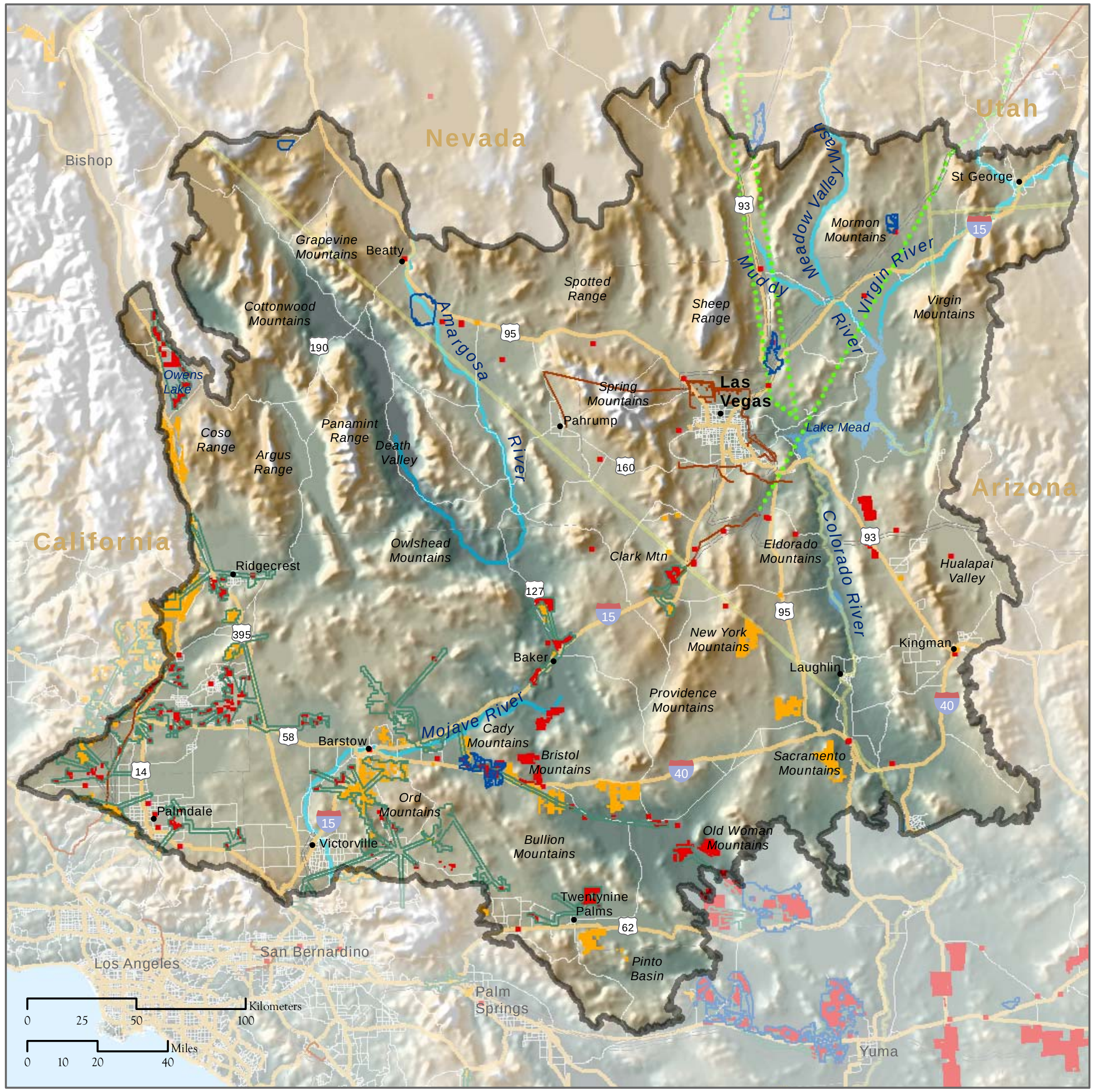
Proposed Transmission Lines

Voltage Class
- 500
- 100 - 345
- Under 100
- DC Line

Electricity Generation Zones
- BLM Solar Energy Study Area
- CA RETI Certified Renewable Energy Zone

Other Features
- State
- Major Road
- County
- Other Road
- Major River

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources



than other solar technologies. Parabolic trough and solar power tower technologies can consume a great deal of water, a resource that is limited in both amount and distribution in the Mojave Desert. Power towers also pose a risk to birds, bats, and insects. Both types of solar thermal technology result in significant disturbance (in some cases laser-leveling) of fragile soils and plants. Stirling engine technologies require less water and can cause less soil and vegetation disturbance than solar trough or power towers, but the technology is relatively unproven at the scales currently proposed.

A solar parabolic trough installation or solar power tower site requires flat land, and grading is the industry norm. The site is typically cleared of all vegetation to allow access to the installed equipment and to prevent fires. Herbicides may be sprayed or vegetation mowed to maintain cleared zones under and around the solar fields. These facilities typically include numerous graded access roads and a surrounding security fence that prevents movement of wildlife through the site. Because some native plant species in the Mojave may take decades or even centuries to re-colonize after disturbance, development of this type has long-term consequences that cannot be undone, even if all of the installed equipment is removed and restoration attempts are made. The disturbance to fragile soil biological crusts can destabilize soils, leading to increased particulate air pollution as soils are whipped by fierce desert winds. In total, the surface disturbance at a solar facility is similar in intensity to commercial facilities such as warehouses, with an additional down-side: the great expanse of exposed, disturbed soils found onsite and on associated roads is susceptible to invasion by non-native invasive plants, and can serve as a reservoir of invasive species, furthering their dispersal into nearby natural lands.

In addition to the direct habitat loss associated with the construction of industrial-scale electrical power plants in the desert, these facilities may have a strong impact on water resources. While photovolataic installations require no water to generate electricity, water is required to wash panels. Power companies have indicated that between two and 10 acre-feet of water per 100 megawatt (MW) per year might be needed for this purpose (TNC 2008). Parabolic trough and solar power tower technologies heat a transfer fluid that is in turn used to heat water to create steam and turn the turbines that generate electricity. Water is also required for the steam circuit and washing mirrors. In addition, if a plant uses wet-cooling of the exhaust steam from its turbines, industry standards indicate that up to 600 acre-feet of water per 100 MW per year may be required.

The proposed sources of water for many future solar facilities are unclear. Water may be drawn from aquifers or purchased through a water district and pumped to the site. For example, the SEGS III-VII plant at Kramer Junction purchased cooling water from the Antelope Valley East Kern Water Agency, which obtained this water from the State Water Project. The amount of electricity required to pump water from the Sacramento-San Joaquin Delta to the Mojave Desert to generate one MW of electricity using solar technologies has not yet been calculated (TNC 2008).

Light and noise pollution associated with electrical power plants can be problematic for wildlife. Polarized light pollution from PV panels can attract aquatic insects and other species that mistake the panels for bodies of water, potentially leading to population decline or even local extinction of some organisms (Horvath et al. 2010). Nighttime lighting for security or other reasons may negatively impact a variety of Mojave Desert species, many of which have developed nocturnal behavior to escape the daytime heat of the desert. In addition, solar thermal plants that employ dry cooling generate noise pollution through the use of large fans. Some of these types of pollution may be reduced or eliminated through changes in design as technologies improve.

Environmental impact studies on wind farms have documented mortality of birds and bats that strike turbines or are buffeted by the turbulence generated by the rotating blades. As some of the ideal locations for siting wind farms are in mountain passes, which migratory birds may use to traverse mountain ranges, bird strikes are of particular concern. Quantifying mortality due to collisions on wind farms is difficult, but research indicates that mortality is greater in areas that have more birds. In addition, the access roads used in the construction and maintenance and construction of wind farms may cause significant damage directly and indirectly by providing corridors for the spread and establishment of invasive plants, which may in turn promote more frequent and severe fires.

5.1.2.2 Transmission Lines and Utility Corridors

Transmission lines extend across the Mojave Desert, carrying electricity from sites of generation to sites of consumption in urban centers (Figure 5-4). With the development of more industrial-scale electrical generation plants in the desert, there are calls for more transmission lines to distribute electricity to the sites where it is used. The construction, operation, and maintenance of these transmission lines and associated access roads and other infrastructure cause habitat loss, degradation, and fragmentation. Many of the problems associated with wind farms apply to transmission lines as well: road construction disrupts soils, uproots plants, and creates barriers between patches of habitat. Disturbed soils promote the invasion of non-native plants. Under certain conditions, transmission lines can be associated with increased fire risk. In addition, transmission towers can serve as Raven perching and nesting sites, providing them with ideal vantage points from which they can conserve energy while hunting. Ravens can then exert a potentially devastating effect on newly-hatched desert tortoise as well as numerous other small animal species.

Transmission lines, like wind turbines and power towers, also pose a direct threat to birds and bats when these animals strike them in midair. Mortality estimates due to these strikes vary greatly by species, location, and date, but estimates have been as high as 200 fatalities per mile of transmission line per year in some areas (Faanes 1987).

5.1.2.3 Other Related Infrastructure

Industrial-scale electrical power plants require maintenance. A staff of technicians, engineers, and other personnel will be required on site as these facilities generate electricity. Because many of the proposed locations for these power plants are remote, it is highly likely that new urban development will occur in locations close to the new power plants. Housing, roads, and associated infrastructure constitute a significant threat to biodiversity in the desert (Section 5.1.1).

Figure 5-4
Current Electricity Generation & Transmission

Project Area
- Mojave Desert

Electricity Generating Unit

Type, megawatts
- Photovoltaic < 5.2
- Photovoltaic 10
- Photovoltaic 30
- Steam Turbine < 15
- Steam Turbine 30 - 36
- Steam Turbine > 60

Non Solar
- Combined Cycle
- Gas Turbine
- Geothermal
- Hydraulic Turbine
- Internal Combustion Turbine
- Wind Turbine

Transmission Line

Voltage Class
- 500
- 100 - 345
- Under 100
- DC Line

Other Features
- State
- Major Road
- County
- Other Road
- Major River

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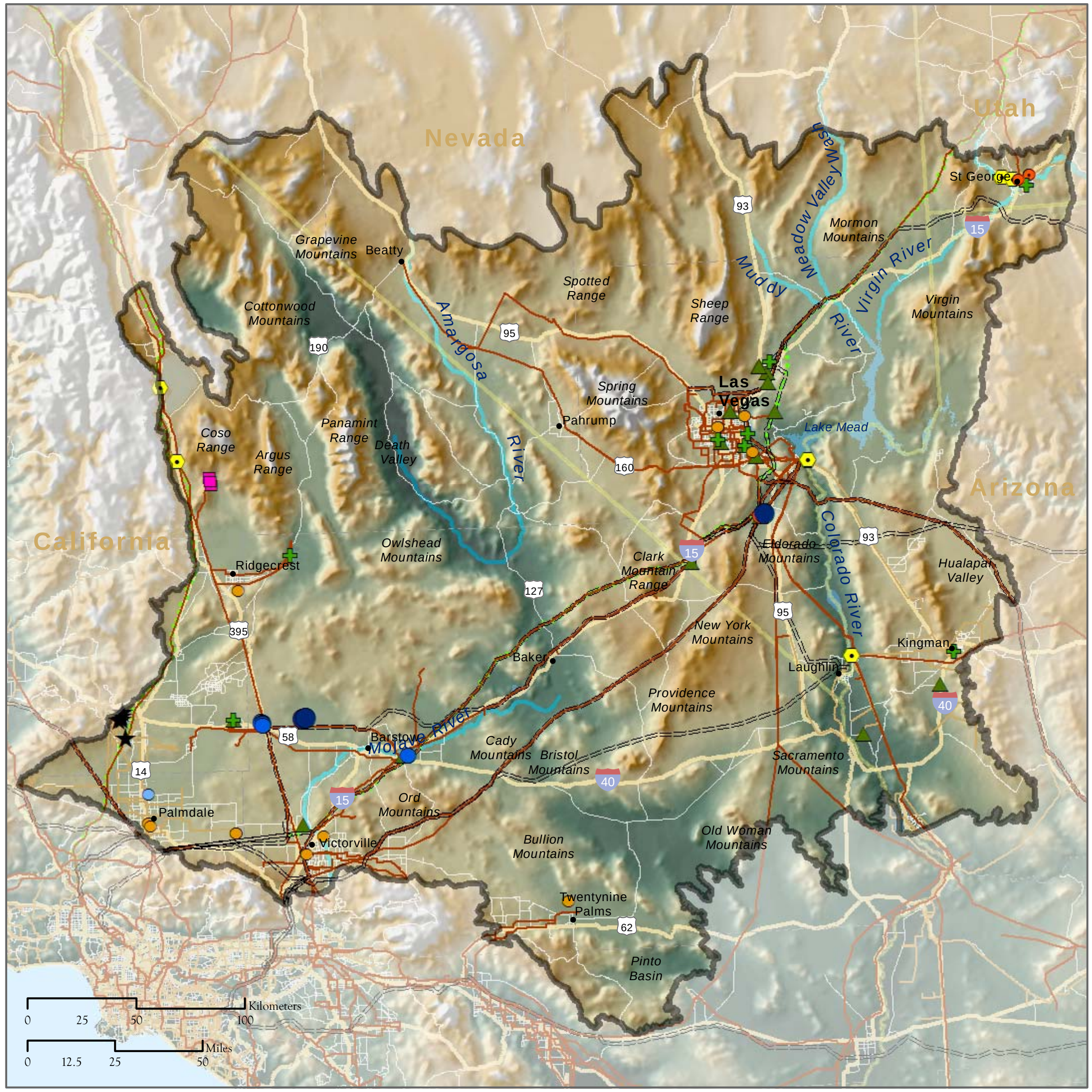


5.1.3 Groundwater Pumping, Water Diversions, and Streambed Modifications

In the Mojave Desert Ecoregion, urban development, agriculture, and mining activities are all associated with groundwater pumping, water diversions, and streambed modifications. Newfound interest in industrial-scale electricity production through the use of solar thermal technologies has reminded us yet again how scarce water resources are in this region, and raised the issue of how water use should be monitored and/or regulated. In recent years, an expanding demand for water for various uses, in combination with rapid population growth and climate change, has led to serious concern over future water availability, and called into question how development, agriculture, and vulnerable natural ecosystems can coexist in the arid Mojave Desert.

Much of the desert-derived water used in the Mojave Desert comes from one of the major drainage systems within the ecoregion, which include the Colorado River, the Virgin River, the Muddy River, the Mojave River, the Amargosa River, the White River drainage system, and the Meadow Valley Wash system (Figure 2-2). Additionally, many towns, cities, and industrial operations extract water from groundwater basins that are fed by precipitation in nearby watersheds. A large amount of water is also imported into the Mojave Desert Ecoregion from the California State Water Project.

Risk of Groundwater Impairment

The bi-state Amargosa River (Figure 5-5), apart from rare storm events, is wholly dependent on groundwater. The Death Valley Regional Flow System, a hydrologically complex series of aquifers, supplies the vital perennial streams, seeps, and springs that in turn keep the river flowing year-round. Groundwater pumping has lowered the water table and dried up desert springs, and threatens the natural communities that are wholly dependent on groundwater-fed surface water. Legal controls on groundwater pumping and protection of water for biodiversity are weak in California and Nevada.

Water diversion is one of the five most commonly-cited causes of species endangerment in the ecoregion (Flather et al. 1998). Even plant communities not typically associated with water can be negatively impacted when water tables drop due to excessive dumping and groundwater overdraft (Figure 5-5). Urban and industrial development, agriculture, roads, and mining all contribute to the use, diversion, and contamination of watersheds and water resources. Each of the major riparian systems is impacted to varying degrees by diversion of surface waters, overdraft of groundwater, or the impending threat of massive residential development occurring in their watersheds.

Diversion and apportionment of the Colorado River occurs according to the 1932 Law of the River (CRWQCB 2005), and large amounts of water are removed upstream of the Mojave Desert Ecoregion. Some of the water withdrawn from the Colorado River as it flows through the Mojave Desert is used within the ecoregion, but much of it is exported for domestic and agricultural use in other parts of Arizona and California. So much water is withdrawn from the Colorado River that its flow and sedimentation patterns have been greatly altered (Pitt 2001). In addition, the floodplains of the Colorado River have been converted in many places from native riparian

Figure 5-5

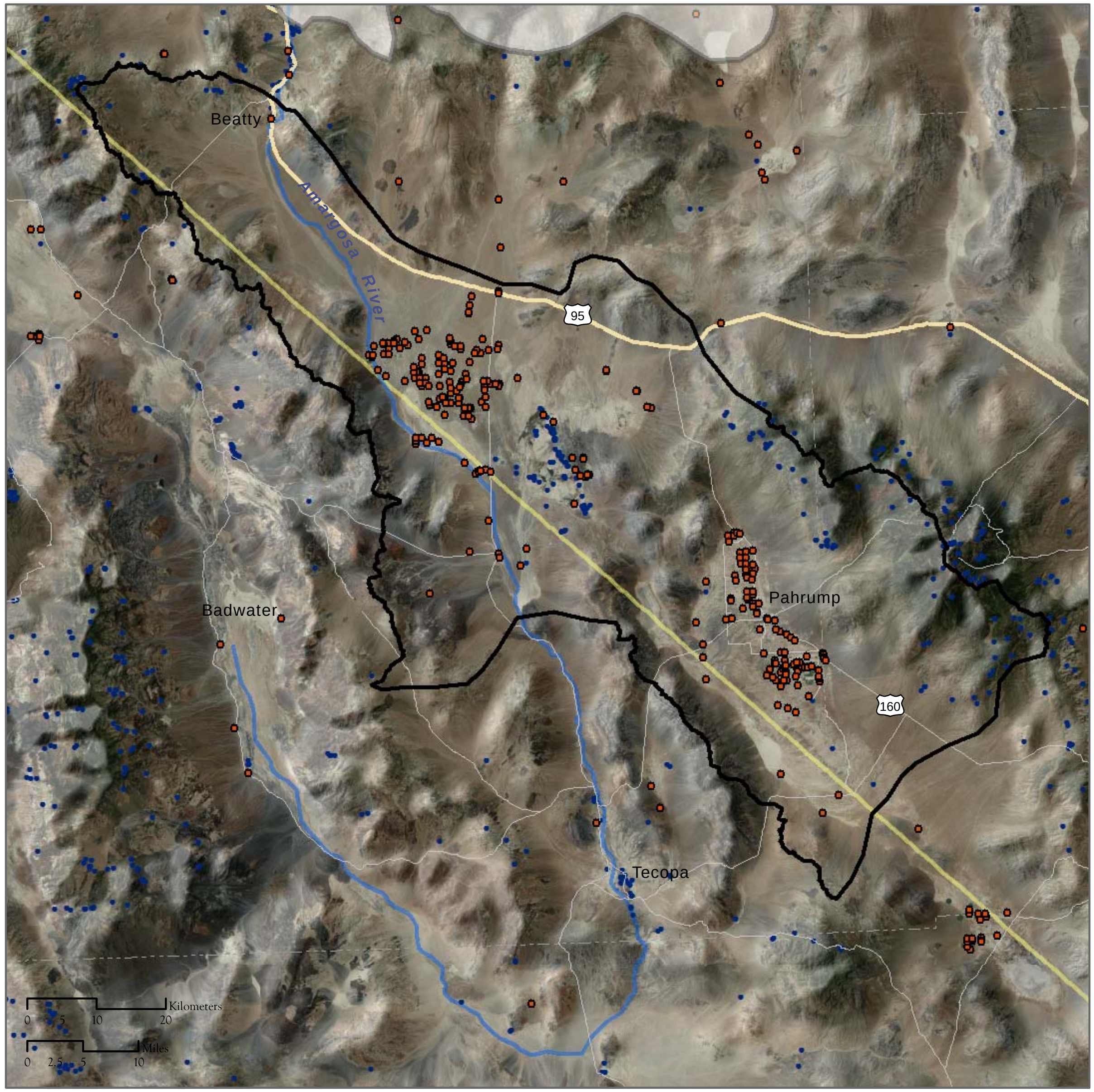
Amargosa Hydrology

Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Major Road
- Other Raod

Hydrology
- Seep or Spring
- Pumping Well
- Major River
- Hydrographic area where pumpage exceeds 100 million cubic meters (Mm^3)



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Map Date: July 1, 2010
See Table A.1 for sources

cottonwood and willow habitats to agriculture (Marshall et al. 2000), or have been invaded by non-native tamarisk (Poff et al. 1997, Briggs and Cornelius 1998).

Throughout the Mojave Desert, groundwater extraction threatens springs, seeps, ciénagas, lakes, and riparian habitats, all of which are tied to groundwater levels, and depend on them for renewed water sources. Many worry about aquifer contamination, and the fact that the current rates of use of groundwater resources in the Mojave Desert are not sustainable over time (Brown et al. 2007).

Gaining a better understanding of the ecoregion's hydrology, particularly the connections between groundwater and surface water is crucial to determining the tolerances of the hydrologic systems and their abilities to recharge. In addition, we lack information about the ability of some species and communities to adapt to changing water availability, quality, or timing of delivery.

5.1.4 Recreational Off-highway Vehicle Use

Recreational off-highway vehicle (OHV) use has become a popular activity throughout the United States, with over 40 million participants nationwide in 2005-2007 (Cordell et al. 2008). This pastime is rapidly increasing in the desert Southwest and in California alone, the number of registered OHV users increased by 108% between 1985 and 2002 (California Department of Parks and Recreation 2002). On any given weekend, more than 40,000 motorcyclists, dune-buggy riders, and racing trucks can gather at a single location, and activities range from casual use to highly organized, well-funded, competitive off-road racing across hundreds of miles of public land.

Off-highway vehicle use directly kills native plants and animals, damages and destroys soil biological crusts and natural desert pavement (Wilshire 1983, Lovich and Bainbridge 1999), causes soil compaction, alters water runoff patterns, and promotes erosion (Iverson 1980, Adams et al. 1982). Soils that have been disturbed by OHVs are susceptible to wind and water erosion, leading to human health risks. Disturbed soils are also vulnerable to the spread of invasive non-native plants, many of which are capable of carrying fire when ignited by sparks from an OHV. Because soil biological crusts and natural desert pavement form over decades to centuries, their destruction can cause long-term problems. In addition, OHVs create noise pollution (Brattstrom and Bondello 1983). Exposure to the low frequency noise produced by OHVs results in significant degeneration of the central auditory system and increased mortality in species such as kangaroo rats, which have evolved sensitive hearing to detect predators (McGinn and Faddis 1997). Studies have demonstrated that reptiles, small mammals, and plants have reduced density and biomass in OHV use areas (e.g., Bury et al. 1977, Lathrop 1983, Groom et al. 2007).

Creation of undesignated routes through repeated unregulated use of public land is a common occurrence, leading to destruction and fragmentation of otherwise intact habitat. Due to the difficulties of regulating a widespread activity in a vast landscape, the potential for OHV trespass and inappropriate OHV use is huge. Even where public lands managers have designated areas for open, trail only, and special uses, protection of conservation targets is not enhanced. Insufficient enforcement and inadequate rider education remain huge problems that must be overcome before public lands are protected from destruction by OHV use.

5.1.5 Agriculture

Farming results in a number of direct threats to natural systems and native species in the Mojave Desert. Agriculture necessitates the removal of native vegetation, causing a loss of habitat for native plants and animals. Tillage results in the destruction of soil biological crusts, which destabilizes soil and makes it vulnerable to erosion by wind and water. The disruption of soils often facilitates the growth of non-native invasive plants, which can grow quickly and outcompete native plants. Use of fertilizers and production of manure in dairying operations can elevate the nutrient content of agricultural soils, further encouraging the growth of weeds. Abandoned agricultural fields do not necessarily return to native vegetation, as it is difficult for native species to become reestablished in areas dominated by non-native invasive plant species.

Some types of agriculture, such as alfalfa farming, require large amounts of water. If groundwater aquifers are tapped for this purpose, farming can lead to a drop in groundwater levels and a full suite of deleterious effects to water-dependent species (Section 5.1.3). As an example, groundwater pumping for agricultural purposes in the Ash Meadows area threatened the endangered Devil's Hole pupfish with extinction in the late 1960s to early 1970s. This eventually led to a landmark Supreme Court decision in 1976 (Cappaert vs. U.S.), which recognized the priority of a federal reserved water right, created when Devil's Hole was originally added to Death Valley National Monument, over subsequent state water rights (NPS 2010). In addition to depleting water resources, irrigation of tilled and/or fertilized fields can result in the contamination of waterways, causing negative consequences for aquatic species downstream of farms. Various farming practices such as fertilization, burning, and dairy operations can lead to emissions of airborne pollutants, which can negatively impact conservation targets (Section 5.3).

Despite the threats to biodiversity caused by agricultural practices, it is important to note that some native species can benefit from farming. Irrigated crops can provide cover, nesting habitat, forage, migratory stopovers, and/or hunting opportunities for some species of native birds, including hawks, ibises, plovers, and Burrowing Owls. In this way, agriculture can sometimes provide greater conservation value for some species than other types of human land use.

5.1.6 Livestock Grazing

The grazing of livestock in the Mojave Desert occurs both on privately owned land and on several large livestock allotments located on BLM and U.S. Forest Service lands. Livestock grazing results in well-documented impacts that can threaten conservation targets. Given the history of livestock grazing in the desert, many of these impacts have been occurring for over a century. In some locations, where allotments have been retired, recovery is underway. At other sites, intense grazing over many decades resulted in severely-degraded landscapes with little evidence of recovery of native plants and animals to date.

Direct impacts of grazing by cattle, sheep, horses, or feral burros include removal of native vegetation. The degree to which vegetation is removed depends on how the grazing is managed, but it is largely uncontrolled in the case of herds of feral horses and burros, many of which are located in Nevada. If not properly managed, grazing can greatly alter plant cover, biomass, composition, and structure of native vegetation communities; impact sensitive plants and native species that rely on them; and cause extensive erosion and damage to sensitive soils. Soil damage can, in turn, impede nutrient cycling, such as nitrogen fixation by soil biological crusts (Belnap et al. 1994. Soils disturbed by hooved ungulates are vulnerable to invasion by non-native plants, which can, in turn, promote fire. Modification of native vegetation communities can impact terrestrial and aquatic animal species, and trampling can collapse small mammal and reptile burrows.

Although the negative impacts of overgrazing have long been recognized (Bentley 1989, cited in Lovich and Bainbridge 1999), there may be cases where limited and selective grazing provides the only economically feasible tool available for the control of invasive non-native species. Certainly, the risks and benefits of livestock grazing depend on management protocols and the setting in which grazing occurs, and on the precipitation and other weather conditions before, during and after grazing. For this reason, grazing on public lands has been judged to be a major Federal action requiring an environmental impact statement mandated by the NEPA (BLM 1999).

The impact of livestock grazing on desert environments is not fully understood, because of the lack of long-term studies and the rarity of undisturbed “control” sites (Lovich and Bainbridge 1999). Desert environments where forage and water are naturally limited may be especially sensitive to cattle grazing. In arid desert environments, cattle depend on troughs and other artificial water sources for survival. These artificial water sources can facilitate the range expansion of native predators (such as Ravens or coyotes), allowing them to persist in locations where they otherwise could not survive, and thus to prey on native animals they otherwise would not be able to reach. Roads that are cut to supply and service livestock infrastructure (fences, corrals, troughs, pumps, etc.) fragment and degrade patches of native vegetation.

Where livestock have access to riparian habitat, creekside congregation of herds can alter stream channel morphology, water quality and quantity, and the structure of riparian soils (Kauffman and Krueger 1984; Platts 1981, quoted in Fleischner 1994). Because riparian systems are a rare habitat type in the Mojave Desert and support a large component of the desert’s biodiversity (Section 3.1), concentration of cattle in these areas can magnify the negative impacts of grazing. Research in the western Mojave Desert has demonstrated that protection of riparian areas from disturbances such as livestock grazing and OHV use, through installation of protective fencing, can result in measurable improvements in vegetation biomass, seed biomass, cover of perennial shrubs, and rodent density and diversity (Brooks 1995).

5.1.7 Mining

Mining has occurred in the Mojave Desert for over a century. Historically, mines were much smaller than many of the open-pit sites operating today. Over time, land in the Mojave Desert Ecoregion has been mined for borates, talc, copper, lead, zinc, coal, calcite, tungsten, strontium, uranium, precious metals such as gold and silver, gem quality non-metals, and building materials such as sand, gypsum, cinders, decorative rock, and gravel (BLM 1999, California State Parks

2005). All of these activities lead to surface disturbances, and result in damage to desert soils and destroy fragile soil biological crusts, leading to erosion and negative consequences for water and air quality. Strip and open pit mining are the most visibly destructive to terrestrial habitat. Open-pit mines provide ideal sites for invasive non-native plants. Many mining operations require huge amounts of water for processing (millions of gallons daily), which can also impact the local water availability if groundwater overdraft occurs. In addition, mines, such as those for gold, may also be significant sources of pollution if they use cyanide or mercury processing. Gravel and sand mining that occurs in desert washes, mountain foothills, and alluvial fans can severely alter the natural hydrology of a site, leading to changes in the infiltration of water into groundwater aquifers. Mining of active materials contributes to high levels of fugitive dust and airborne toxicants (Chaffee and Berry 2006). Additionally, after these material sites have "played out" they are left behind as depressions in the landscape with altered soil morphology often serving as ideal nursery sites for invasive weeds. Finally, access roads leading to mines destroy and fragment habitat, and lead to a variety of problems detailed above.

5.1.8 Military Activities

Military training, maneuvers, and bombing practice can have a significant impact on conservation targets. Data from U.S. Fish and Wildlife Service records through 1996 indicated that nationwide, 4% of federally-listed species are harmed by military activities (Wilcove *et al.* 2000). Military training and maneuvers conducted in the Mojave Desert have increased in recent years as the U.S. Armed Forces prepare for engagements in the deserts of the Middle East and central Asia (Figure 5-6). At least one species, the desert tortoise, has suffered high mortality after being relocated during the expansion of Ft. Irwin in California. Despite these negative effects, lands owned and managed by the military can vary a great deal in conservation value, and some species can benefit from the lack of public access imposed on military lands. Efforts to buffer military installations from encroaching developments can also have important conservation co-benefits.

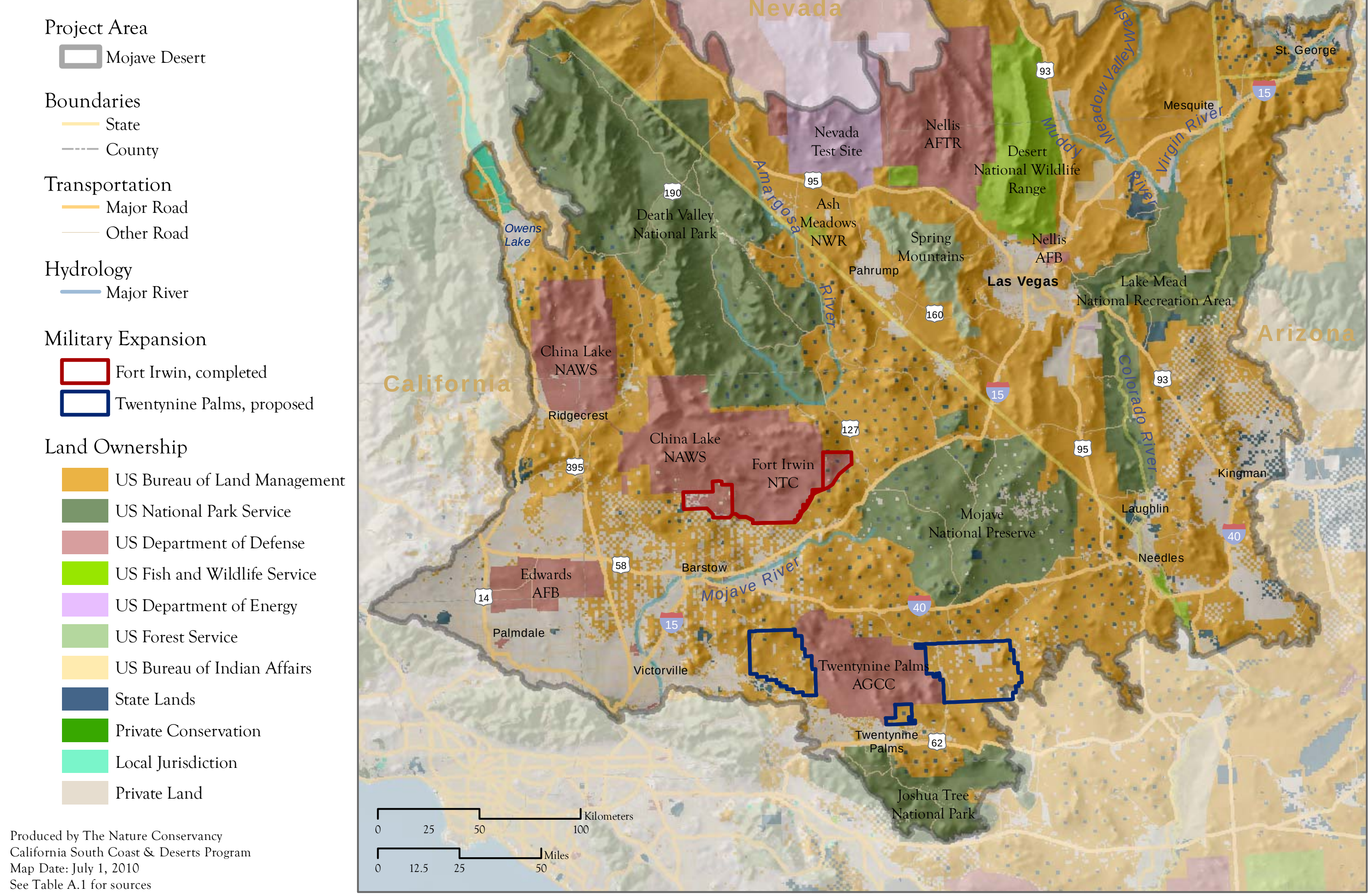
5.1.9 Waste Disposal

The desert has long been a final resting place for waste and other materials that are no longer wanted. Landfills and open dumps are filled not only with local municipal waste, but also industrial materials, mining slag, construction debris, sewage sludge residue, radioactive materials, and municipal waste from cities throughout the Southwest. While the arid environment of the desert ensures that the waste sites are relatively inert, it also results in slow decomposition, and historic trash heaps are easy to find.

Waste disposal in the desert has many consequences, including direct destruction of habitat, fragmentation by roads, and contamination of soils, air, and groundwater. Waste disposal sites are typically unfit for other uses after they have served their storage purpose. In addition, the edible waste in uncovered landfills subsidizes native predators such as coyotes and Ravens, increasing their populations and causing considerable damage to prey species such as rodents and reptiles, including desert tortoise hatchlings. Such subsidized predation of desert tortoises was identified as one of the major sources of population decline in the species' recovery plan (USFWS 1994).

Figure 5-6

Military Expansion



5.2 Invasive Non-native Species

Invasive non-native species come in many taxonomic forms, including plants, mammals, fish, insects, amphibians, and reptiles. These non-native species have multiple negative impacts, direct and indirect, because they can modify native plant and animal communities, endanger native species, and alter ecological processes including hydrology and fire regimes. They can also threaten agricultural crops and harm human health. Next to habitat loss, non-native species are considered the second most common cause of U.S. species being listed as threatened or endangered (Randall 1996). It is beyond the scope of this assessment to discuss all the potential invasive non-native species that threaten the Mojave Desert. Rather, we introduce some of the most common invasive species in the ecoregion, address their general impacts, and discuss in more detail one of the most problematic and difficult-to-control plant invaders.

A number of non-native plant species are well established in the Mojave Desert, generally widespread, and of great concern to conservation biologists. Some were introduced through both purposeful planting and others were brought in accidentally. Many non-native plant species spread and become invasive after human activities modify the environment in ways that provide non-natives with a competitive advantage. Soil disturbance, changes in soil fauna, or other alterations to the soil often make conditions more favorable for non-native plant species. Global climate change may benefit invasive species because increased levels of atmospheric CO_2 are known to enhance production of species such as non-native annual grasses and forbs (Brooks and Berry 1999). In addition, nitrogen inputs from anthropogenic air pollutants can benefit non-native plants where they occur. Even small increases in nitrogen have been associated with increased density and biomass of non-natives (Brooks 2003, Section 5.3). The most prominent plant invaders in the Mojave Desert Ecoregion can be assigned to the following three broad categories, each of which has a different invasion pattern, though all pose serious threats to biodiversity:

1. Grasses: Non-native grass species that are highly invasive in the Mojave include red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), ripgut brome (*Bromus diandrus*), and schismus (*Schismus barbatus*). These species can spread rapidly, increase plant cover, and increase the frequency and size of fires. This so-called grass-fire cycle has transformed native shrub-dominated plant communities into primarily grass-dominated landscapes in some parts of the Mojave Desert.
2. Forbs: Invasive non-native forbs can suppress and out-compete native annual plants, may deplete soils of important nutrients and decrease soil moisture, and can increase fire frequency and size. Sahara mustard (*Brassica tournefortii*) and Russian thistle (*Salsola tragus*) are two of the most common invasive forbs in the Mojave Desert Ecoregion.
3. Riparian Shrubs: Invasive non-native riparian shrub species may change hydrological processes, outcompete native riparian plant communities, and alter habitat for a number of riparian-dependent animal species. The most common riparian invader in the Mojave Desert is tamarisk (*Tamarix spp.*).

Tamaris is perhaps one of the most problematic and difficult to control invaders. Though it may have been introduced into North America by Spaniards, tamarisk didn't became widely distributed until the 1800s, when it was planted as an ornamental plant, as windbreaks, and for shade and riverbank stabilization; it is now found throughout nearly all western and southwestern states (Lovich 2000). Tamarisk impacts native wildlife by changing the community composition of forage plants, changing the structure of native riparian systems, and causing surface water sources to dry up. It has, for example, been reported to have negative impacts on native pupfish species (Kennedy et al. 2005). Along streambeds, tamarisk often spreads from the edges to the middle, thereby narrowing the stream channel and increasing the potential for flood damage (California State Parks 2005). It has been found to alter the breakdown of organic materials in desert streams (Kennedy and Hobbie 2004), and it exudes salt above and below the ground that can inhibit the establishment of other plants (Sudbrock 1993). Tamarisk tolerates a wide range of soil types, but is most commonly found in soils that are seasonally saturated (Brotherson and Field 1987). A mature saltcedar can produce hundreds of thousands of seeds that are easily dispersed by wind and water (Sudbrock 1993). Seeds have been known to germinate while still floating on water, and seedlings may grow up to a foot per month in early spring (Sudbrock 1993). Areas most threatened by tamarisk include riparian habitats, washes, and playas (Figure 2-2; Section 2.5). Efforts to slow the advance of tamarisk have been complicated by the fact that the Southwestern Willow Flycatcher (*Empidonax extimus trailii*), uses tamarisk stands for nesting along the Colorado River and its tributaries (USGS 2009a). In June, 2010 the USDA released a memo stating that is will not permit the interstate movement of the saltcedar leaf beetle introduced as a biological control agent for tamarisk until "endangered species issues are resolved." This highlights one of the weaknesses of single-species focus in conservation management.

The Mojave Desert is also threatened by a number of non-native, invasive animal species. Some of these, such as feral goats, horses, and burros are large herbivores that were historically managed. Although free-ranging goats, sheep, and horses have been removed from most locations in the Mojave Desert, feral burro populations still persist. Wild burros can have similar environmental impacts as domestic livestock (Section 5.1.6). However, aspects of their behavior and physiology likely make their potential impacts on the desert environment unique when compared to cattle. Although both species are dependent on water, the digestive systems of burros differ from those of ruminant cattle, allowing them to go without water for longer time periods (Dill et al. 1980). Burros are also more agile and better able to negotiate rugged terrain. Both of these attributes make it likely that burros will disperse greater distances and have a wider impact on desert lands. In the Grand Canyon, long-term grazing by burros was reported to cause the near extinction of burrobush, which acts as an important "nurse plant" for other plants such as barrel cacti and saguaros (Webb and Bowers 1993). Loss of burrobush due to grazing was hypothesized to have impeded recruitment of barrel cacti, causing an observed discontinuity in population age structure (Bowers 1997).

Burros may be particularly damaging to desert riparian habitat, where they frequently congregate, by increasing sedimentation and nitrogen levels in water sources and competing for water with native wildlife such as bighorn sheep (Bunn et al. 2007). Indeed, studies have found evidence of competition between burros and bighorn sheep in desert environments (Marshal et al. 2008). Burros are protected under the 1971 Wild Horse and Burro Act, and although target management numbers were established by the Bureau of Land Management prior to 1980 as part of an effort to limit their numbers, current population sizes still exceed established targets (BLM 1999, Bunn et al. 2007).

Other non-native animals in the Mojave Desert Ecoregion include bullfrogs (*Rana catesbeiana*), crayfish (*Procambarus clarkia*), and western mosquitofish (*Gambusia affinis*), which negatively impact native aquatic species (USFWS 1986, Ivanyi 2000, California State Parks 2005, USGS 2010). Terrestrial invaders include European starlings (*Sturnus vulgaris*), wild turkeys (*Meleagris gallopavo*), honeybees (*Apis mellifera*), and brownheaded cowbirds (*Molothrus ater*). All of these have had some level of impact on native species and their habitat via competition, predation, or parasitism. Other non-native invasive animals, often associated with urban areas and other human-dominated landscapes and documented to threaten native species, include domestic dogs (*Canis lupus familiaris*) and cats (*Felis catus*), Argentine ants (*Linepithema humile*) (Holway 2005), and fire ants (Forys et al. 2002). The introduction and spread of these invasive animals are facilitated by development and fragmentation, but many of them can spread far beyond these disturbed areas.

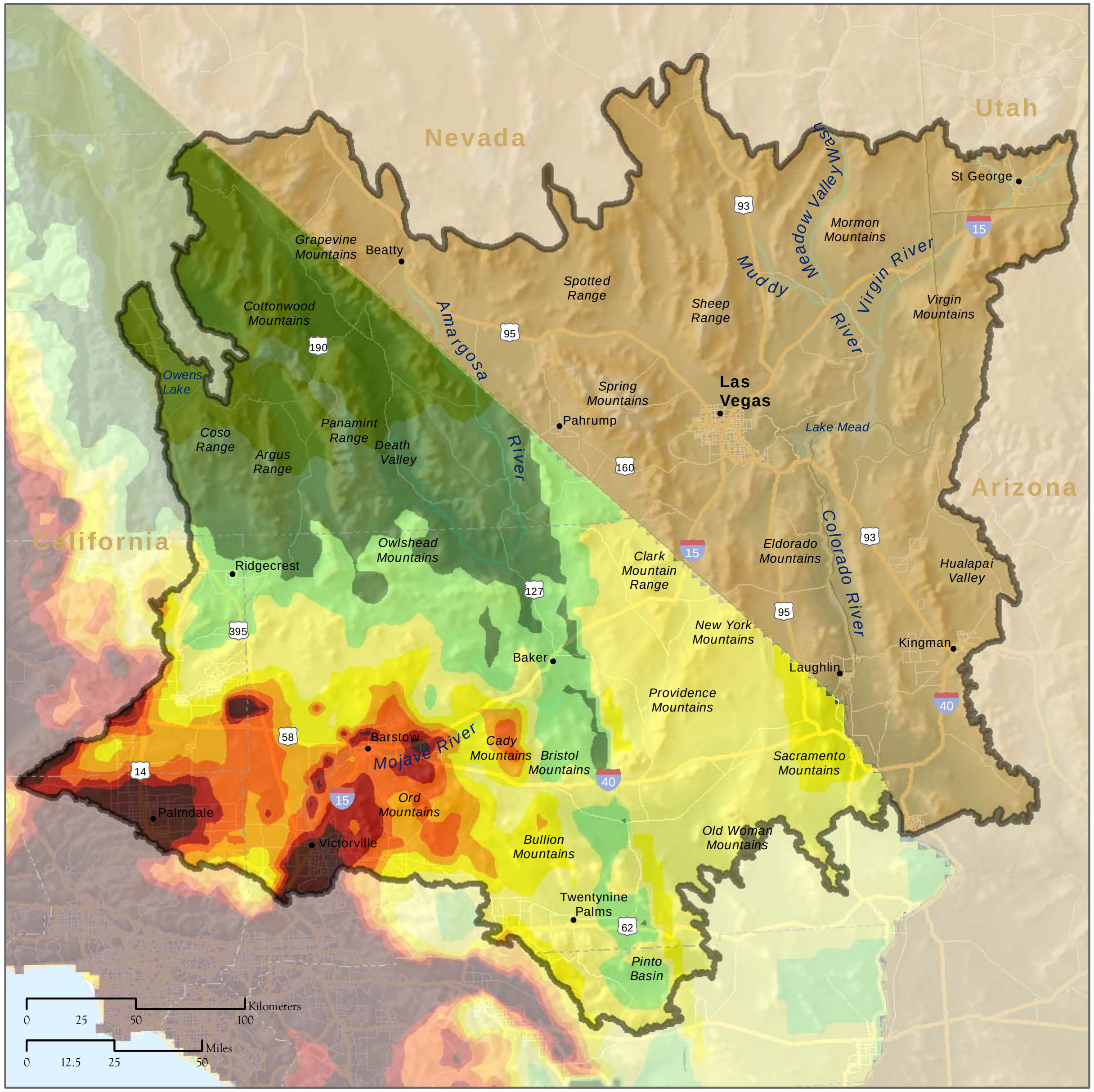
5.3 Deposition of Air Pollutants

Increasing amounts of nitrogen entering the atmosphere from automobiles, agriculture, and industrial emissions have, in turn, increased the amount of nitrogen deposited across the landscape (i.e., nitrogen deposition). Nitrogen deposition continues to increase and is recognized as a serious threat to natural ecosystems and biodiversity (Fenn et al. 2003). Nitrogen deposition can negatively impact native desert ecosystems through three primary mechanisms: 1) direct toxicity to plants (e.g., 100% of sagebrush seedlings died when grown experimentally in soils with nitrogen levels similar to soil levels measured near Riverside, California), 2) changes in composition of native plants, and 3) promoting invasive species (Weiss 2006, Brooks 2003, Section 5.2). Elevated levels of nitrogen-containing pollutants also impact air quality and contribute to impaired visibility, thereby impacting the aesthetic value of open spaces and wildlands (Fenn et al. 2003). Because deserts are naturally nitrogen limited, even small additions of nitrogen may benefit non-native plants (Brooks and Berry 1999, Brooks 2003), and very small increases in available nitrogen levels, such as 3.2 g m^{-2} yr^{-1}, can increase non-native plants and decrease native annual plants (Brooks 2003). Nitrogen deposition rates have been reported to be as high as 4.5 g m^{-2} yr^{-1} in the Los Angeles Basin (Brooks and Berry 1999). Nitrogen deposition therefore creates a risk to desert vegetation communities such as desert scrub, sand dunes, and alkali sinks (Weiss 2006), and contributes indirectly to altered fire regimes, which further promote type conversion, loss of native plant species, and negative impacts on native animal species due to changes in habitat quality (Section 5.4). Of 11 western states tested, California had by far the highest nitrogen deposition levels (Fenn et al. 2003).

Additional research and monitoring of nitrogen deposition is needed within the Mojave Desert Ecoregion (Adams 2003, Fenn et al. 2003); however, several monitoring studies suggest that the Western Mojave Desert is experiencing especially high deposition rates (Tonnensen et al. 2007). Model results suggest that areas adjacent to urban areas in southern California represented one of several hotspots for total nitrogen deposition (Fenn et al. 2003, Weiss 2006, Tonnensen 2007; Figure 5-7). In western states, primary nitrogen emission sources are, in declining order of

Figure 5-7

Nitrogen Deposition (CA)



Project Area

Mojave Desert

Boundaries

State

County

Transportation

Major Road

Other Road

Hydrology

Major River

Nitrogen Deposition

kg N / ha / yr

- less than 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 7
- 7 to 8
- more than 8

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California South Coast & Deserts Program
Map Date: July 1, 2010
Sources: Weiss 2006, Tonnesson et al 2007, CMAQ Model Dataset 2009, see Table A-1 for details.

importance, transportation, agriculture, industry, and power plants. An unknown amount of nitrogen comes across the Pacific Ocean from Southeast Asia (Fenn et al. 2003). Deposition is likely highest downwind of large urban areas, but may also be high downwind of agricultural sources (Tonnesen et al. 2007). In most parts of the western United States, deposition due to both transportation and agriculture has increased. However, transportation sources are projected to decrease slightly in coming years due to new emission standards, while agricultural sources, which are not regulated, are expected to increase (Fenn et al. 2003).

While airborne nitrogen acts as a fertilizer when it hits the ground, other airborne pollutants are more accurately described as contaminants. Four state-based government entities regulate the emission of these contaminants in the Mojave Desert. In the California portion of the desert, the California Air Resources Board controls emissions of airborne pollutants. The Clark County Department of Air Quality Management and the Nevada Bureau of Air Pollution Control implement air pollution control requirements in the Mojave Desert of Nevada, and the Air Quality Division of the Arizona Department of Environmental Quality has this responsibility in Arizona. The Utah Air Quality Board enacts rules pertaining to air pollutants in Utah's Mojave Desert. Airborne pollutants include gaseous, liquid, and particulate emissions—everything from fugitive dust to heavy metals. Mining, metal smelting, construction, transportation, electricity production, and a host of other activities release various toxicants into the atmosphere. These airborne pollutants can negatively impact conservation targets because many of the compounds contained in these emissions are toxic to plants and animals. Cutaneous dyskeratosis, a shell disease in desert tortoise, is suspected to be caused by or exacerbated by these toxicants (Berry et al. 2002). Water-dependent species are particularly susceptible to harm, as toxicants can be washed across the surface of the land and accumulate in rivers and streams when it rains.

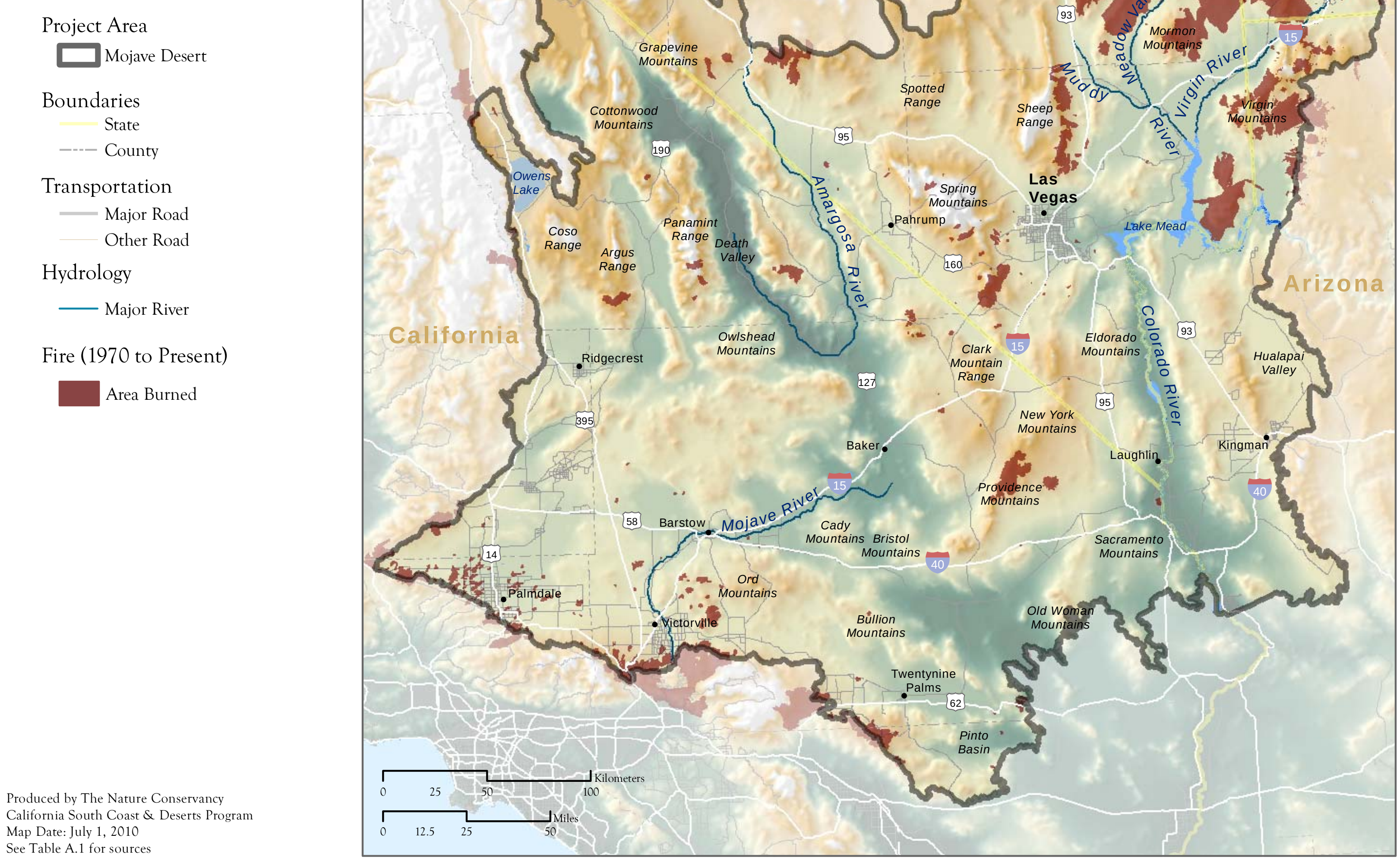
5.4 Modified Fire Regimes

Fire regimes in the Mojave Desert Ecoregion have been altered by two primary factors: increased ignition rates, and an increase in biomass (fuels). Although fires in the desert were historically caused by lightning, the increase in ignition rates between 1980 and 1995 was due to an increase in human-caused fires (Brooks and Esque 2002; Figure 5-8). Increased amounts of fuels, which can increase fire intensity and size, are mainly a result of invasions of non-native plant species. As described in Section 3.6.4., most of the desert's natural vegetation communities, including the dominant creosote bush scrub communities, are not considered to be fire-adapted. Historically, fires in these vegetation communities were rare and did not travel great distances because of limited biomass (fuel), wide spacing between plants, and sparse ground cover (Humphrey 1949, Rogers 1986, Brown and Minnich 1986). Today, however, invasions of exotic plants, in particular non-native grasses and Sahara mustard, provide additional biomass that often forms a continuous blanket of flammable vegetation that allows fires to spread more readily.

Increased ignition rates and fuels have resulted in more frequent and more extensive fires. In the Mojave Desert, estimates of historical inter-fire intervals range from 30 years to more than 1,000 years, while current inter-fire intervals are as short as five years in some areas (Brooks et al. 1999,

Figure 5-8

Fires in the Mojave Desert



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Map Date: July 1, 2010
See Table A.1 for sources

Edith Allen pers. comm. 2010). This change in fire frequency has dramatically increased the risk to long-lived perennials such as creosote bush and Joshua trees, because they have low post-fire recovery rates (Brown and Minnich 1986). It can also result in permanent changes or "type-conversion" of native vegetation communities, which are replaced by exotic plant species (Brooks et al. 1999), or significantly reduce numbers of native of "nurse" plants, woody plants, and succulents (Alford et al. 2005, Bock and Block 2005). Increased fire frequency and size can negatively impact native animals, such as desert tortoise, by killing them, reducing the quality of their habitat, (Brooks et al. 1999) and altering species composition of the vegetation (Simons 1991, Esque et al. 2003).

Although fires are a natural process and can play beneficial roles in some ecosystems, such as chaparral and forests, this is not the case in most of the Mojave Desert's vegetation communities, and it has been suggested that in these areas risk of fire should be reduced through removal of exotic plants and suppression of most fires (Brooks et al. 1999, Brooks and Esque 2002). Bock and Block (2005) echoed this suggestion and stated that although prescribed fires should be increased in some regions of the southwestern United States, desert scrub and riparian woodlands are an exception due to the historical rarity of fire and the susceptibility of native species to damage by it. Measures to maintain and restore natural fire regimes are therefore important conservation actions in the Mojave Desert (Mojave Desert Land Trust 2006). Mapping altered fire regimes was beyond the scope of this assessment; however, it is likely that altered fire regimes are linked to the presence of roads and urban development and the presence of non-native, invasive plant species.

5.5 Collection of Plants and Animals

A variety of desert species are collected for pets, food, or commercial trade. While a few species are common and widespread enough that current rates of collection pose little problem, significant declines in populations of some species have been attributed to collection. The relative affluence of North Americans and Europeans has created a huge demand for wild-caught animals for the pet trade with gila monsters (*Heloderma suspectum*) fetching up to $10,000 per individual on foreign markets. The internet has spurred the growth of trade and facilitated the worldwide sale of Mojave Desert species. Few species are protected from collection, and wild-caught animals can easily be added to stocks of captive bred individuals and sold as "captive bred" to unknowing consumers (Pianka and Vitt 2003).

Chuckwalla
(Photograph by James Moore)

Several Mojave Desert reptile species are commonly sought-after, collected, and sold as pets. Horned lizards (*Phrynosoma spp.*), chuckwallas (*Sauromalus obesus)*, collared lizards (*Crotaphytus collaris*), and desert iguanas (*Dipsosaurus dorsalis)* are particularly sought after in the commercial collection trade. Collectors in Nevada have unlimited bag limits while paying only a $100 license fee to the State Department of Wildlife. The desert tortoise (*Gopherus agassizii*) used to be a popularly collected animal in the Mojave and Sonoran deserts, but has been protected by various state and federal regulations since the mid-1980s. The desert tortoise is found in California, Nevada, Utah, and Arizona and all of the states require permits for the possession of this federally-listed threatened species. In addition, it is listed in Appendix II of CITES, which requires permits for collection or scientific use in international trade (Leuteritz and Ekbia 2008). Despite these regulations, the desert tortoise is still illegally collected when encountered along roads or around newly constructed housing developments on the edge of its habitat.

Many Mojave Desert plant species desired by gardeners and landscapers are extremely slow-growing or difficult to start from seed; this has incentivized collection of large specimens from the wild as an alternative to nursery propagation. The collection of cactus species is of particular concern. Because cacti typically grow slowly and have low reproductive rates, the occasional loss of a few plants to collecting can pose a significant threat to a population (USFWS 1985), particularly if it is naturally small or sparse.

5.6 Disease

Disease occurs naturally in ecological systems and plays an important role in regulating populations of species. However, a significant increase in rates of infected individuals, a rise in the virulence of a disease, a shift in location of disease outbreaks, or a rise in mortality attributable to a disease can occur when environmental conditions change in ways that promote disease vectors or when other threats weaken the immune response of individuals. The extreme heat and aridity of the Mojave Desert has served to block many disease vectors, but alterations in temperature and rainfall due to global climate change may allow some diseases to gain a foothold in new locations.

A thorough review of the diseases afflicting Mojave Desert species and the factors that contribute to these diseases is beyond the scope of this assessment. However, one notable illness of conservation concern is Upper Respiratory Tract Disease (URTD), which has contributed significantly to desert tortoise population declines. This disease is characterized by mild to severe nasal discharge, puffy eyelids, and dullness to the skin and scutes. Caused by a *Mycoplasma*, URTD is commonly found in captive tortoises, and spreads easily to uninfected individuals (Jacobson et al. 1991). In the Desert Tortoise Natural Area in the West Mojave, long-term studies showed that over 70% of adult tortoises died between 1988 and 1992 (Kristin Berry pers. comm., cited by Jacobson 1992). The disease was noted in tortoises throughout the Mojave Desert. Tortoises may become susceptible to the disease through other stresses such as poor nutrition, drought, and release of URTD-infected captive tortoises into the wild (Jacobson 1992). In this way, the disease contributes to higher rates of desert tortoise mortality than would otherwise occur. While the symptoms of URTD may be treated, no cure has been found.

5.7 Climate Change

The burning of fossil fuels such as coal and oil, along with extensive deforestation throughout the world, has resulted in increased concentrations of heat-trapping greenhouse gases in the Earth's atmosphere. The heat trapped by gases such as carbon dioxide and methane has caused a gradual increase in global temperatures. It is anticipated that, along with increased temperatures, the earth will experience additional climatic changes such as more intense heat waves, new wind patterns, worsening drought in some areas, and more precipitation in others (IPPC 2007).

Although it is not precisely known how much the Earth's climate will change, or what the exact effects will be, it has been predicted that 20-30 percent of plant and animal species will be at increased risk of extinction (United Nations Environment Programme 2008). Increased risk of extinction may result from vegetation community changes due to altered precipitation and temperature patterns, disruption of pollinator-host plant relationships (such as relationships between butterflies and their host plants), reduction or alteration of water-related habitats, and changes to processes such as wildfires, flooding, disease, and pest outbreaks (Field et al. 1999).

Due to the sensitive nature of desert communities, warming of ambient air temperatures and stream temperatures could increase heat stress for both terrestrial and aquatic species. Patterns of future precipitation are highly uncertain; nevertheless warming alone may increase evapotranspiration rates leading to increased drought stress and decreased freshwater availability.

Current climate projections for California's deserts are severe, with the typical summer maximum temperatures by the end of the century reaching levels that are hotter than the most extreme year documented in the last 100 years (Figure 5-9). The majority of global climate models also predict the Mojave Desert will become even more arid, losing an average of 1.6 inches of precious rain each year (Figure 5-9). These changes in climate are also likely to exacerbate other threats, for example by promoting invasions and spread of non-native, disturbance-tolerant, and fire-promoting plants, and increasing the frequency and intensity of fire in areas of the desert that have historically not experienced fire and whose species are not adapted to it (Rogers 1986, Brooks et al. 1999).

Changes in climate that could be of great importance in the Mojave Desert, such as the timing, frequency, and yield of precipitation events, are especially difficult to predict. However, with respect to general climate impacts we defer to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and proceed with the understanding that: 1) warming is unequivocal and will continue even if greenhouse gas emissions stabilize, 2) natural communities are already responding to recent changes in climate through shifts in distributions and phenology, changes in community composition, and local extirpations, 3) future trajectories of precipitation are less certain than temperature increases, 4) extreme weather will likely increase, but rarity of such events impairs modeling, and 5) climate change will likely exacerbate many existing threats, such as catastrophic wildfires, non-native species invasions, and disease (IPCC 2007).

Even subtle climate changes may have large impacts on desert ecosystems, where species are already living in extreme conditions of heat and aridity. Elevated temperatures and altered rainfall patterns may cause valuable water sources to dry up seasonally or altogether, and may alter stream flow and recharge of groundwater basins. Small changes in water temperature can influence dissolved oxygen levels and concentrations of dissolved salts and other toxins in water, which may reduce the viability of populations of desert pupfish (Gerking and Lee 1983) and other aquatic species.

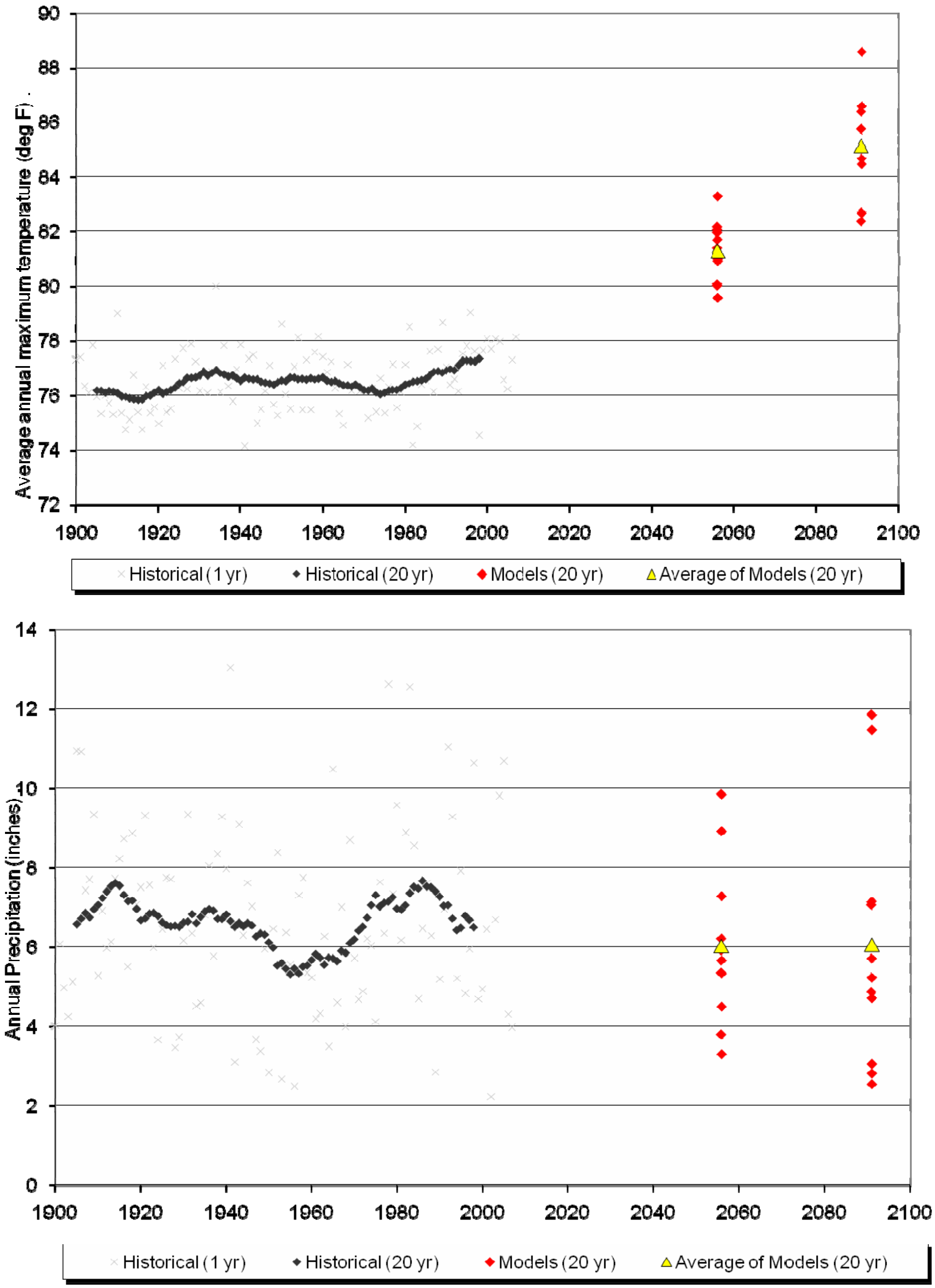


Figure 5-9 Climate Change Predictions for the Mojave Desert Ecoregion: Comparison of observed historical climate variables (one and twenty- year averages) and future projections (twenty-year averages) using the 11 General Circulation Models under the "A2" scenario, showing average annual maximum temperature (top) and annual precipitation (bottom).

Summer thunderstorms in the deserts may increase in number and/or intensity (Sheppard et al. 2002), which could cause significant changes in plant phenology, flooding patterns, and fire frequency. Other studies suggest that climate change will alter the distribution of grasslands in relation to desert vegetation communities; however the direction of this change depends on still uncertain precipitation scenarios (Lenihan et al. 2006). Such vegetation changes will also likely have large influences on desert fire regimes (Section 5.4).

Changes in seasonal precipitation totals and patterns can impact a wide variety of plant species, because their growth is tied to seasonal patterns in precipitation (Weltzin et al. 2003). In addition, increased levels of atmospheric carbon dioxide may alter the competitive relationships between native and non-native species, through influences on plant productivity (Ziska 2008), while changes in fire regimes may promote invasion of non-native plants. Epps et al. (2004) found that populations of desert bighorn sheep living in lower, drier mountain ranges may be more susceptible to extirpation than those living in higher, moister mountain ranges. Thus, climate change could present a very real challenge to desert bighorn sheep populations, and probably numerous less-studied species that share their habitats. Plant and animal species may shift their distribution in response to climate change (Field et al. 1999) and recent studies have shown that species responses may vary considerably (Loarie et al. 2008)

Climate is just one of the factors that determine the distributions of plants, animals and other organisms. Often species distributions are constrained by predators, diseases, competitors, soils and/or nutrients as much, or more, than precipitation or temperature regimes. Nevertheless, in the Mojave Desert, we expect mean and extreme temperatures will increase, and as a result, soil moisture will decrease even if precipitation remains constant. If temperatures increase as projected, thermal and drought tolerances of many species may be exceeded in parts of, or across, their current ranges in the decades and centuries ahead. Because different species respond to changes in climate and other habitat factors differently and some may respond by moving in different directions or at different rates, we predict that species will not move as together in intact communities. Some communities with no analogues today may form in the centuries ahead, and some communities that are common today may fade out as their members move in different directions (Williams and Jackson 2007). The protection of a large network of core conservation areas connected by corridors and buffer areas will help ensure that species have the opportunity to move and track changes in climate and the distributions of other species on which they depend. On the other hand, fragmented landscapes may block such movements for some species, putting them at increased risk of extinction.

Given all the complexities and uncertainties inherent to climate change, modeling offers one inexpensive means of testing a wide range of future biodiversity scenarios based upon simplifying assumptions. The Nature Conservancy's California Climate Adaptation Team developed species distribution models for nine species of plants and animals in the Mojave Desert with the goal of identifying examples of potential future climate refugia in the ecoregion (The Nature Conservancy, unpublished data). Model projections support the hypothesis that species will move largely independent from one another as climate changes, resulting in species-specific refugia across the region. Our mid-century forecasts (2045-2065) fortunately identify potential climate refugia for almost all flora and fauna considered.

One key difficulty encountered by our modeling process was that current distributions of many Mojave flora and fauna are poorly described, in part because they often straddle borders between states and nations (Section 4.7.2). This will particularly challenge attempts to scale up this approach toward more comprehensive biodiversity forecasts including more than nine species. Often the rare and imperiled species distributions are well-described; however, those of many species that are common today but might be vulnerable to future changes in climate are not. Conservation practitioners urgently need more surveys of desert biota, suggesting a critical role for increased public-private partnerships and data sharing. As an example of how occurrence data gaps led to an attrition of species in our modeling process, we started by selecting 20 relatively common species for modeling. Of those 20, only nine species had sufficient range-wide observation data to generate models and of the nine, only four species had adequate observation data within the Mojave Desert Ecoregion to test the proportion of known occurrences today that are also projected to be future climate refugia. Furthermore, in terms of interpreting models to support conservation decisions, species distribution models appear best suited for identifying potential climate refugia within areas where species already occur today. Characterizing vulnerability in areas where climates are projected to change the most, however, will require an explicit understanding of species physiological tipping points and dispersal ability.

Mojave Yucca blooming in Chicago Valley with the Kingston Range in the background (Photograph by James Moore)

6 Results of the Assessment

6.1 Anthropogenic Disturbance

A key factor we used to evaluate conservation value was the level of anthropogenic disturbance, which represents the inverse suitability of a planning unit to contribute to the long-term conservation objectives; high disturbance indicates low suitability and vice versa. To calculate disturbance, we used existing data on roads, trails, and agricultural development to assess both the intensity of disturbance (e.g. dirt roads versus paved roads) and the percentage of each 259-hectare (one-square-mile) planning unit that was disturbed. We also visually surveyed recent imagery for the entire planning area to ensure that we captured recent forms of disturbance such as OHV trails that may not have been consistently included in data we used (see Appendix A for details). Geographic Information System (GIS) data for other threats including invasive plants, modified fire regimes, and nitrogen deposition were not readily available for portions of the ecoregion, thus precluding a quantitative assessment of the intensity of such threats or their distribution across the entire Mojave Desert Ecoregion.

Disturbance scores were high for much of the Western Mojave and the greater Las Vegas Valley area and smaller areas around Pahrump and Laughlin, Nevada; Kingman, Arizona; and St. George, Utah (Figure 6-1). On the other hand, our analysis revealed several large blocks with low levels of anthropogenic disturbance. Especially noteworthy is the large northwest to southeast trending band with low disturbance scores roughly paralleling and largely west of the California-Nevada border. This band extends from the northern reaches of Death Valley National Park south to Interstate 40 and beyond to the southern edge of the ecoregion with only a few fissures that are a consequence of roads. Other blocks with low disturbance occur north of Las Vegas, in the area encompassing Joshua Tree National Park, and the adjacent Pinto Basin southeast of Twentynine Palms, California (Figure 6-1).

6.2 Conservation Values

We classified each planning unit into one of four conservation value categories: Ecologically Core, Ecologically Intact, Moderately Degraded, and Highly Converted (Figure 6-2, Appendix A). Ecologically Core lands comprise 37.2% of the study area at 12.1 million acres[6] (4,940,409 hectares) and Ecologically Intact lands comprise another 48.7% at 16.0 million acres (6,474,006 hectares). Thus 85.9% of the Mojave Desert Ecoregion retains high conservation value.

Ecologically Core lands are relatively undisturbed, have known occurrences of conservation targets and contribute to meeting the assessment's quantitative conservation goals. They comprise a core network of lands that collectively capture the ecoregion's biological diversity within a minimal

[6] While the Mojave Desert Ecoregion covers 32.1 million acres (13,013,215 hectares), the planning area for this assessment included 32.8 million acres (13,286,509 hectares) because planning units on the perimeter extend beyond the Mojave Desert Ecoregion.

Figure 6-1

Anthropogenic Disturbance

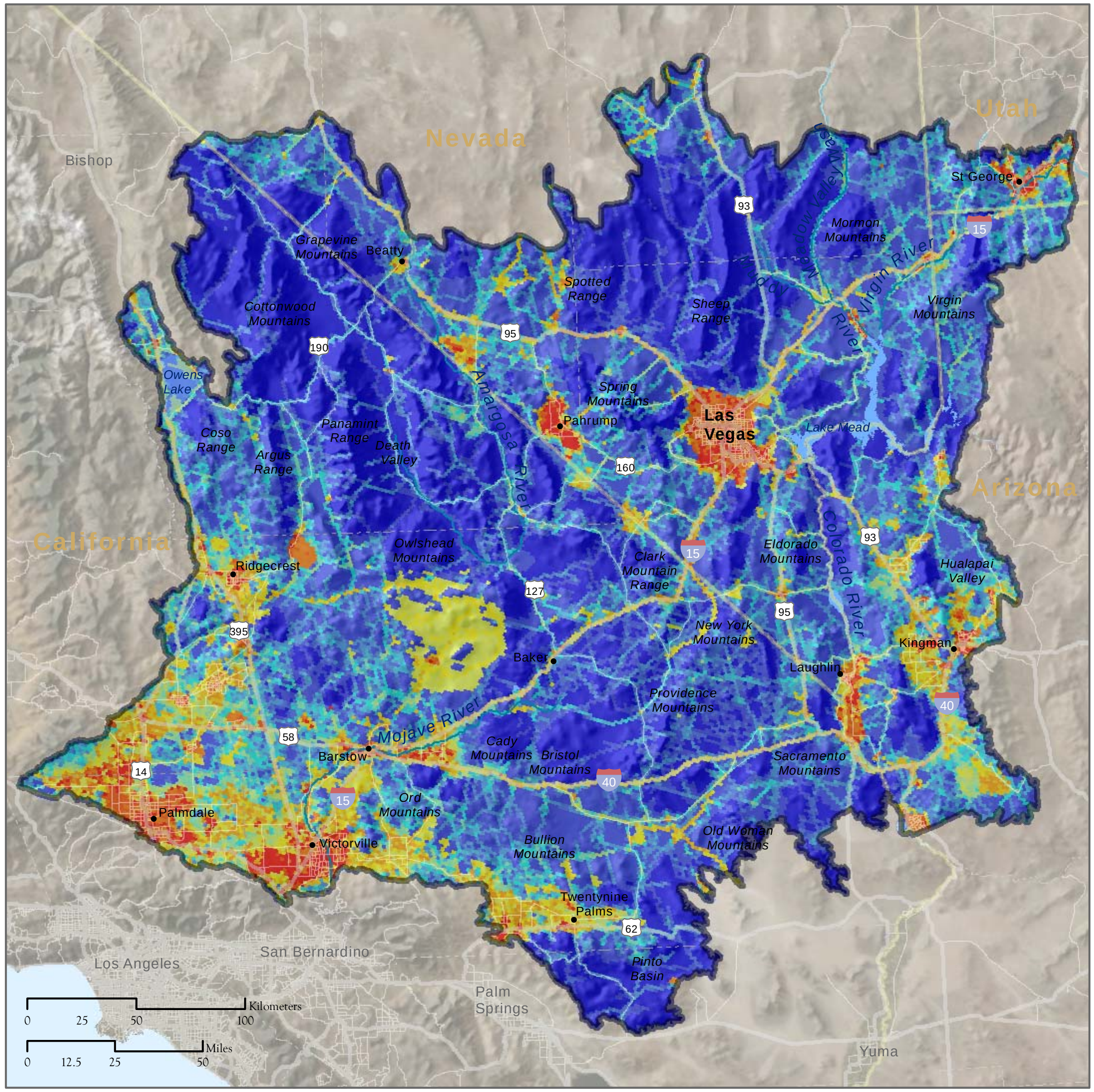
Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Major Road
- Other Road

Hydrology
- Major River

Anthropogenic Disturbance Score
- Very Low
- Low
- Medium
- High
- Very High



Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Figure 6-2

Mojave Desert Conservation Value

Project Area

Mojave Desert

Conservation Value

Ecologically Core

Land with low levels of anthropogenic disturbance which support conservation targets and whose protection is critical for the long-term conservation of the ecoregion's biological diversity

Ecologically Intact

Land with low levels of anthropogenic disturbance or which supports conservation targets and which requires a level of protection that will enable it to continue to support ecological processes and provide connectivity

Moderately Degraded

Land fragmented by roads, off-road-vehicle trails or in close proximity to urban, agricultural and other developments

Highly Converted

Land in urban and agricultural areas that is fragmented and most impacted by human uses

Boundaries

State

County

Transportation

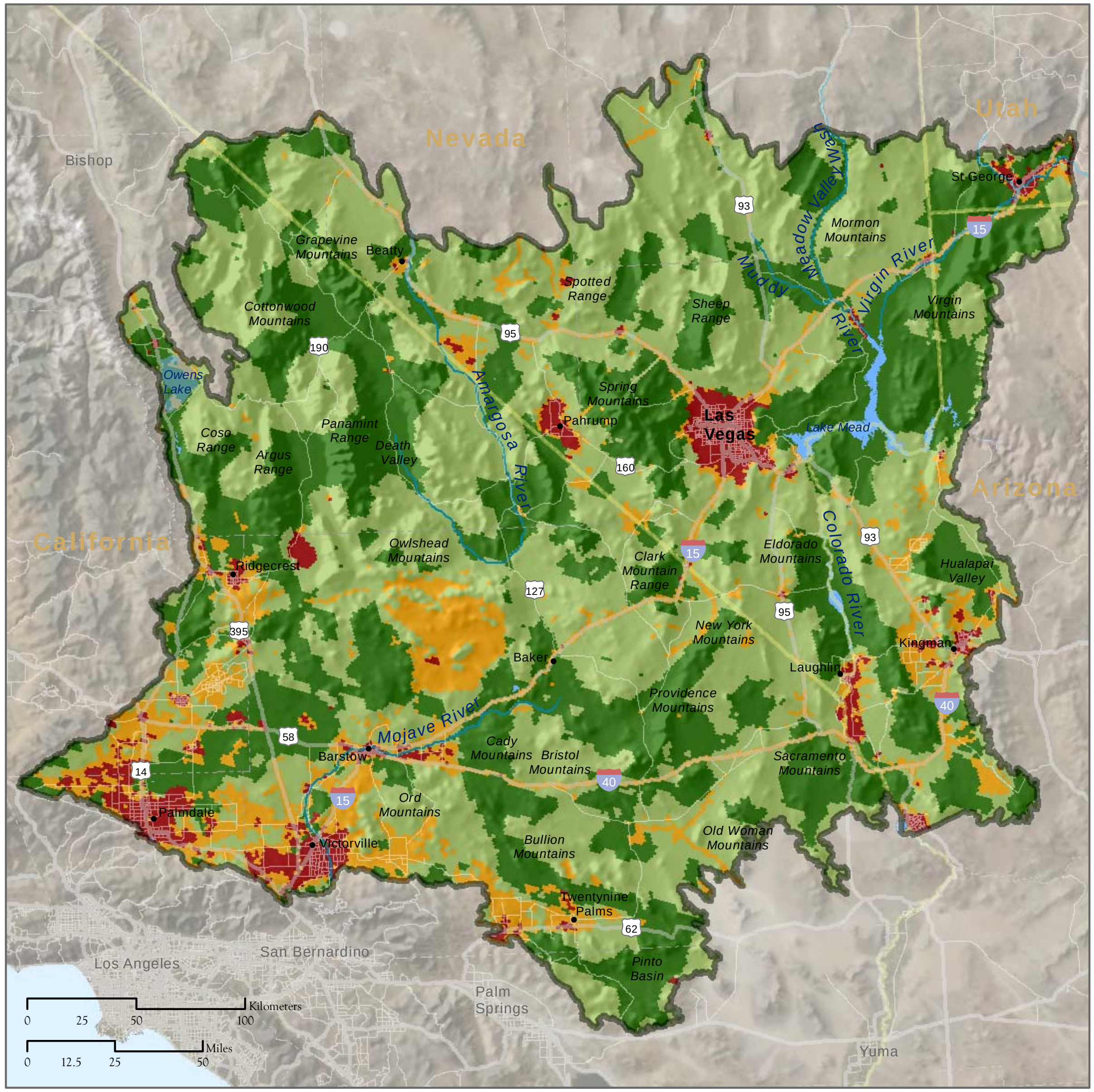
Major Road

Other Road

Hydrology

Major River

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources



area and whose protection is critical to safeguard the long-term persistence of the conservation targets.

Most Ecologically Intact lands are functionally equivalent to Ecologically Core lands and may contain many of the same conservation targets, including sensitive species. They may have been classified as Ecologically Intact rather than Ecologically Core, because:

- they support more widespread ecological systems;
- they contain conservation targets for which the conservation goals were already met in Ecologically Core lands; or
- they are at higher risk of degradation due to their proximity to threats such as residential development or designated OHV recreation areas.

While Ecologically Intact lands are of high conservation value in and of themselves, they also enhance the value of Ecologically Core lands, connecting them with one another and buffering them from disturbance and fragmentation. Ecologically Intact lands require levels of protection that will allow them to continue to play these roles, retain their landscape integrity, support ecological processes, and provide habitat for conservation targets.

Moderately Degraded lands comprise 10.4% of the study area, or 3.4 million acres (1,379,015 hectares) and Highly Converted lands comprise another 3.7% of the area or 1.2 million acres (493,079 hectares). This means that significant levels of disturbance are now evident on 4.6 million acres (1,872,094 hectares) throughout the study area.

The Mohave Ground Squirrel in Moderately Degraded and Highly Converted lands

Found throughout the western portion of the ecoregion, the Mohave ground squirrel (*Spermophilus mohavensis*) is endemic to the Mojave Desert and listed as threatened by the State of California.

Over 30% of the known occurrences of this species are on lands categorized as either Moderately Degraded or Highly Converted. Several of these occurrences are located between more intact areas managed by the BLM for Mohave ground squirrel conservation.

These Moderately Degraded and Highly Converted lands may link larger blocks of habitat. Changes in the use of these lands could sever these linkages, and permanently isolate Mojave ground squirrel subpopulations.

Moderately Degraded lands are disturbed and fragmented by roads or OHV trails, or are in close proximity to urban, agricultural, and other developments. They often maintain ecological functionality (e.g., maintain groundwater infiltration and flow, serve as sand sources, provide connectivity), provide habitat for native species, or are known to have conservation target occurrences. Highly Converted lands are in urban or agricultural areas and have been heavily altered. Some can support conservation targets, although their ecological contexts are compromised. Conservation targets occur on Moderately Degraded and even Highly Converted lands, but often they are remnants of formerly larger, more robust populations that existed prior to the human impacts. It is important to note that there is ecological value in maintaining open spaces, parks, and other non-developed lands within the Moderately Degraded and Highly Converted lands areas. They may support local populations of some organisms and may even serve as corridors for movement of the more mobile species such as coyote, kit fox, bighorn sheep, and some avian targets.

Bighorn Sheep
(Photograph by Tupper Ansel Blake)

Unfortunately, little consideration of the importance of incorporating conservation principles into land-use plans is evident in past and even current development planning in most urban and suburban areas of the Mojave Desert. From the highly checker-boarded landownership and haphazard development patterns in northwest Arizona, to the high-density sprawl of the Las Vegas, Victorville, Barstow, and Pahrump valleys, opportunities to retain or restore ecosystem functionality either in or around these metropolitan areas have been mostly lost. Coupled with the impacts of the groundwater withdrawal, the prospects of restoring ecological functionality to these landscapes are not good.

6.2.1 Current Land Ownership Patterns

Examination of the percentage of land held by major landowners that is within each of the four categories reveals that the majority of federal agency lands retain high conservation value (Table 6-1). The BLM, DOD, and state agencies also hold substantial areas of land that are Moderately Degraded. Slightly over half (53.5%) of private landholdings in the ecoregion are Moderately Degraded or Highly Converted (Table 6-1).

Table 6-1 Conservation Value of Lands Held by Different Landowners. The columns total 100%.

Category	BLM	NPS	DOD	USFWS	USFS	State	Tribal	Private	Other
Core	37.2%	52.4%	35.1%	36.2%	85.3%	43.0%	22.5%	20.2%	28.0%
Intact	55.6%	46.4%	48.5%	63.5%	8.9%	43.5%	48.8%	26.3%	57.5%
Degraded	6.7%	1.1%	15.1%	0.4%	4.4%	10.3%	16.2%	32.3%	12.6%
Converted	0.5%	<0.1%	1.3%	<0.1%	1.4%	3.2%	12.5%	21.2%	2.0%

Evaluation of the proportional ownership of land within each category indicates that the Bureau of Land Management, the largest landowner in the ecoregion, holds the largest percentage of land in both the Ecologically Core and Ecologically Intact categories, with 44.8%, and 52.7% respectively (Table 6-2). The National Park Service and Department of Defense also hold substantial percentages of the lands in the highest conservation categories. In contrast, private landowners hold only about 8% of the lands in the highest conservation value categories, but nearly half (46.5%) of the Moderately Degraded land and the great majority of the Highly Converted land (84.8%; Table 6-2).

Table 6-2 Proportional Ownership of Land in Each Conservation Category. The rows total 100%.

Category	BLM	NPS	DOD	USFWS	USFS	State	Tribal	Private	Other
Core	44.8%	27.4%	11.0%	2.5%	2.5%	2.2%	0.3%	8.1%	1.3%
Intact	52.7%	19.1%	11.9%	3.4%	0.2%	1.8%	0.4%	8.3%	2.1%
Degraded	29.1%	2.1%	17.0%	0.1%	0.5%	1.9%	0.7%	46.5%	2.1%
Converted	6.4%	0.3%	4.1%	<0.1%	0.4%	1.7%	1.4%	84.8%	0.9%
Core & Intact	49.3%	22.7%	11.5%	3.0%	1.2%	2.0%	0.4%	8.2%	1.7%
Degraded & Converted	23.1%	1.6%	13.6%	0.1%	0.4%	1.8%	0.9%	56.7%	1.8%

Nearly all (92.4%) of the land in the Mojave Desert that is critical for connectivity, as indicated by the California Essential Habitat Connectivity Project (Spencer et al. 2010), was designated by our analysis as either Ecologically Core or Ecologically Intact (Figure 6-3). Notable exceptions include Essential Connectivity Areas in close proximity to the City of Barstow, where some of the land is either Moderately Degraded or Highly Converted, and a portion of the Lucerne Valley east of Victorville, which is degraded by OHV activity and other activities associated with rural residential development.

Red Rock Canyon National Conservation Area, Nevada (Photograph by Bill Christian)

Figure 6-3

Mojave Desert Conservation Value & CA Statewide Essential Habitat Connectivity

Project Area
- Mojave Desert

Boundaries
- State
- County

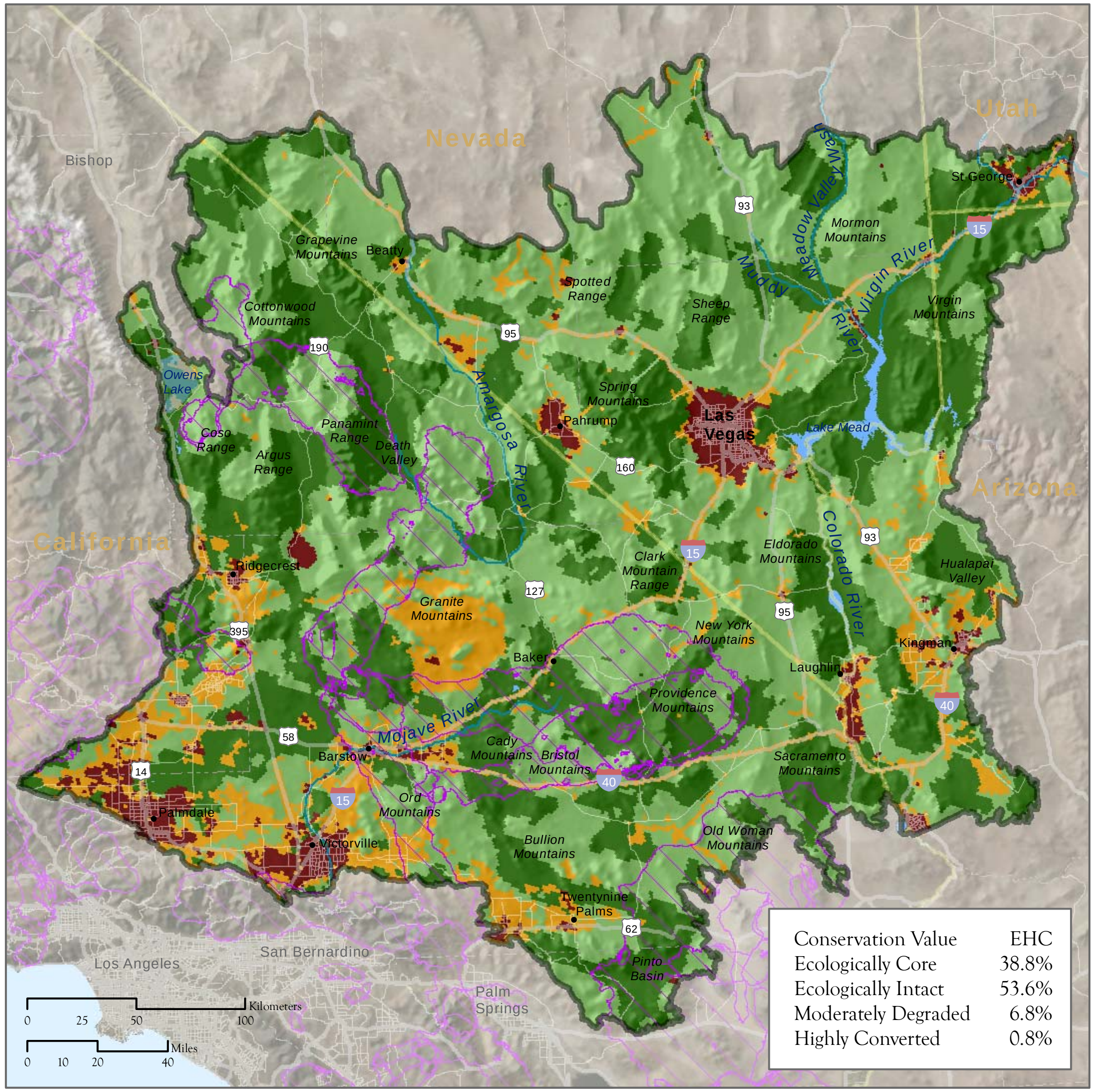
Transportation
- Major Road
- Other Road

Hydrology
- Major River

Connectivity
- CA Statewide Essential Habitat Connectivity

Conservation Value
- Ecologically Core
- Ecologically Intact
- Moderately Degraded
- Highly Converted

Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources



Conservation Value	EHC
Ecologically Core	38.8%
Ecologically Intact	53.6%
Moderately Degraded	6.8%
Highly Converted	0.8%

6.2.2 Areas with High Conservation Value that are not Fully Protected

Only 55% of the lands identified as Ecologically Core are adequately protected within lands designated as GAP status 1 or 2, while 45% of these lands are unprotected or inadequately protected (GAP status 3 or 4; Table 6-3; see Section 2.8 for information on the four GAP status categories). Of the Ecologically Core land in GAP status 3 or 4, 24% is publicly-owned. On these lands, conservation will require a change in the management prescription to ensure persistence of the species and communities they support. Similarly, less than half (45%) of lands identified as Ecologically Intact are in GAP status 1 or 2. The remainder of the Ecologically Intact lands can also play a crucial role in maintaining the ecological health of the highest priority areas, and will require increased attention and protection.

Table 6-3 GAP Status of Lands in Each Conservation Value Category

	GAP Status Category (Percent of Total Area)			
Type	1	2	3	4
Ecologically Core	29%	26%	25%	20%
Ecologically Intact	25%	20%	36%	19%
Moderately Degraded	1%	6%	35%	58%
Highly Converted	0%	1%	9%	90%

6.3 Landscape Resilience

Landscape features that may provide refugia for species by buffering the impacts of climate change include north-facing slopes that heat up less than other areas even on hot days, seeps and springs that provide perennial sources of water, and riparian corridors (including washes and *arroyos*) that could allow species to move to cooler locations in response to climate change (Appendix B). We identified the areas with the highest concentration of these landscape resilience features in much of the Mojave Desert Ecoregion and evaluated their occurrence with respect to Ecologically Core and Ecologically Intact lands. We found that these two categories include 95% of the areas of highest landscape resilience. The Ecologically Core areas are particularly important because they capture 53% of the areas of highest landscape resilience, while only covering 37% of the ecoregion. While more detailed assessments are needed when developing climate change adaptation strategies for the long term conservation of target species, this assessment indicates that in general, the areas of highest conservation value today also include the areas with the highest concentration of features that may enhance the resilience of species to climate change.

7 Vision for Effective Conservation of the Mojave Desert

We propose a vision for the Mojave Desert of enhanced protection and management that ensures the long-term survival of the native species, natural communities, and ecological processes that represent and sustain the full variety of life in the ecoregion. This vision can be realized by:

1. expanding the network of core protected areas to safeguard under-protected species and systems;
2. buffering and connecting these core areas with areas permeable to dispersal and migration of desert species; and
3. ensuring protection of wetlands, springs, and higher-elevation regions and other areas most likely to provide habitat to vulnerable species as climates change.

Achieving this vision also requires abating threats to the ecoregion's biodiversity, and ensuring that human uses of the desert do not come at the expense of sustaining its extraordinary conservation value into the future.

The map of conservation values across the Mojave Desert Ecoregion (Figure 6-2) provides a template for accomplishing this vision. The lands categorized as Ecologically Core represent a core network of areas needed to safeguard the full complement of the Mojave Desert's biodiversity. The Ecologically Intact lands represent areas needed to buffer and connect this network and to support the continuation of key ecological processes and interactions among species and communities. Maintaining ecological permeability through these areas will be necessary for the dispersal and migration of plants and animals and their ability to persist and adapt over time.

These high conservation value areas are surrounded by a web of Moderately Degraded and Highly Converted lands, which have been altered to greater degrees by urbanization, agriculture, and other human uses. Moderately Degraded lands are not dominated by urban or agricultural uses but are fragmented by roads or OHV trails or are in close proximity to urban, agricultural, and other developments. Highly Converted lands are urban and agricultural areas, or other areas that have been most impacted and fragmented by human use. Despite the impacts to habitat in this category, these lands support important conservation values (Section 1.2.2 and Appendix A). In general, however, Moderately Degraded lands and Highly Converted lands represent areas where new developments and intensive human uses may have less overall impact on the long-term viability of the conservation values of the Mojave Desert.

7.1 Conservation Objectives

We propose distinct conservation objectives for each of the four conservation value categories in support of this vision.

Ecologically Core (land with low levels of anthropogenic disturbance that support conservation targets and whose protection is critical for the long-term conservation of the ecoregion's biological diversity):

Protect the large, intact habitat blocks constituted by Ecologically Core lands to conserve irreplaceable conservation targets, support the natural ecological processes upon which they depend (e.g., sand transport and water-flow regimes), and maintain habitat connectivity. Prevent the fragmentation of these areas caused by development and roads, and prevent the degradation caused by invasions of exotic species, uncharacteristic (frequent) fire regimes, and other direct and indirect human impacts.

Ecologically Intact (land with low levels of anthropogenic disturbance or that supports conservation targets and requires a level of protection that will enable it to continue to support ecological processes and provide connectivity):

Promote land uses and management practices that maintain or improve landscape integrity and protect conservation targets. Promote restoration of habitat connectivity, natural vegetation communities, and ecological processes (e.g., sand transport and water-flow regimes).

Moderately Degraded (lands fragmented by roads, off-highway -vehicle trails or in close proximity to urban, agricultural and other developments):

Encourage sustainable land uses that minimize impacts to native species and communities and other natural resources, protect sensitive species and isolated high value native ecosystems, and maintain landscape permeability to wildlife movement.

Highly Converted (land in urban and agricultural areas that is fragmented and most impacted by human uses):

Encourage clustering of new land uses in areas that have already been converted for human uses and encourage designs of renewable energy facilities that minimize impacts to conservation targets and other biological resources. Focus conservation and management efforts within Highly Converted lands on existing open spaces, riparian habitats, and canyons that support local wildlife, improve air and water quality, recharge and maintain groundwater aquifers, and otherwise improve human quality of life. Promote appropriate management of agricultural lands and urban landscapes that are significant for the support of wildlife (e.g., Burrowing Owls, Athene cunicularia*).*

Although lands classified as Moderately Degraded and Highly Converted have been subject to a higher degree of disturbance and degradation, it should not be assumed that they are necessarily appropriate for development or other intensive human uses. Rather, they represent areas likely to have fewer environmental constraints. Site-specific analyses would be needed to assess their actual development suitability.

7.2 Conservation Strategies

Major factors likely to shape conservation in the Mojave Desert Ecoregion in the coming decade include: the decisions and actions of the diverse group of federal agencies that manage the great majority of the land; a continued focus on efforts to recover state- and federally-listed species, particularly the Mohave ground squirrel and desert tortoise; intense pressures to develop renewable energy and introduce other human uses of the desert; and the resultant efforts by state and federal agencies to develop long-term conservation and land-use planning and permitting processes to address these pressures.

A variety of strategies will be required to accommodate these factors and achieve a robust and enduring conservation outcome. They include protecting high conservation value lands through re-designation of public lands for conservation use and acquisition of private and state school lands, and enhanced management and restoration of all public lands; promoting collaborative conservation among stakeholders; addressing information gaps and uncertainty; and promoting adaptive learning that puts new information to use to improve and enhance the positive effects of employing these strategies.

7.2.1 Protection through Re-designation

Although the Mojave Desert has the highest percentage of federally-owned and managed lands among all U.S. ecoregions, only a portion of those lands are currently designated and managed in a manner that affords conservation top priority. As a result, the wildlife and native vegetation on many public lands in the Mojave Desert Ecoregion continue to be stressed by a variety of threats. One example is the Mojave population of the desert tortoise, which was federally listed in 1989, designated as threatened in 1990, and for which critical habitat was officially designated in 1994. Despite this status, many recommendations in the approved 1994 Desert Tortoise Recovery Plan have yet to be implemented over large areas of habitat on public lands, in part because the land is still designated as multiple use. Remarkably, 78% of the land in Desert Wildlife Management Areas[7] in the Mojave is still managed for multiple uses, according to the latest information available. More than 20 years after the federal listing, desert tortoise populations continue to decline (USFWS 2006). In addition, 20% of the area categorized in this assessment as Ecologically Core and 19% of that categorized as Ecologically Intact is in Gap Analysis Program (GAP) Land Management Status 4 (Section 6.2.2), meaning that it lacks any restrictions that prevent conversion of natural habitat types to anthropogenic habitat types (Section 2.8).

Increased protection may be achieved by changing the designation of multiple-use public lands that are crucial for continued viability of native plants and wildlife (e.g., Ecologically Core and Ecologically Intact).[8] Re-designations could provide mandates that these lands be primarily managed for conservation of habitat and native species and that known threats to habitat and species be abated to the degree feasible. Any re-designation of public lands would need to entail clearly defined boundaries and management objectives coupled with adequate dedicated funding

[7] Desert Wildlife Management Areas (DWMAs) were identified by the U.S. Fish and Wildlife Service in the 1994 Recovery Plan for the Mojave population of the desert tortoise, and were to be implemented by the BLM through official designation as Areas of Critical Environmental Concern. In this report, a DWMA is defined as an "administrative area within the recovery unit which is managed such that reserve-level protection is afforded desert tortoise populations while maintaining and protecting other sensitive species and ecosystem functions (e.g., watersheds)." Many of the 14 DWMAs identified in the 1994 recovery plan have not yet been designated.

[8] We note that a mechanism for the re-designation of public lands is currently not available. It is possible that a new type of legislatively-created designation is needed to allow the withdrawal of multiple-use lands for conservation purposes. Under a mitigation scenario, there is the alternative possibility to create a conservation bank on a limited amount of public lands following guidance provided by the U.S. Fish and Wildlife Service (2003); however, this method cannot be widely employed to remove public lands from multiple uses. The goal of re-designation should be to provide a clear and enduring mandate to manage specifically identified lands for conservation and to immediately abate threats to habitats and species by eliminating all other known or suspected incompatible uses from these lands.

for these areas. Greater protection through designation should also be structured to ensure enduring protection of these public lands, which would enable effective investment in management and restoration activities.

7.2.2 Protection through Acquisition

Private lands account for 8.2% of the high conservation value lands (Ecologically Core and Ecologically Intact) in the Mojave Desert Ecoregion. Some of these areas, as well as high-conservation-value state school lands, deserve protection through acquisition of fee simple title or conservation easement. For example, California state school land sections, which are held to maximize economic returns, and former railroad properties still form a checkerboard within a matrix of high-conservation value federal lands in some areas. The occurrence of state school lands and private lands within public lands increases the difficulty of managing the surrounding public land and increases the possibility that high-value conservation lands may be used for development or other activities incompatible with conservation. Priority should also be accorded to acquisition of lands from willing sellers that connect existing protected areas and provide corridors that animals and plants need for movement. Concentrations of high-conservation-value private lands, important for both the wildlife habitat and the connectivity they provide, exist in portions of the western Mojave, the Pahrump and Las Vegas valleys, and the region around Kingman, Arizona.

7.2.3 Protection through Enhanced Management and Restoration

Once protection through re-designation or acquisition of high-conservation-value lands has been achieved, biodiversity conservation requires appropriate management to prevent and abate threats and promote viability of native species and the health of native communities. “Effective conservation” is a condition in which targets are viable, threats to their viability are abated, and institutional and other enabling conditions are in place to ensure those conditions persist into the future (Higgins et al. 2007).

Many areas of the Mojave Desert Ecoregion, including some that already enjoy the highest formal protection for biodiversity, do not experience conservation management that is sufficient to abate threats to long-term viability of targets. This is due in part to the multitude of threats in this ecoregion and also limited and inconsistent funding. Moreover, the focus of agency management is often directed to recover listed species. While this is likely to also benefit other plants and animals that share the habitats of these species, broader efforts to improve management in other habitats will be necessary to ensure that the full biodiversity of the ecoregion is effectively protected.

The scarcity of conservation management funding calls on managers of desert resources—and the researchers and other stakeholders that care about conservation of the Mojave Desert—to improve collaboration across sectors and jurisdictions to identify ways in which monitoring and management resources can be combined and/or coordinated, focused on the most essential management imperatives, and directed to actions at scales necessary to be effective. Through collaboration, important efficiencies and economies of scale may be achieved.

7.2.4 Protection through Enhanced Collaboration

Given the pressures threatening the Mojave Desert in the face of limited resources devoted to conservation, there is an urgent need to increase the efficiency and enhance the effectiveness of conservation efforts. Collaborative efforts are one means of accomplishing better conservation outcomes and can be a powerful way to assemble existing resources and bring new funding and attention to the ecoregion. Although the many agencies and organization working in the Mojave Desert have varied mandates and management goals (Section 4), the protection of natural communities, native species, and biodiversity is at least an element common to nearly all of them. Rationales for protecting natural resources may differ (e.g., the Department of Defense may be interested in buffering military lands and the Bureau of Land Management's goal may be, in part, to maintain or reestablish habitat connectivity for native species), but collaboration will increase the likelihood of all agencies successfully achieving their conservation objectives.

We encourage agencies, organizations, and individuals to initiate or continue dialog about, and to act on, their specific needs, shared goals, and mutually-beneficial opportunities. We offer the following recommendations.

- Continue and expand activities of the Desert Managers Group in California and the Southern Nevada Agency Partnership (SNAP) in Nevada as a means of increasing cooperative management among agencies. Re-activate inactive working groups and consider creation of new working groups to address issues such as climate change, watershed and ground water basin conservation, and habitat connectivity.
- Develop a multi-state, Mojave-wide desert management group, modeled on the Desert Managers Group in California and the Desert Tortoise Recovery Team, which would collect and disseminate information, coordinate federal and state actions across state boundaries, and maximize ecosystem protection and conservation activities.
- Promote a regional approach for conservation of the Mojave Desert in California by pursuing a collaborative effort to retain the California Desert Conservation Area in the National Landscape Conservation System (NLCS).
- Encourage partnerships between public land managers and conservation organizations working in the region to acquire fee title or conservation easements on key inholdings and buffer zones. Foster activities of land trusts such as the Mojave Desert Land Trust, the Wildlands Conservancy, and the Amargosa Conservancy to acquire and protect inholdings, especially those containing aquatic and riparian resources that are scattered throughout Ecologically Core and Ecologically Intact lands.
- Develop and promote collaborative relationships with private land owners to maximize the conservation value of private lands. This may include restoration of lands that will benefit adjacent public lands (e.g., exotic plant removal) or land management actions to maintain wildlife permeability across private lands.
- Build upon collaborations between the Department of Defense, other federal and state agencies, and conservation groups, to encourage military land buffering as a means of protecting both military training missions and natural resources. The Readiness and

Environmental Protection Initiative (REPI) is designed to prevent encroachment of land uses around military bases that would be incompatible with military testing and training activities. Such initiatives can represent valuable tools for conservation of natural resources.

- Develop collaborative programs for long-term sustainability of groundwater basins and perennial and seasonal surface water flows dependent on groundwater sources. This will require joint efforts from state and federal agencies, Tribes, private land owners, and water users (e.g., residential, industrial, resort, and agricultural).
- Federal and state agencies should seek funding for cooperative studies by the USGS of desert hydrology and groundwater resources, and for the development of predictive models that can be used to limit harm over the long-term to natural communities dependent on water.
- Agencies should agree to limit the use of desert groundwater to sustainable quantities—that is, to amounts not in excess of recharge rates, and that anticipate reduced precipitation in the century ahead. New developments, including renewable energy projects, should be required by both federal and state agencies both to minimize water use and provide mitigation for their groundwater impacts.
- Where groundwater systems cross state boundaries (for example, the Death Valley Regional Flow System), state agencies should develop cooperative, cross-boundary methods to limit and fairly allocate water use.
- Where groundwater basins are adjudicated, regulatory agencies and all water users should collaborate in ensuring that adjudicated groundwater levels are attained or exceeded.
- Where groundwater basins are threatened by overdraft or over-allocation of resources, seek adjudication or other legally protective mechanisms to ensure that ecological uses of water are recognized and protected.
- Encourage partnerships between researchers, land managers, and conservation organizations to identify and prioritize groundwater infiltration zones for protection.
- Establish collaborative programs to maintain and restore watershed health. Management and restoration to reduce water diversion and pollution will depend greatly on collaboration between federal and state agencies, Native American Tribes, and private land owners.
- Promote status and protection of selected rivers by developing and enforcing scientifically-sound Wild and Scenic River management plans, and by proposing additional streams for Wild and Scenic Rivers status, under the National Wild and Scenic Rivers Act.
- Be prepared to respond to opportunities presented by the Clark County (NV) MSHCP and the Washington County (UT) MSHCP (Figure 4-1) to further protect Ecologically Core and Ecologically Intact lands.
- Look for opportunities to conserve key resource areas by utilizing and building on existing regional conservation programs such as the Lower Colorado River Multi-Species Conservation Program, BLM's West Mojave Plan (WEMO), Northern and Eastern Mojave Desert Plan (NEMO), and Northeast Colorado Desert Plan (NECO; Figure 4-1)

- Establish and continue collaborative programs to control non-native invasive plants. Collaborations such as the establishment of the Mojave Weed Management Area, initiated by the Desert Managers Group, should be promoted and expanded. Coordination with others such as the California Invasive Plant Council will benefit this effort.
- Plan for localized or widespread surges in non-native invasive plants in response to increasing atmospheric carbon dioxide (as a result of climate change) or nitrogen deposition (currently the greatest areas of concern include the western Mojave and downwind of metropolitan Las Vegas).
- Continue collaborative efforts to maintain landscape connectivity across the ecoregion and with adjacent ecoregions. Use the linkage evaluation coordinated by South Coast Wildlands for the California deserts and conduct a linkage evaluation for the remainder of the Mojave Desert Ecoregion. Identification of these areas will provide guidance on where wildlife-friendly transportation infrastructure enhancements, such as fencing and underpasses, and land management activities are most likely to increase wildlife permeability and landscape integrity.
- Promote transit and land management measures that reduce nitrogen deposition and greenhouse gas emissions. These measures, which will be most effective if pursued in collaboration with jurisdictions outside of this region, particularly in the Los Angeles Basin, may include:
    - automobile regulations to reduce vehicle emissions;
    - public mass transportation options to reduce vehicle use; and
    - agricultural and landscape protocols that reduce or limit the use of nitrogen-based fertilizers.

These efforts will require increased coordination and specific allocation of funds. Reaffirming a commitment to the working groups of the Desert Managers Group may facilitate some of these efforts, and should be pursued as a means of increasing communication and sharing information. Joint management planning will be needed, ideally within an established framework to ensure long-term follow-through. Ideally all agencies would contribute funding, and joint fund-raising efforts could be undertaken. Shared commitment to protection of the Mojave Desert can result in shared policy positions related to water conservation, land-use practices, and land designations.

7.2.5 Addressing Information Gaps and Uncertainty

Although several of the Mojave Desert Ecoregion's most scenic and remarkable locales and some of its most characteristic plants and animals have been the subject of attention by biologists and other researchers for decades, much of this roughly 32.1-million-acre area has been only lightly surveyed and remains incompletely known at best. Data are most abundant for a few of the region's animal species and sub-species that are listed by the federal or state governments as endangered or threatened, including the desert tortoise, Peninsular bighorn sheep, and the Mohave ground squirrel. However, there are major data gaps even for some of these species; notably, the distribution of the Mohave ground squirrel has been particularly difficult to determine. Moreover, knowledge is far from complete for portions of the eastern Mojave that are distant from roads, and for the flora and fauna that are most active and apparent in the late summer and early autumn.

All stakeholders in the ecoregion would benefit from more active mapping of species by university researchers, state Natural Heritage Programs, agency scientists, and museums. This would provide greater information on the distribution of many species now regarded as rare or narrowly distributed. There is a large backlog of occurrence data that has been submitted but not yet uploaded to the California Natural Diversity Database (CNDDB) and three state Heritage Program databases. Conservation efforts would benefit significantly if occurrence data were processed in a timelier manner. Similarly, development of distribution models for more species would provide information that could be used to better map, monitor, and manage them, and to identify associations and patterns that would inform management of larger groups of organisms and larger sites.

The consequences of data and knowledge gaps are many. Obviously, gaps impede robust conservation planning and strategic action. But they can also lead to inefficiencies and risks in land-use decision making. The pressure to rapidly develop renewable energy generation facilities in the Mojave Desert, including in many under-surveyed areas, is a reminder of the importance of having comprehensive and current information concerning biodiversity distribution and status, in a manner that is accessible to decision making. Given that the pressures to develop the Mojave Desert are unlikely to subside, we underscore the imperative for:

1. investing in monitoring and research to establish baselines and understanding of key systems;
2. focusing monitoring on impacts of new developments in order to inform future land-use siting and mitigation decisions;
3. fostering data archiving, sharing, and synthesis so that data can serve a conservation purpose; and
4. ensuring that, before commitments to develop land are made, an adequate inventory of conservation values is in hand.

It is critical that an institutional framework for adaptive learning be established in the Mojave Desert, so that land-use decisions a decade from now are more informed than they are today.

To encourage their use by the full array of stakeholders, the four land category data generated by this assessment are publicly available, not only in this document, but also in a Map Service available on ConserveOnline (http://conserveonline.org/workspaces/mojave/documents/mojave-desert-ecoregional-2010/@@view.html.). We repeat the caution that, because this analysis was conducted at an ecoregional-scale and all of the data were aggregated into one-square-mile, hexagonal planning units, the results are appropriate for viewing and analyses only at a scale of 1:250,000 or coarser. We hope these data will encourage further data sharing and cooperative efforts among stakeholders to assess and plan conservation and other land uses in the Mojave.

7.3 Application of the Assessment to Regional Planning

We conducted this assessment in part to help inform regional conservation and land-use planning efforts for the Mojave Desert by the responsible agencies and other stakeholders including industry and the conservation community. It offers a regional-scale vision for a conservation reserve design. It also identifies broad patterns of conservation value that can be used to guide potential impacts away from Ecologically Core and Ecologically Intact lands where development is likely to cause fragmentation and other damage to conservation targets, and steer it towards other appropriate areas in Highly Converted and perhaps portions of Moderately Degraded lands. Designation of high conservation value areas can also be used to help direct investment of mitigation funds and actions to areas that may provide conservation values in addition to those that are the subject of specific mitigation requirements.

7.3.1 Informing Development and Infrastructure Siting Decisions

This assessment may be of use in guiding siting decisions by identifying areas of high conservation value where proposed development would have a high likelihood of encountering environmental constraints and challenges, and, if implemented, would cause irreparable damage to ecological values. Ecologically Core and Ecologically Intact lands are largely undisturbed and un-fragmented and support conservation targets such as known occurrences of rare or declining species and ecological systems. Although approximately 29% of Ecologically Core lands and 25% of the Ecologically Intact lands are already in GAP Land Management Status 1, the highest level of conservation protection (Section 2.8), large percentages of the remainder are subject to renewable energy, mining, or other lease claims in addition to other actions incompatible with conservation values. These lands are likely to be difficult or impossible to develop without causing damage that will be ecologically irreparable on the one hand and require costly compensatory mitigation on the other.

Avoiding ecological harm—or at least minimizing it—is far more likely to be possible on Highly Converted lands and perhaps on some Moderately Degraded lands. We also note that Highly Converted and Moderately Degraded lands are more likely to be in close proximity to existing infrastructure and centers of energy demand. In addition, over half (56.7%) of the lands in these categories are in private ownership. Because many gaps exist in the regional-scale data used in this assessment, it is essential that site-specific assessments be conducted to determine appropriate sites and configurations for all proposed development, regardless of location—even within already urbanized areas. In some cases, state or local databases will be available to support these finer-scale assessments. In others, field assessments by competent scientists and professionals will be required.

In short, this assessment can help apply the precautionary principle to land-use decisions: conserve first the "no regrets" areas known to have high conservation value; direct new development and intensive land uses first to places known to have the lowest conservation (and cultural) values and the least uncertainty about likely impacts of development or use. Meanwhile, hold off decisions about lands of intermediate conservation value and work to improve knowledge so that sufficiently informed decisions about their use can be made later. In all cases, no decision committing land to a new use should be made without a clear understanding of its conservation importance so that irreparable harm can be avoided or minimized. This approach seems especially appropriate in the context of the intense and likely continuing pressure to develop renewable energy facilities in the ecoregion.

7.3.2 Informing Mitigation Decisions

Federal and state environmental laws require that harm to protected resources be avoided, minimized, or compensated. This protection of resources and environmental values is asserted through the combination of environmental effects analyses under the National Environmental Protection Act (NEPA) and state laws, such as the California Environmental Quality Act (CEQA), and the requirements of other environmental laws (federal and state endangered species acts, water and air quality laws) under the rubric of mitigation.

This assessment can be used to guide attention to broad areas that warrant more site-specific analyses for their potential to fulfill compensatory mitigation obligations. For example, in areas with high conservation value, finer-scale, spatially-explicit analyses of land ownership, landscape condition, species occurrences, key threats, and climate change refugia might reveal specific sites best suited for acquisition, re-designation, or enhanced conservation management.

This assessment can also provide a foundation for a regional advance mitigation plan (RAMP) that would integrate the expected longer-term demand for renewable facility siting and other land uses with a regionally identified set of conservation priorities to enable large-scale desert conservation. Such a plan would seek to align infrastructure and conservation broadly by avoiding high value areas in siting decisions and directing compensatory mitigation resources to established conservation priority areas and actions.

It is preferable to use compensation funds to acquire lands with suitable habitat to offset impacts to "replace" the lands subjected to disturbance. However, less than 9% of the high conservation value lands in the Mojave Desert Ecoregion are in private ownership and large areas of the desert contain few private lands. Moreover, private lands that are available may have low and un-restorable conservation value. Accordingly, many Mojave conservation and recovery plans have recommended using compensatory mitigation funds to enhance management of, restore, or provide additional protection to, public lands. Where these approaches are used, it will be essential to ensure that the mitigation investment is maintained for the entire time that the effects of the threat being abated continue. It is also important that compensatory mitigation funds are spent to enhance management on or restore public lands only where doing so will provide clear, additional conservation benefits and will not simply replace existing agency activities, responsibilities, and resources. Alternative mitigation actions should be considered and selected based on deriving the maximum conservation return on the investment of the mitigation funds.

In planning mitigation it is important to take into account the low productivity and extreme sensitivity of desert soils and biota to destruction. Accordingly, it is difficult (and in some cases impossible, given reasonable time and cost constraints) to return an area of desert, once developed, back into a fully-functional desert ecosystem. This has implications even for short-term projects, since even if the direct impacts are time limited, the indirect impacts will likely be indefinite. This again underscores the importance of following the precautionary principle in making such land-use decisions because damage will be difficult or impossible to undo.

7.3.2.1 The Mitigation Hierarchy and the Ecoregional Assessment

Land-use decisions should adhere to the principles of the mitigation hierarchy (Table 7-1). First, harm to resources should be avoided. If harm cannot be completely avoided, damages should be minimized or resources restored or damage reduced over time. Finally, compensatory mitigation for any remaining harm must then be provided by the party seeking approvals.

Adhering to the mitigation hierarchy in the scoping, planning, and implementation of any developments is widely recognized as an efficient way to minimize negative ecological impacts. [9] Avoidance and effective minimization both reduce the potential ecological impact of a project, while compensation offsets the unavoidable harm (Table 7-1). The net benefit in terms of reducing biodiversity impacts and increasing the efficiency in project planning decreases as one moves down the hierarchy from avoidance to compensation. For conservation interests, this provides a systematic way to limit ecological impacts and offers strategically-directed compensation for unavoidable harm.

7.3.2.2 Cumulative Impact Assessment

The data on targets and threats provided by this assessment as well as the analysis of conservation values across the entire ecoregion can support cumulative impacts analysis, which is required under both state and federal impact assessment laws. Cumulative impacts assessments predict and weigh the overall effects of development proposed for, and occurring at, multiple sites on the biodiversity and other natural resources of the region over the long term. In evaluating the contribution of actions at individual project locations to cumulative impacts on species and habitats, permitting agencies consider not only the effect on the distribution and quality of habitat affected, but also the effect on essential ecological processes, such as maintenance of connectivity between subpopulations of a species, or of physical processes like groundwater flow or delivery of habitat structure (e.g., sand sources). In light of projected impacts from climate change on species distributions, disturbance regimes, and the timing and amounts of precipitation, an explicit consideration of these projected impacts must also be included in cumulative impact analyses.

Incorporating climate change impact projections into the assessment of cumulative impacts does not imply that individual project developers would be responsible to mitigate future climate change impacts. However, it does provide limits on development where collective climate impacts

[9] The mitigation hierarchy was originally developed principally to apply to wetlands mitigation under the Clean Water Act (Section 404), but has been adopted by the Council of Environmental Quality as a component of all environmental analyses and expanded to provide the framework for integrating other ecosystems and multiple types of infrastructure with conservation objectives (FHWA 2008, AWWI 2009). In addition to providing a framework applicable for regulatory processes, it has also been used to promote voluntary offsetting, especially for biodiversity (ten Kate et al. 2004, McKenney 2005, Kiesecker et al. 2010).

Table 7-1 The Mitigation Hierarchy (40 CFR, Sec 1508.20)

Step in the Hierarchy	Definition (40 CFR, Sec 1508.20)	Role of Ecological Data and Conservation Priorities	Scale of Information Needed
Avoid	Avoiding the impact altogether by not taking a certain action or parts of an action	Determine what areas should be avoided based on conservation value	Region, landscape, site
Minimize	Minimizing impacts by limiting the degree or magnitude of the action and its implementation	Determining the extent of impact resulting from different options for technology type, different scales of build out, or different practices (e.g. wet vs. dry cooling), different timing of construction activities	Landscape, Site
Restore	Rectifying the impact by repairing, rehabilitating, or restoring the affected environment	Help assess what resources may be restorable, determine the configuration and context for linking restoration with broader ecosystem flows, help define viability criteria or performance measures for "restored" function	Landscape, Site
Reduce	Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.	Same as above	Landscape, Site
Compensatory mitigation	Compensating for the impact by replacing or providing substitute resources or environments	Help define areas where mitigation can contribute to conservation goals, define options for locations, assess landscape context for mitigation to assess viability	Region, landscape, site

in combination with proposed development pose risks to species and ecologically important processes.

Given the extreme sensitivity of desert resources, and the great difficulty of restoring ecosystem functionality following disturbance (Section 4.8), it is important that the evaluation of impacts for any given project be comprehensive. It is similarly essential that decisions regarding land use be made in light of the cumulative impacts of *all* of the developments and myriad other changes existing and occurring or likely to occur across the desert. There are limits as to how much conversion and alteration a landscape can accommodate before it ceases to function in a manner that allows native diversity to persist. For the conservation targets and values of the Mojave Desert Ecoregion, it is extremely important to ascertain where those ecological thresholds are, and not approach a threshold, especially where limits are uncertain. This is essential to avoid learning those limits only after they have been crossed and irreversible damage done. Adherence to the precautionary principle and the mitigation hierarchy in land-use decision making, as well as fostering cross-jurisdictional and cross-sector collaboration in monitoring, management, and research, will be essential to ensure successful stewardship of the extraordinary biological assets of the Mojave Desert Ecoregion into the future.

7.4 Conclusion

The Mojave Desert Ecoregion, one of the most intact and wild places in North America, currently faces unprecedented and intense development pressure. The fate of much of the Mojave Desert's extraordinary conservation value rests on the decisions now being made as to how to tap its renewable energy resources, how to accommodate other new competing human uses of the desert, how to address unsustainable demands for water, and how to overcome the challenges of land-use planning and management over such vast areas with such limited funding. This assessment is intended to help inform these decisions.

This assessment also proposes a vision for effective conservation management of the Mojave Desert, and broad guidance for achieving it. In an ecosystem as fragile as this desert, hope for the long-term viability of its native biota depends upon the preservation of undisturbed and unfragmented landscapes. Here, so much hinges on what is underfoot: the integrity of soil crusts and the maintenance of groundwater levels. This assessment recognizes that sensitivity and suggests how pressures for development in the Mojave Desert might be accommodated without sacrificing the attributes of the desert that make it unique and special. It is in furtherance of that goal that we offer this assessment.

Kingston Mountain Range across Chicago Valley, California
(Photograph by Bill Christian)

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Appendix A Methods for Conducting the Mojave Desert Ecoregional Assessment

Overview of the Ecoregional Assessment Approach

We used the Ecoregional Assessment approach and methodology outlined in *Designing a Geography of Hope: Guidelines for Ecoregion-Based Conservation* (The Nature Conservancy 1997, 2000), which is described in detail in Groves (2003) and has been refined in the process of developing other Ecoregional Assessments (e.g. Tuhy et al. 2002, Marshall et al. 2004) and recent regional conservation frameworks (e.g. Conservation Biology Institute 2009). We evaluated the Mojave Desert Ecoregion as defined by Bailey et al. (1994) and modified by The Nature Conservancy in 1998.

The following list outlines the basic steps of our approach, which are described in detail in the sections that follow.

- Define the study area, and delineate its boundaries.
- Identify **conservation targets**, a set of species, community types and other conservation features that represent the biodiversity of the ecoregion and that will serve as the focus of the assessment. Conservation targets are generally selected from a range of scales (e.g. species to communities to ecological systems) and from different taxa (e.g. fish, mammals, insects, plants) to adequately inform comprehensive biodiversity conservation.
- Gather data and map distribution of conservation targets.
- Stratify, or subdivide, the region, so as to ensure representation of important variation within and among conservation target populations and occurrences.
- Set quantitative **conservation goals** for each target. Goals represent the levels of protection estimated to be sufficient to allow the target to maintain ecological variability, evolve, and persist within the ecoregion as conditions change over the coming decades.
- Identify and map threats to conservation targets (e.g., map areas of human impact).
- Synthesize and evaluate these inputs to identify the suite of areas that would most efficiently meet the conservation goals of protecting all conservation targets.
- Use outputs of this evaluation to map conservation value across the Mojave Desert Ecoregion, using four categories of relative value.
- Manually review mapped conservation values against recent aerial and satellite imagery and revise map where appropriate to produce final database and map.
- Identify conservation objectives and opportunities for lands in each of the four conservation value categories.

Data Sources

Table A-1 lists the data sources used in this assessment. Our primary sources of information for known occurrences of target species were the California Natural Diversity Database (CNDDB) and

Table A-1 Sources of Data Used in the Assessment

Type and Name of Dataset	Source
Conservation Target	
Arizona Natural Diversity Database	http://www.azgfd.gov/w_c/edits/hdms_natural_heritage.shtml
Bighorn Sheep populations and corridors	Clint Epps
BLM North and East Mojave Plan	http://www.blm.gov/ca/st/en/fo/cdd/nemo.html
BLM Western Mojave Plan	http://www.blm.gov/ca/st/en/fo/cdd/wemo.html
California Natural Diversity Database	http://www.dfg.ca.gov/biogeodata/cnddb/
Clark County, NV MSHCP	http://www.accessclarkcounty.com/depts/daqem/epd/dcp/Pages/dcp_mshcp.aspx
Modeled Tortoise Habitat Arizona	http://www.blm.gov/az/st/en/prog/maps/gis_files.html
Modeled Tortoise Habitat Mojave	http://pubs.usgs.gov/of/2009/1102/
Nevada Natural Diversity Database	http://heritage.nv.gov/gis/gis.htm
Seeps and Springs (NHD)	http://nhd.usgs.gov/
Utah Threatened, Endangered, and Sensitive Species Occurrences	http://dwrcdc.nr.utah.gov/ucdc/DownloadGIS/disclaim.htm
Digital Elevation Model	
ESRI Data and Maps	http://www.esri.com
USGS	http://seamless.usgs.gov/
Ecoregion	
Mojave Desert Ecoregion Boundary	http://conserveonline.org/workspaces/ecoregional.shapefile
Energy	
CA Dept. of Cons, Div.Oil, Gas, and Geothermal Resources	http://www.conservation.ca.gov/dog/geothermal/maps/Pages/index.aspx
CA RETI - Renewable Energy Zones and Conceptual Transmission	http://www.energy.ca.gov/reti/documents/index.html
Current and Proposed Production Facilities - Ventyx	http://www1.ventyx.com/velocity/ev-energy-map.asp
Current and Proposed Transmission - Ventyx	http://www1.ventyx.com/velocity/ev-energy-map.asp
Energy Corridors - West Wide Energy Corridors	http://corridoreis.anl.gov/eis/fmap/gis/index.cfm
Renewable Energy Right of Way Applications, BLM California	http://www.blm.gov/ca/gis/
Solar Energy Study Areas (Solar Energy PEIS)	http://solareis.anl.gov/eis/maps/index.cfm

Table A-1 Sources of Data Used in the Assessment

Type and Name of Dataset	Source
GAP Stewardship Ratings	
Protected Areas Database of the U.S. (v. 1-1)	http://gapanalysis.nbii.gov/portal/server.pt/community/maps_and_data/1850/
Southwest ReGAP Stewardship	http://fws-nmcfwru.nmsu.edu/swregap/Stewardship/Default.htm
The California Gap Analysis Project (GAP)	http://www.biogeog.ucsb.edu/projects/gap/gap_home.html
Hydrology	
CALWATER 2.2 watersheds	http://gis.ca.gov/meta.epl?oid=22175
ESRI® Data and Map	http://www.esri.com/
NHD	http://nhd.usgs.gov/
Land Ownership	
29 Palms Expansion	http://www.marines.mil/unit/29palms/las/pages/default.aspx
ARLIS Land Ownership	http://www.land.state.az.us/alris/layers.html
Fort Irwin Land Expansion	http://www.fortirwinlandexpansion.com/
GreenInfo Network's CPAD	http://casil.ucdavis.edu/casil/planning/landOwnership/
Nevada Land Ownership	http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html
Protected Areas Database of the U.S. (v. 1-1)	http://gapanalysis.nbii.gov/portal/server.pt
Public Conservation and Trust Lands, PCTL_05	http://atlas.ca.gov/download.html#/casil/planning/landOwnership
Utah Trust lands - State Surface Ownership	ftp://lands-ftp.state.ut.us/pub/gisdata.htm
Land Use/Land Cover	
Existing vegetation data (eVeg)	http://www.fs.fed.us/r5/rsl/clearinghouse/sec-sinterior.shtml
Farmland Mapping and Monitoring Program (FMMP)	http://redirect.conservation.ca.gov/DLRP/fmmp/product_page.asp
LANDFIRE	http://www.landfire.gov/
Mojave Desert Vegetation - CA	http://www.mojavedata.gov/datasets.php?qclass=veg
Multi-Resolution Land Characteristics Consortium (MRLC)	http://www.mrlc.gov/
NatureServe Ecological Systems	http://www.natureserve.org/getData/USecologyData.jsp

Table A-1 Sources of Data Used in the Assessment

Type and Name of Dataset	Source
Land Use/Land Cover (cont.)	
SouthWest ReGAP Landcover	http://earth.gis.usu.edu/swgap/
Southwest ReGAP Stewardship	http://fws-nmcfwru.nmsu.edu/swregap/Stewardship/Default.htm
The California Gap Analysis Project (GAP)	http://www.biogeog.ucsb.edu/projects/gap/gap_home.html
Planning Boundary	
BLM's WEMO, NECO, and NEMO plans	http://www.blm.gov/ca/gis/
Clark County, NV MSHCP	http://www.redcliffsdesertreserve.com/
Lower Colorado River Multi-Species Conservation Program	http://www.lcrmscp.gov/
Washington County, Utah HCP	http://www.redcliffsdesertreserve.com/
Protected Areas and Management Categories	
Arizona Wilderness areas	http://www.land.state.az.us/alris/layers.html
BLM's WEMO, NECO, and NEMO plans	http://www.blm.gov/ca/gis/
California Department of Fish and Game	http://www.dfg.ca.gov/biogeodata/gis/clearinghouse.asp
Nevada Wilderness Areas (BLM)	http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html
USFS	http://www.fs.fed.us/r5/rsl/clearinghouse/gis-download.shtml
Satellite Imagery	
ESRI Bing Maps	http://www.esri.com/software/arcgis/arcgisonline/bing-maps.html
Threats/Impacts	
Fires, California	http://frap.cdf.ca.gov/data/frapgisdata/select.asp?theme=5
Fires, Nevada	http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html
Fires, Utah	http://www.blm.gov/ut/st/en/prog/more/geographic_information/gis_data_and_maps.html
Groundwater Pumps (NHD)	http://nhd.usgs.gov/
Livestock Grazing Allotments	http://www.blm.gov/ca/gis/

Table A-1 Sources of Data Used in the Assessment

Type and Name of Dataset	Source
Threats/Impacts (cont.)	
Livestock Grazing Allotments	http://www.land.state.az.us/alris/layers.html
Livestock Grazing Allotments	http://www.blm.gov/ca/gis/
Livestock Grazing Allotments	http://www.fs.fed.us/r5/rsl/clearinghouse/gis-download.shtml
Mines, Arizona	http://www.admmr.state.az.us/Info/annual_production.html
Mines, California	ftp://ftp.consrv.ca.gov/pub/omr/amlu/toms/toms.zip
Mines, Nevada	http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html
Mines, Utah	http://gis.utah.gov/sgid-vector-download/utah-sgid-vector-gis-data-layers-by-category
Nitrogen Deposition, California	CMAQ model dataset all_ca_n_02. Produced by University of California Riverside Center for Conservation Biology (CCB) http://pah.cert.ucr.edu/aqm/ndep
OHV Recreation Areas (California)	http://www.blm.gov/ca/gis/
Roads—Arizona	http://www.land.state.az.us/alris/layers.html
Roads—National	http://www.esri.com
Roads—TIGER2009	http://www2.census.gov/cgi-bin/shapefiles2009/national-files
Roads—California	http://www.blm.gov/ca/gis/
Roads—TIGER2000	http://www.esri.com/data/download/census2000_tigerline/index.html
Wild Horse and Burro Management Areas–AZ	http://www.blm.gov/AZ/gis/
Wild Horse and Burro Management Areas–CA	http://www.blm.gov/ca/gis/
Wild Horse and Burro Management Areas–NV	http://www.blm.gov/NV/gis/
TNC Conservation Portfolio Area	
Mojave Desert Conservation Portfolio Areas	http://azconservation.org/downloads/multi/category/ecoregional_assessment/

the Arizona, Nevada, and Utah Natural Heritage programs, along with information gleaned from BLM's West Mojave (WEMO) and Northeast Colorado Desert (NECO) plans, NPS's Northern and Eastern Mojave Desert Management Plan (NEMO), and the Clark County, Nevada Multi Species Habitat Conservation Plan. We modified our primary source of land cover data, LANDFIRE, with additional inputs from the USGS ReGAP dataset and the USGS National Hydrological Dataset (NHD). Our primary source of data for roads and railroads which formed the basis our suitability analysis (analysis of anthropogenic disturbance) used in Marxan was US Census Bureau's TIGER 2009. We utilized aerial and satellite imagery provided through ArcGISOnline.com to verify our categorization of the landscape.

Expert Interviews

While an abundance of data exists with regard to target occurrence information, significant gaps in biodiversity data exist for the Mojave Desert Ecoregion. These gaps represent lack of survey effort on the ground, lack of reporting of survey results, and significant lag-times between data reporting and data availability in publicly-accessible databases. For example, in the California portion of the Mojave Desert, many records reported to the CNDDB have yet to be catalogued in the database due to staffing and other resource limitations. In addition to the gaps in occurrence data, little to no information exists regarding the viability of species and community targets in the Mojave Desert.

To remedy these shortfalls, the planning team traveled throughout the Mojave Desert Ecoregion conducting an extensive expert interview process. The interviewees included nearly 50 experts from conservation organizations, educational institutions, government agencies, and private consulting firms, including:

- Ash Meadows National Wildlife Refuge
- Bureau of Land Management (CA, NV, UT, AZ)
- Brown-Berry Biological Consulting
- California Department of Fish and Game
- Center for Biological Diversity
- California Native Plant Society
- Desert Research Institute – Las Vegas
- University of Idaho
- Joshua Tree National Park
- Los Angeles County Parks and Recreation
- Mojave Desert Land Trust
- Mojave National Preserve
- Nellis Air Force Base and Ranges

- Nevada Department of Wildlife
- Oregon State University
- PRBO Conservation Science
- Science and Collaboration for Connected Wildlands
- Shelton Douthit Consulting
- Sonoran Institute
- The Wildlands Conservancy
- Transition Habitats Conservancy
- University of California, Riverside
- University of California, Los Angeles
- University of California Natural Reserve System
- University of Nevada, Las Vegas
- United States Fish and Wildlife Service
- United States Forest Service
- United States Geological Survey
- Utah Division of Wildlife Resources
- Western Watersheds

Appendix C lists the experts interviewed. Note that inclusion on this list in no way signifies that the interviewee endorses the methods or results of this Mojave Desert Ecoregional Assessment.

The experts were queried regarding target localities, target viability, threats, processes, and land management information. The information provided by the experts was used to create a table of expert information (Appendix D) and a spatially-explicit portfolio of sites within the desert that have notable conservation value. This also creates a list of biological site attributes for each polygon that informs both reserve selection and configuration (design).

Conservation Target Selection and Data

To guide identification of conservation opportunities, we selected multiple conservation targets (Table A-3, located at the end of this appendix). Conservation targets are species, native plant communities, and ecological systems. They are the basic unit of analysis which, along with the conservation goals, drive the ecoregional assessment process. Conservation targets are identified based on the "coarse filter- fine filter" approach (The Nature Conservancy 2000). The method attempts to integrate several different strategies for conserving biological diversity by evaluating and synthesizing data at the ecological system and species levels (Groves 2003). It also is referred to as a "representative" approach to conservation based on the underlying premise that protecting representative examples of ecosystems would also protect the vast majority of species contained within them.

Coarse filter targets are plant communities and other ecological systems including both rare and common systems. Analyzing biological organization at this scale has two advantages. First, it enables one to factor in the role of ecological processes, such as the dominant disturbance regimes, that play an important role in maintaining the structure and function of ecological systems. Second, these larger scales of analysis are more likely to capture two important components of biological diversity: ecological and genetic variation. We selected coarse filter targets from the ecological systems in the LANDFIRE and USGS GAP analysis program ReGAP datasets.

The premise of the fine filter is to evaluate the individual species whose rarity or some aspect of life-history requirements might not be adequately captured by coarse-filter analyses. Candidates for the fine filter include, but are not limited to, species with narrow habitat requirements, rare or declining species, species extirpated from systems where their re-introduction is still feasible and important from an ecological standpoint, and species that have specific dispersal needs across multiple ecological systems and, therefore, may be particularly vulnerable to habitat fragmentation. The selection of fine filter species is necessarily biased by available data. However, ecoregional assessments typically include dozens of fine filter targets selected from a variety of taxonomic groups and spanning all levels of rarity (i.e., rare to common).

In this assessment, conservation targets, both species and ecological systems, were selected based upon their degree of endemism to the Mojave Desert Ecoregion, their current population status as endangered, threatened or declining, and their identification by experts in the field that they are unique or emblematic of this ecoregion. Natural Heritage data from the four states were used to identify all the globally rare species (labeled as G1 or G2) that inhabit this ecoregion and additional species or natural communities were added as warranted. Species such as the bighorn sheep (*Ovis canadensis nelsoni*) were included not for their rarity or uniqueness within the ecoregion but because of their ecology; they require a great range in elevation during the course of their life history. Species such as these become surrogates for the landscape-scale conservation needs of the Mojave Desert. When relatively common species such as kit fox (*Vulpes macrotis*) and Burrowing Owls (*Athene cunicularia*) were identified by field experts as formerly common but now in decline or subject to habitat-degrading activities such as expanding residential development, we included these species in our analysis whenever we had ecoregional-wide data for their occurrences.

In total, we selected 122 animal species and 399 plant species as conservation targets for the Mojave Desert. No new data or occurrence points were generated by this exercise since it was beyond the scope and the limited resources of the ecoregional assessment process. We used Natural Heritage occurrence data on the distributions for all target species except the desert tortoise for our spatial analysis. To correct for spotty and disparate information on tortoise occurrence data in the four states, we utilized the Desert Tortoise Recovery Office's (DTRO) recently completed habitat model for this species (Nussear et al. 2009). For example, the Nevada Natural Heritage Program considers all habitat below 5,000 feet as tortoise habitat rather than recording individual observations or collection points. California Natural Diversity Database includes large polygons for their tortoise records, whereas Utah Heritage Program normalizes all records to the square mile. The DTRO model indicates what should be appropriate tortoise habitat based upon a large number of individual occurrence record parameters such as slope, aspect, elevation, soil type, and surrounding vegetation composition. While this may overestimate the extent of current tortoise populations, it is undoubtedly more accurate in predicting where they are not found.

The ecoregion also supports a variety of ecological systems; for example, LANDFIRE data include 89 cover categories in the Mojave and REGAP data includes 98. Using both of these sources and the NatureServe Ecological System Descriptions for the Mojave Desert, we aggregated them into a list of 44 targets. The Ecological System Descriptions differ by ecological region, and our aggregation process removed those differences in order to simplify target identification (Table A-3). For example, Inter-Mountain Basins Mixed Saltbush Shrubland, Inter-Mountain Basins Mixed Salt Desert Scrub, and Sonora-Mojave Mixed Salt Desert Scrub were aggregated into the more general term "Mixed Salt Desert Scrub".

We used the LANDFIRE data to identify the location and spatial distribution of these ecological system targets. Where LANDFIRE mapped the landscape as Sparsely Vegetated or Barren, we inserted ReGAP data which yielded finer distinctions in these areas and introduced the categories: Cliff and Canyon, Desert Pavement, Dune, Playa, Marsh, Meadow, and Wash. We also extracted the locations of dry lake beds or playas from the USGS National Hydrologic Dataset in order to update the LANDFIRE/ReGAP data.

We also identified seeps and springs as conservation targets because of their great importance for plants and animals in this desert, including the fact that single springs and seeps or small clusters of them support narrowly distributed endemic species such as spring fishes, springsnails, amphibians, and plants.

Conservation Goal Selection

Conservation goals are identified for both coarse-filter and fine-filter targets. They are used for two purposes in ecoregional assessments: first, as a hypothesis for the number and distribution of each conservation target needed to maintain its viability; and, second, as an accounting unit to aid in determining the degree to which the identification of conservation areas meets established conservation goals. Conservation goals are typically expressed as a number and distribution of populations for species, and as an overall acreage, minimum patch size, and geographic distribution for ecological systems. Goals were set for our conservation targets following guidelines established in previous ecoregional planning processes and as described in Geography of Hope (TNC 2000).

> **Conservation Goals** represent the levels of protection estimated to be sufficient to allow the target to maintain viability, evolve, and persist within the ecoregion.

Conservation Status Ranks

The California Natural Diversity Database and the various state Natural Heritage Programs use a standardized system to assign conservation status ranks to plant, animal and fungal species. The rank is designated by a number from 1 to 5, preceded by a letter reflecting the geographic scale of the assessment (G = Global, N = National, and S = State) and it provides an estimate of extinction risk for the species. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable
4 = apparently secure
5 = demonstrably widespread, abundant and secure.

For example, G1 indicates that a species is critically imperiled across its entire range (i.e., globally). In this sense the species as a whole is regarded as being at very high risk of extinction. A rank of S3 indicates the species is vulnerable and at moderate risk within a particular state (or province), even though it may be more secure elsewhere. http://www.natureserve.org/explorer/ranking.htm

There is no hard and fast rule for setting conservation goals, as long as the rationale for their establishment is laid out *a priori*; the justification can be debated and the analysis rerun with different goals if necessary. In general, for species targets, we set goals based upon the degree of global rarity as tracked by the Natural Heritage Databases in each of the four states. High goals of 75 or 90% of occurrences were set for G1 or G2 species because they can be found nowhere else and are limited in their range and number of populations. For more common but declining species (G3-G5), such as the chuckwalla (*Sauromalus ater*), the goals were set lower, at 50 or 60%.

For ecological system targets, goals were based upon their typical patch size (matrix, large patch, small patch, or linear) as well as their global distribution (widespread, limited, or endemic). An example of a matrix-forming natural community in the Mojave Desert is Creosote-Bursage Scrub with a goal set at 25% of its spatial coverage in the ecoregion. Small patch communities such as Mesquite Bosque were assigned a goal of 60%, while that for seeps and springs was 90%. Table A-3 lists all the conservation goals for all targets.

It is important to note that these goals were set using general criteria commonly used in ecoregional assessments. As such, however, they should be considered to be statements of an initial hypothesis for viability of that target. As more detailed, target-specific information becomes available regarding needs of targets, protection goals may need to be adjusted, and the overall analysis adapted accordingly.

Stratification of the Planning Area

Due to the large size of the Mojave Desert Ecoregion and the significant vegetative, climatic (temperature and precipitation), and associated biotic differences across it, we sought an appropriate method of subdividing the ecoregion into subsections that would assist us in capturing the variation in representative target elements. Adhering to standards of ecoregional conservation reserve design used by The Nature Conservancy throughout the world, we stratified (subdivided) the Mojave into six subregions. These were the same subregions used and discussed in the 2001 Mojave Desert Ecoregional Assessment (The Nature Conservancy 2001[10]). These are a combination of previous Desert Tortoise Recovery units and divisions suggested by Dr. Peter Rowlands based upon dominant vegetation community variations throughout the Mojave Desert (Figure 2-2). This subdivision has also more recently been supported by Webb et al. (2009). The original Mojave Desert Ecoregional assessment (The Nature Conservancy 2001) provides additional details on the development of these subregions.

Marxan Analysis

The methods used in this assessment are based on the principles of systematic conservation planning (SCP), as originally described by Margules and Pressey (2000), and currently broadly adopted by government agencies and non-governmental organizations worldwide as a framework for prioritizing conservation investments. One of the primary components of SCP is the use of a transparent method to select areas as conservation priorities and the definition of design criteria that can be used to evaluate the effectiveness of the regional network in maintaining long-term ecological viability. These design criteria are based on broad principles of conservation biology that are meant to apply to multiple levels of biological organization (genes, species, populations, ecosystems) and provide opportunities for successful adaptation to rapid environmental change. To guide our selection of conservation priorities, we defined the following criteria:

- Representative: encompass full range of variability and full complement of biodiversity
- Redundant: include multiple examples of targets stratified across biophysical gradients
- Efficient: build on existing network of conservation lands where possible and appropriate
- Resilient: large enough to withstand disturbance, environmental change, and provide refugia
- Connected: maintain connectivity at multiple spatial and temporal scales for species and ecological processes.

Interestingly, many of these design criteria echo the recommendations for the creation of Desert Wildlife Management Areas in the Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994). In this assessment, these methods were implemented at various times during the planning process, from the selection of targets, definition of goals, assignment of subregions and suitability factors, selection of the boundary length modifier parameter, and assignment of planning units (259-hectare hexagons) to our tiered priority categories.

One key component common to many SCP processes is the use of software tools with reserve selection algorithms to generate multiple configurations of areas that meet conservation objectives. This allows planning teams to quickly generate reasonable solutions and test various assumptions regarding suitability, inclusion of existing conservation efforts, and goal levels. The choice of

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[10] The 2001 assessment, "*Ecoregion-based Conservation in the Mojave Desert*" is available for download at http://azconservation.org/downloads/multi/category/ecoregional_assessment/

quantitative representation and replication goals (discussed above) and the factors used to represent suitability for conservation (discussed below) have a significant effect on the location and total size of areas selected.

For this assessment, we used the conservation planning software tool Marxan, which has been the tool of choice for many Nature Conservancy projects around the world over the past decade (Ball et al. 2009). Also employed by many other organizations and governments, Marxan has been used in a total of 110 countries and is the most widely adopted conservation planning tool in the world. Hundreds of assessments and plans that employed Marxan have been published in peer-reviewed scientific publications[1] (Watts et al. 2009). It also has an active and connected user community and a peer-reviewed "Good Practices Manual" that discusses appropriate and effective methods for integrating Marxan in to conservation planning processes (Ardron et al. 2008).

The utility of Marxan is in the flexibility of inputs that can be used and the efficiency with which it can show the user what areas are important to achieve different conservation objectives. It uses a simulated annealing algorithm to meet an *objective function*, which incorporates multiple input factors including the suitability or "cost" of conservation in a given area, the level of dispersion of selected areas (measured by total length of boundaries of selected areas), a penalty for not attaining representation goals, and an optional penalty for exceeding total reserve cost. Within one scenario (same inputs, settings and goals), the software is run several times and each run selects areas that, as a group, efficiently meet the goals. Because the software does not use a strict optimization approach (which greatly increases computational time), each run selects a slightly different set of areas. Therefore, the number of times a planning unit is selected across the different runs is an important indicator of how important the planning unit is to meet the goals. This selection frequency is output by the model as the "summed solution" and is often used as a proxy for the *irreplaceability* of a location with respect to its contribution to overall goals. That is, if the user has Marxan run 10 (the number use used in the assessment) different runs, those planning units that get selected in eight of the ten runs are more irreplaceable than those that are selected less frequently.

The suitability or cost layer is one of the factors that can have a strong influence on the sites selected by Marxan. This can represent the actual monetary cost of land acquisition and management, but more commonly represents a proxy for the feasibility of successfully implementing conservation such as the degree of anthropogenic disturbance or fragmentation of natural habitats. Used in this way, fragmented areas are more "costly" and are avoided by Marxan. These factors will steer Marxan to areas that are more intact and less degraded to meet goals, with the assumption that conservation targets will be more viable when embedded in intact landscapes.

In this assessment, we used a composite of multiple inputs to calculate an anthropogenic disturbance score for each planning unit. This value was derived from the length of roads present in the planning unit and the extent of agricultural land. The urban footprint is often used in similar cost calculations. However, we opted to use the road network as a proxy for development,

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[1] For more information about Marxan, see : http://www.uq.edu.au/marxan/
For a brief list of Marxan references, see: http://www.uq.edu.au/marxan/index.html?page=80365

as there are many areas in the Mojave Desert where there are extensive road networks both with and without paved areas between them. This allowed us to assign high scores to highly-roaded but unpaved areas, which are highly disruptive to the ecology of the desert. We weighted the scores (length of road in meters per planning unit) by the type of road, with Interstates, State Highways, Divided Roads, and Railroads being given the highest weight (5x), followed by paved streets (3x), and then other roads (1x). We modified this layer to account for the relative influence of different management of road use and access. In particular, we reasoned that roads have a relatively low impact in National Parks, National Preserves, designated Wilderness, and Wilderness Study Areas because of the greater emphasis placed on patrolling and limiting traffic and illicit off-road use in these areas. Following this reasoning, we created a Potential Vehicular Impact index to adjust the cost score due to roads for each planning unit in these areas by multiplying the road score by 0.5.

The area of intensive agriculture (e.g., row crops, orchards, and irrigated pasture) in hectares was also calculated for each planning unit and added to the road score. The resultant raw anthropogenic disturbance scores had a wide range of values. We used a log transformation to narrow the range of the anthropogenic disturbance scores to 0 to 1,500. Scores falling within this range have been used effectively in other planning efforts by The Nature Conservancy in California that used Marxan with planning units of roughly the same size. We added 125 to the planning units with an anthropogenic disturbance score of 0 to dissuade Marxan from selecting them solely because of their extremely low cost relative to other planning units.

Marxan allows the user to automatically "lock-in" protected areas to act as nodes for selecting new areas to meet goals. We opted not to lock-in any existing protected areas into the runs because these areas are so extensive and were not designated based on their ecological value. This also allows Marxan to select planning units solely based on their contribution to the conservation objectives.

Another factor which influences the areas selected by the Marxan model is the boundary length modifier (blm). This parameter determines the maximum boundary to internal area ratio of areas selected by the model. A blm of 1 places the greatest restriction on the ratio, forcing the model to aggregate the sites selected, while lower values place fewer restrictions on the total boundary length allowing it to select areas based more on their individual contributions to the conservation goals. We tried multiple blm values and evaluated the degree of clumping and the goal attainment. In the end, in order to identify the set of areas that would both efficiently meet conservation goals and comprise a networked set of conservation areas vital to the long-term persistence of our targets, we conducted two scenarios of the Marxan model: one with a blm of 0.75 and another with a blm of 0.25.

We combined the summed solution results from both Marxan scenarios and the anthropogenic disturbance scores to assign each planning unit to one of four categories of conservation value: Ecologically Core, Ecologically Intact, Moderately Degraded, or Highly Converted (categories described in more detail below). Planning units that were selected in at least 8 of the 10 runs in either Marxan scenario were classified as Ecologically Core. Planning units that were identified fewer than eight times in both scenarios but that had an anthropogenic disturbance score of less than 250 (lower scores represent less disturbance) were classified as Ecologically Intact. Planning units that had an anthropogenic disturbance score of 800 or greater were classified as Highly Converted, and the remaining planning units were then classified as Moderately Degraded. These cut-offs were not statistically derived, but were based on evaluation of the level of disturbance evident from GIS data and aerial imagery. The process by which these "default" assignments of conservation value were revised and verified is described below.

Distinguishing Conservation Values of Lands in the Mojave Desert Ecoregion

Typically, an ecoregional assessment results in the identification of a portfolio of conservation areas that will ideally meet the conservation goals set for the protection of all of the targets while optimizing the shape and size of the proposed conservation areas to minimize both the inclusion of converted lands and the ratio of area to boundary. The aim of this approach is to design a portfolio that will protect as much biodiversity by preserving as little land (and water) as possible—that is, in the most efficient, cost-effective configuration of conservation sites. The Nature Conservancy utilizes such a portfolio to prioritize our work in an ecoregion with limited staff and other conservation resources.

In conducting our assessment, we initially followed the typical ecoregional assessment process by selecting targets and setting goals for these targets. We attributed high conservation value to areas with high landscape integrity, high target occurrence density (ecological systems and species occurrences), and unique examples of targets. These included areas with assemblages of targets not found elsewhere and areas with seeps and springs because these support high densities of target plants and animals, especially narrowly-distributed endemic species. However, since the purposes of this assessment differ in part from those which typically drive ecoregional assessments, it was determined that it would be more useful to represent the relative conservation value of all of the land in the Mojave Desert using a four-category scheme, designating each square-mile planning unit of the Mojave Desert as either Ecologically Core (greatest conservation value), Ecologically Intact, Moderately Degraded, or Highly Converted. Our categorization is explained in Table A-2.

An important principle in categorizing the whole of the ecoregion (rather than a collection of discrete sites) is that the ecological context in which conservation lands are embedded matters. Being complex and interconnected, ecosystems function across myriad scales. This assessment translates that concept into a spatial representation of relative conservation value across the desert. Fundamental to our thinking is that large, intact landscapes are more resilient to adverse changes and easier and more efficient to manage; thus, they should be a focus of protection and resource investments. It is important not to misconstrue the more altered categories as not having conservation value, however. We underscore that all areas, even those in the most altered category, may have important roles to play in protecting the full suite of the Mojave Desert's diversity. For example, a given site with a Highly Converted area may be important for the protection of a local population of a rare plant, or as a wildlife corridor between protected areas.

Table A-2 Conservation value categories

Category	Explanation
Ecologically Core	These lands have the highest conservation value. They are largely undisturbed and unfragmented, support conservation targets (species, ecological systems, springs and seeps), and were identified as critical to fully protect for the long-term conservation of the ecoregion's biological diversity. Despite the high inherent value of Ecologically Core lands, they do not stand alone; their conservation value is highly dependent on the connections between them and the buffering that the Ecologically Intact and even some of the Moderately Degraded lands around them provide. If significant portions of surrounding Ecologically Intact and Moderately Degraded lands are disturbed, developed, or otherwise compromised or further degraded in the future, then the conservation value of nearby Ecologically Core lands will diminish as well.
Ecologically Intact	These lands are relatively undisturbed and unfragmented and support conservation targets. They require levels of protection that will allow them to remain relatively undisturbed and to continue to support ecological processes and provide habitat and habitat connectivity for native animals, plants, and communities within and between ecoregions. The majority of Ecologically Intact lands are functionally equivalent to Ecologically Core lands and may contain many of the same conservation targets, including sensitive species. There are a number of reasons these lands may have classified as Ecologically Intact rather than Ecologically Core, including, but not limited to, the following: • Ecologically Intact lands may support more widespread ecological systems (e.g., creosote-scrub) that have lower conservation goals. • Ecologically Intact lands may be located in closer proximity to Moderately Degraded and Highly Converted lands and, therefore, are at higher risk of degradation due to edge effects or expansion of human disturbance. Areas that contain isolated conservation targets are more likely to be classified as Ecologically Core, as they are needed to attain the conservation goals.
Moderately Degraded	These are lands fragmented by roads or OHV trails, or are in close proximity to urban, agricultural and other developments. Moderately Degraded lands are partially to moderately compromised by fragmentation and other human impacts such as rural development, agriculture, OHV use, and military use. They often maintain ecological functionality (e.g., maintain groundwater infiltration and flow, serve as sand sources, provide connectivity), provide habitat for native species, or are known to have conservation target occurrences. The potential for Moderately Degraded lands to provide long-term conservation value and to be restored is greater where they are located adjacent to Ecologically Intact lands rather than Highly Converted lands. Without protection and perhaps restoration, the ability of Moderately Degraded lands to maintain functionality and sustain conservation targets will be reduced.

Table A-2 Conservation value categories

Category	Explanation
Highly Converted	Urban, agricultural and suburban lands were classified as Highly Converted. These lands are heavily altered. Some can support important conservation targets, although the ecological context of these targets is compromised. There are a few conservation targets, such as Burrowing Owls, a variety of migratory birds, and bats that use or congregate in these heavily modified landscapes. Highly Converted lands also subsidize predatory species such as coyotes and Ravens that can have detrimental effects on conservation targets such as the desert tortoise.

It should be noted that our assessment did not include an analysis of migratory bird pathways: an important component of a regional conservation assessment. Therefore, the utility of this assessment as a means of evaluating the appropriate siting of wind power generating facilities to avoid conflicts with migrating raptors or neotropical migratory bird species is limited.

The following post-Marxan processing was used to most accurately designate land categories.

1. All planning units within 0.5 mile of an Interstate or State highway road were designated as Moderately Degraded (or remained Highly Converted if already classed in this category). Planning units that intersected large paved roads (Class 3 from TIGER) were designated as Moderately Degraded (or remained in the Highly Converted category). An exception to his latter rule was made for those planning units within lands managed for conservation such as National Parks or Preserves. Further, we adjusted these latter areas through inspection of current imagery (ArcGISOnline.com) and corrected the designation where appropriate. Images exemplifying these categorical variations are provided in Figure A-1.

2. All planning units immediately adjacent to Highly Converted lands associated with most types of human land use such as residential, industrial, or agricultural land were designated as Moderately Degraded (unless they were already designated as Highly Converted). This rule did not apply to mining areas where the contained operations of a mine and private land surrounding the mining operations contributed to less disturbance and degradation of lands immediately adjacent to mines when compared to lands immediately adjacent to other human use areas such as suburban housing development or designated OHV open areas.

3. We evaluated the accuracy of the designation of each planning unit using satellite and aerial imagery to look for disturbed and otherwise degraded areas. Where appropriate, we also smoothed the edges of large landscape-scale blocks of each category type. Finally, we used the portfolio site polygons from the 2001 Mojave Desert Ecoregional Assessment (TNC 2001) and present-day information from expert interviews conducted in 2009 and 2010 to inform our categorization of the land. The portfolio site polygons from 2001 represent the status of lands at the time they were assessed, and there are cases where the conservation status of lands has changed in the interim. Therefore, information from the old portfolio was included in the current assessment following an audit using current

satellite and aerial imagery and expert opinion from the 2009 and 2010 interviews. Given the investment that The Nature Conservancy has made in place-based conservation work in the Mojave Desert, our own knowledge of on-the-ground conditions served as an additional means for ground-truthing the Marxan results in specific locations.

Through these verification processes, we attempted to ensure that our mapping effort represents the most accurate representation of lands according to our four-category scheme. This was a departure from the typical ecoregional assessment exercise of trying to capture as much biodiversity by preserving as little land as possible. Instead, we have endeavored to ensure that all lands are accurately categorized, and that high-conservation value lands are not designated as fragmented or as having urban or agricultural uses.

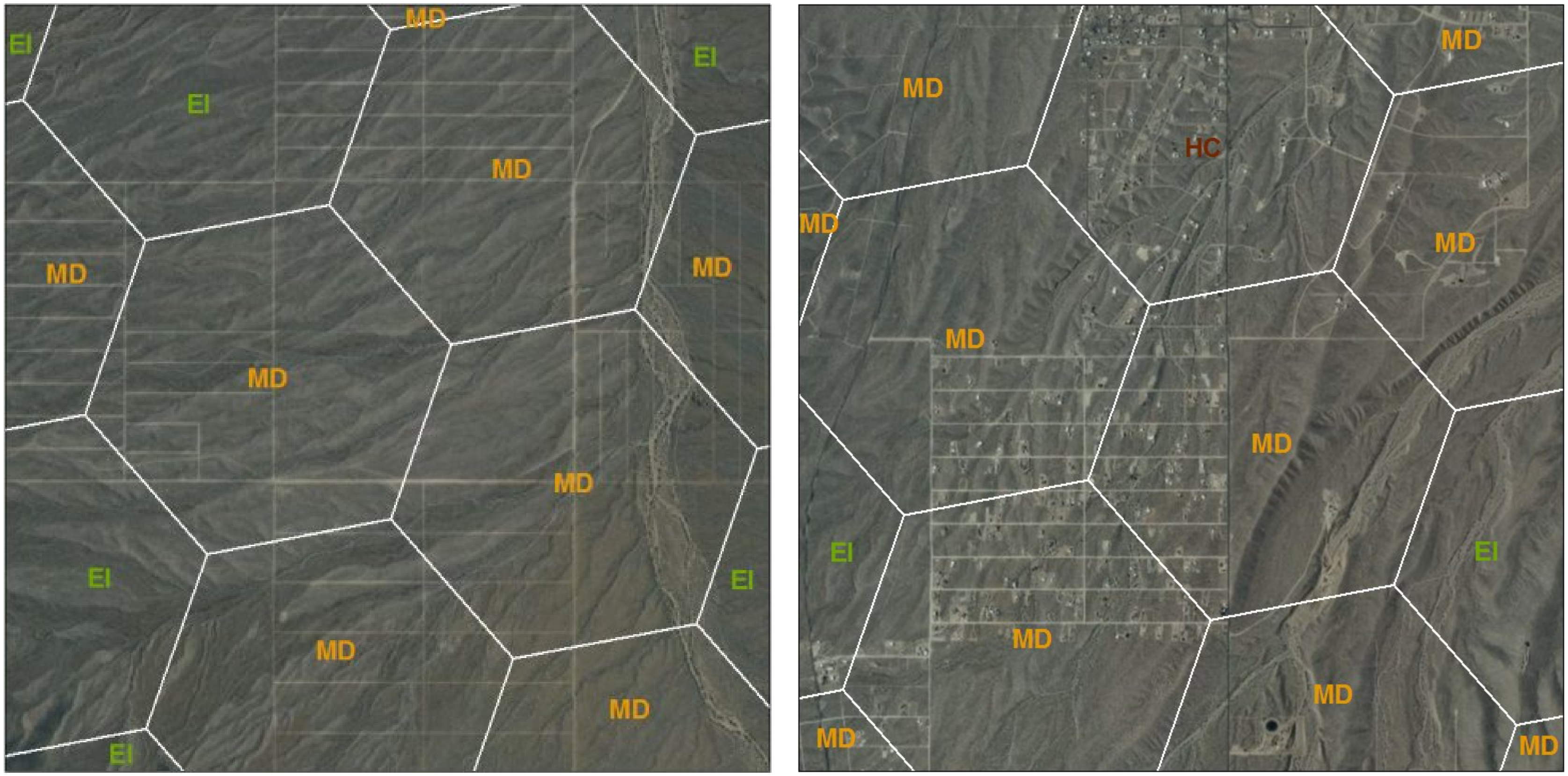

Figure A-1 Illustration of the Methods Used to Assign Disturbance Categories. While much of the historic land division is based on the square Township-Range section boundaries, with alternating sections being either publicly or privately owned, our planning units are hexagonal. This incongruity resulted in a broad range of land use density impacts within each category, particularly within the Moderately Degraded (MD) category. The predominance of impact in a planning unit overrides the presence of intact landscape and results in that planning unit receiving the lower categorical value. However, in many cases the integrity of the adjacent planning units can influence the resultant classification.

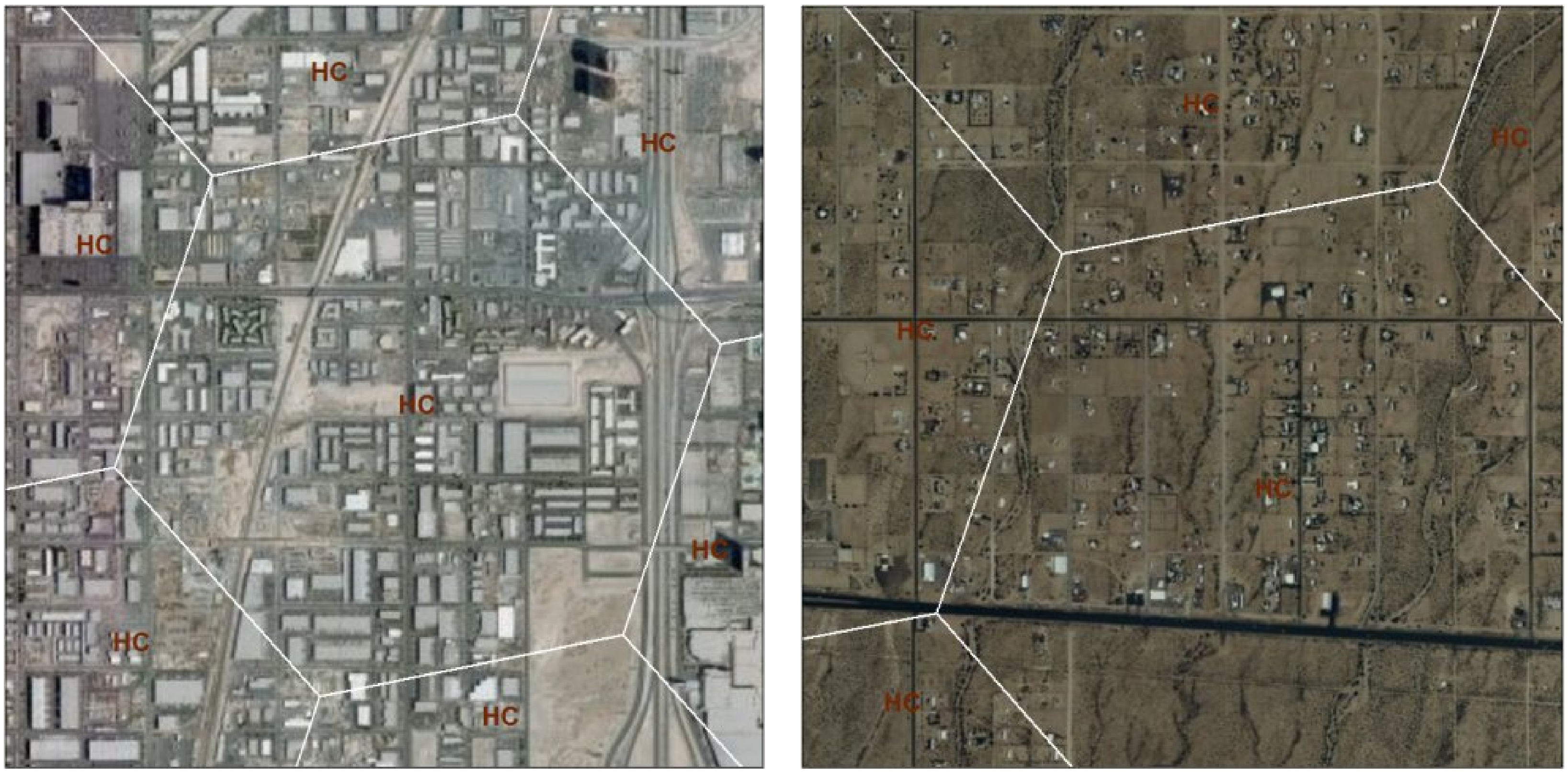

Figure A-1 (cont.) Range of land use impacts in the Highly Converted (HC) category, showing industrial development in Las Vegas (left) and rural residential development in the West Mojave (right). Both were classified as Highly Converted because, even though the rural residential development still contains natural habitat, the future viability of any conservation targets in that setting is low as the area is projected to continue to degrade.

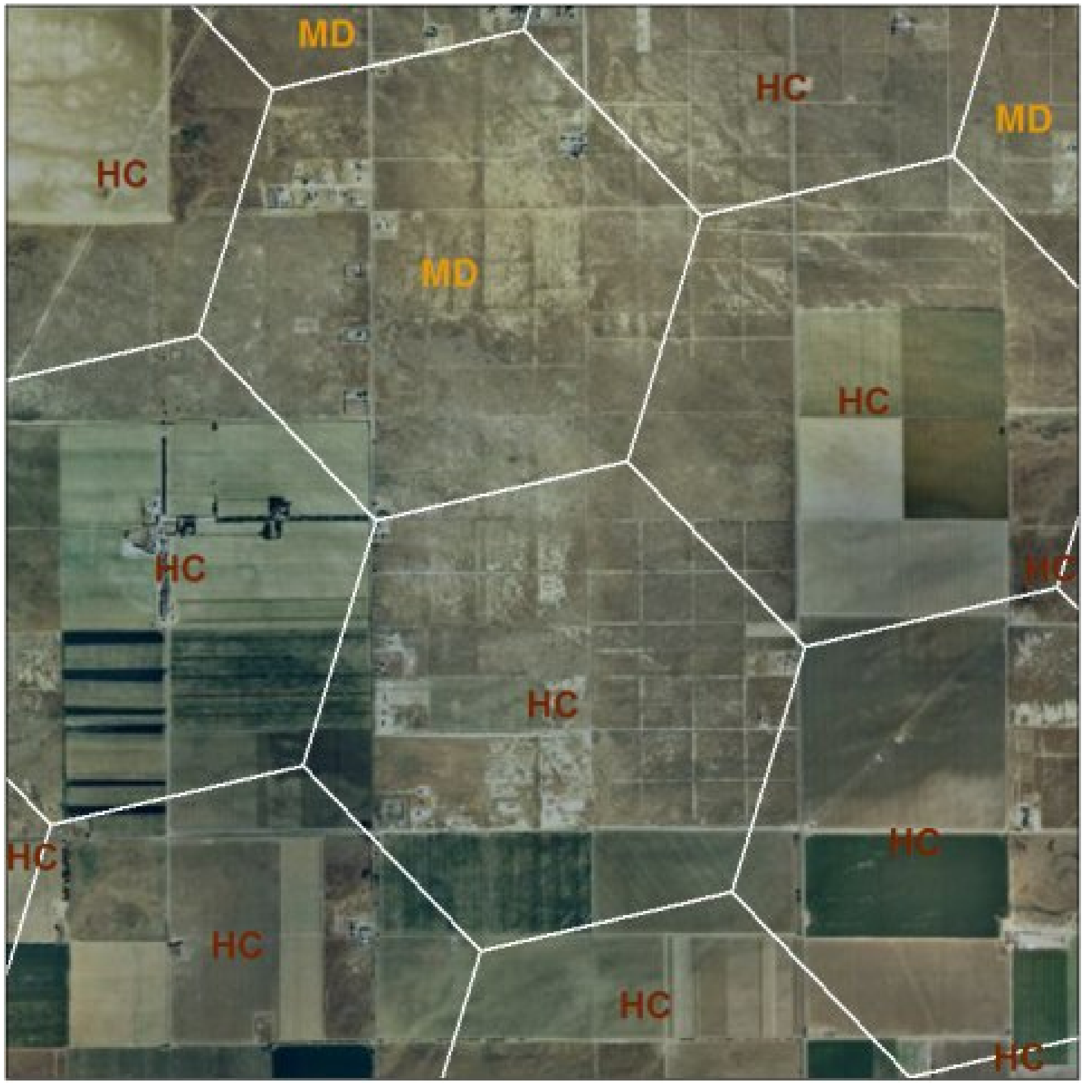

Figure A-1 (cont.) The existence of active agriculture across more than 25% of a planning unit resulted in its assignment to the Highly Converted (HC) category. This designation reflects both the surface degradation due to leveling and the subsurface aquifer depletion due to groundwater extraction for irrigation.

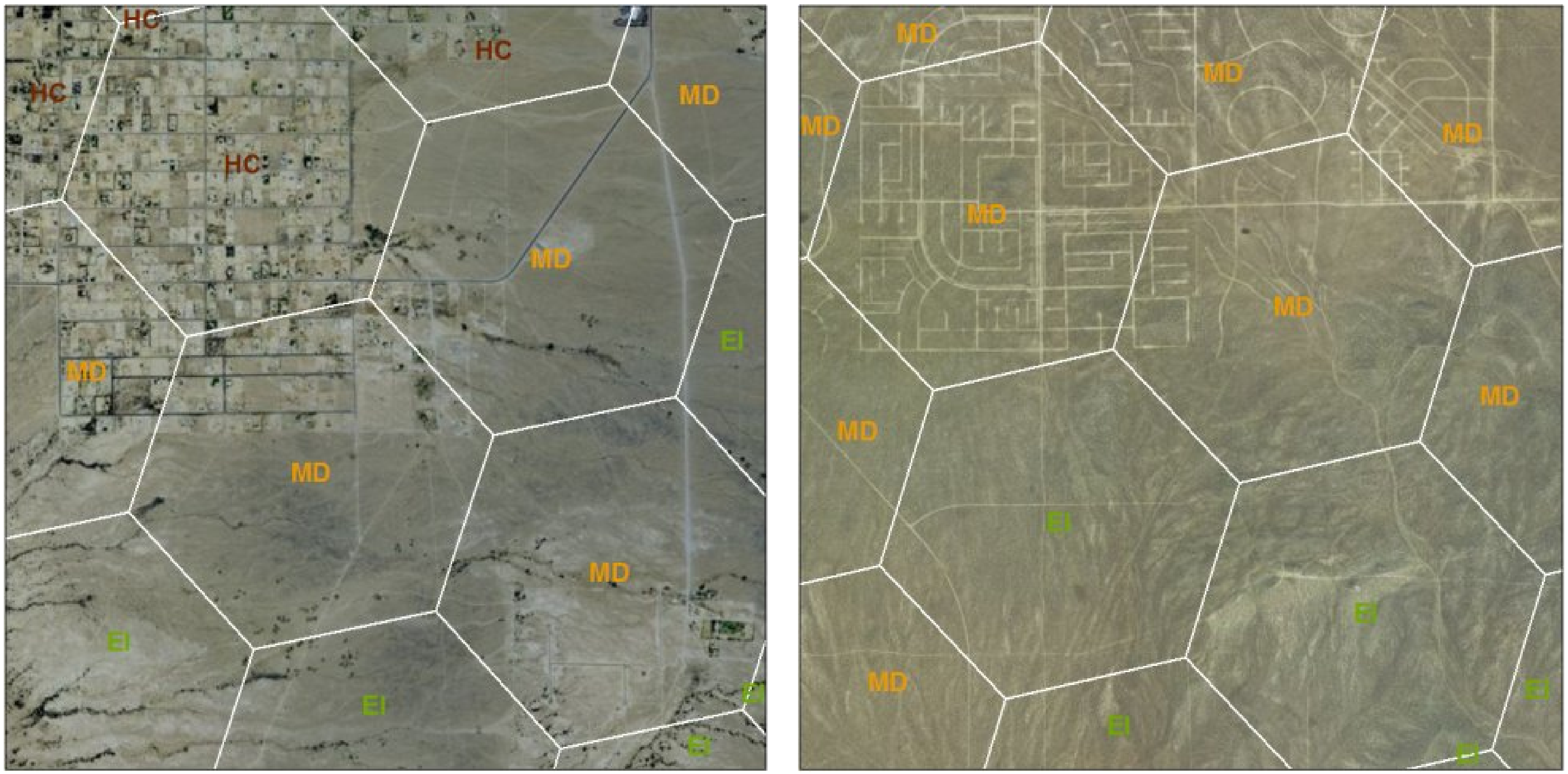

Figure A-1 (cont.) On the edge of development in Parhump, Nevada (left), the density of rural residential development and the associated habitat degrading activities (i.e., trash, OHV, pets, subsidized predators, etc.) lead to designation of the planning units as Moderately Degraded (MD) or Highly Converted (HC). On the outskirts of California City, California in the West Mojave (right), the density of roads associated with uninhabited speculative development was used to designate planning units as Moderately Degraded (MD) or Ecologically Intact (EI).

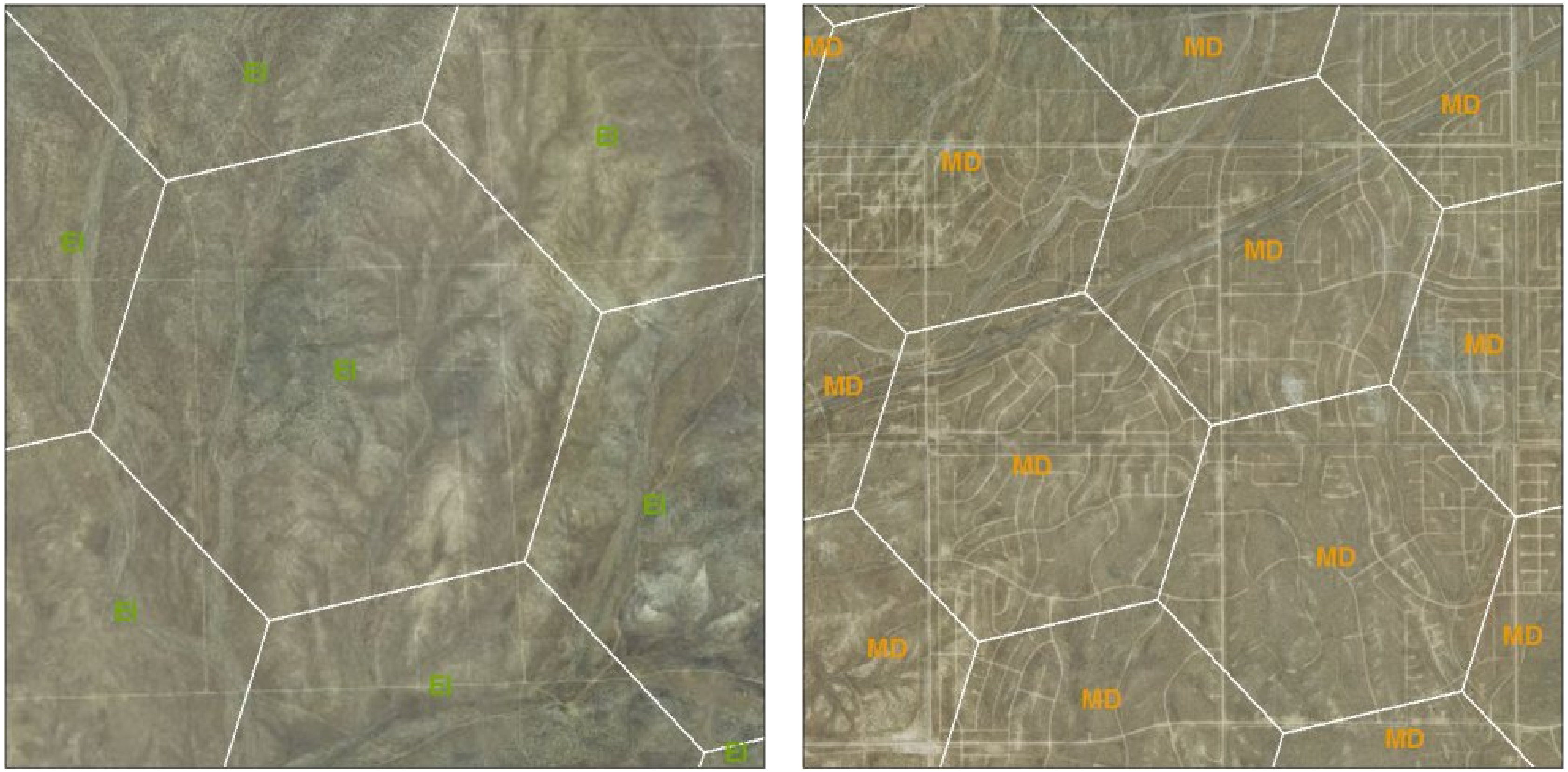

Figure A-1 (cont.) Unused roads in speculative land development areas, showing older roads that have begun to rehabilitate naturally and have regained their natural function (left), and newer roads that still compromise the integrity of the landscape. This difference accounts for their inclusion in separate categories.

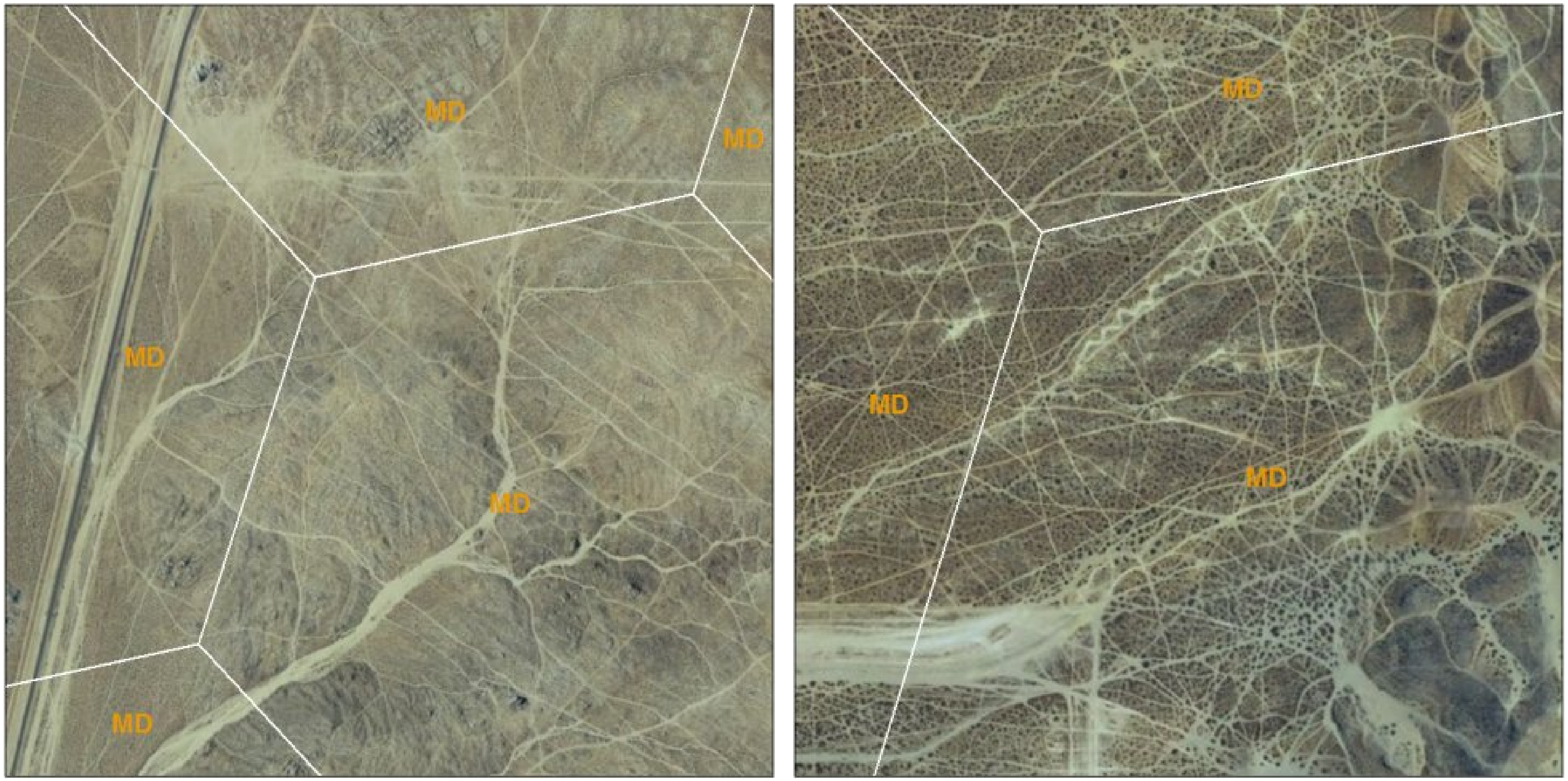

Figure A-1 (cont.) Degradation associated with vehicular use in the desert, showing land-based military training activities (left) and off-highway vehicle recreation on public lands (right), both of which cause high amounts of road and trail proliferation and subsequent loss of landscape integrity. These lands are degraded for the long-term (hundreds of years), but have not been completely converted with structures and paved roads, and were therefore designated as Moderately Degraded (MD) instead of Highly Converted (HC).

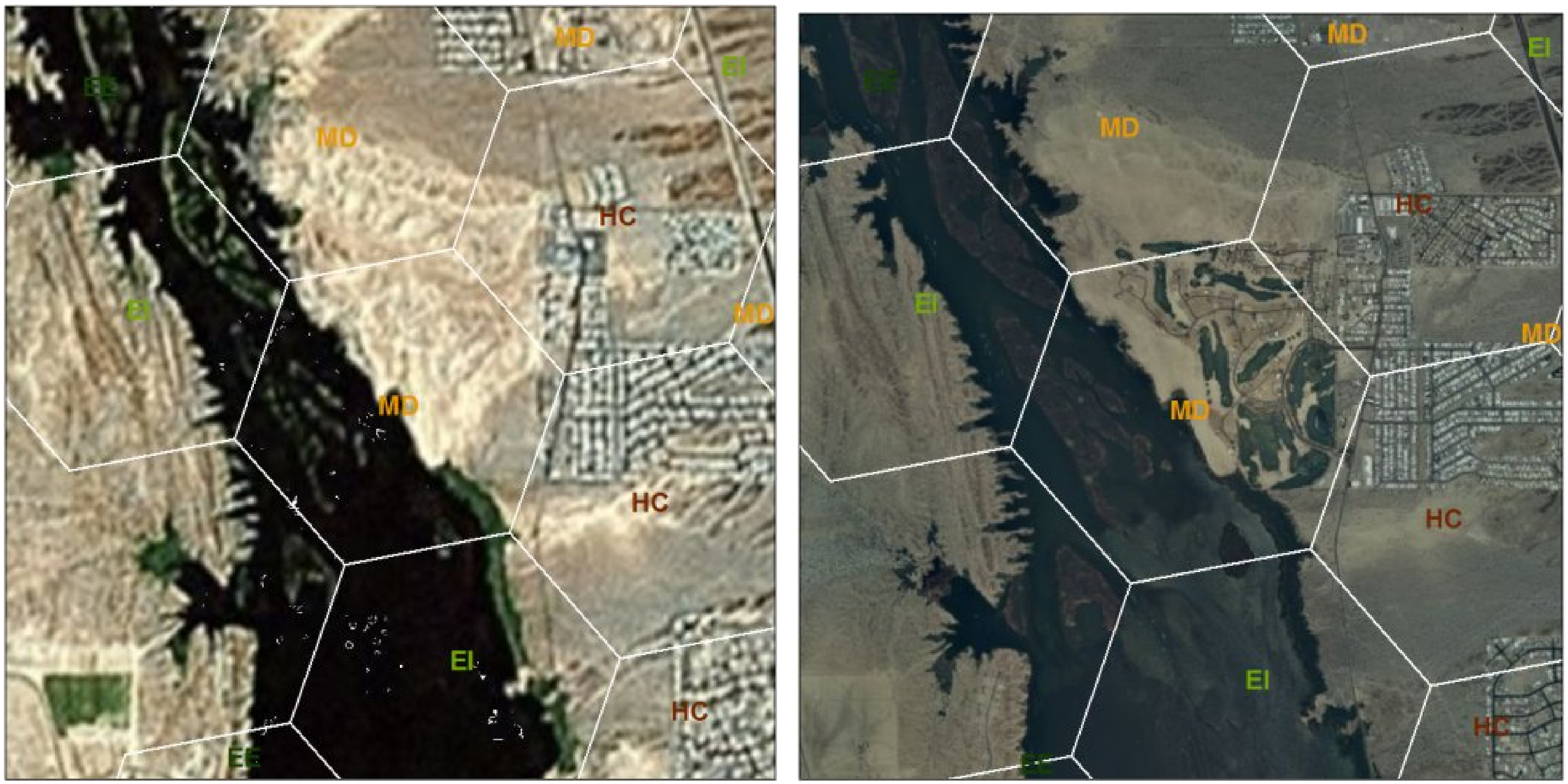

Figure A-1 (cont.) Resolution of imagery, showing how the imagery server (ArcGIS online Bing Maps) sets a scale threshold, such that lower resolution imagery (left) is shown until the scale of the view is set to 1:50,000 or larger (right). This can lead to errors of classification during the visual assessment, emphasizing the need to view the landscape at the proper scale in order to capture the most current land conversions.

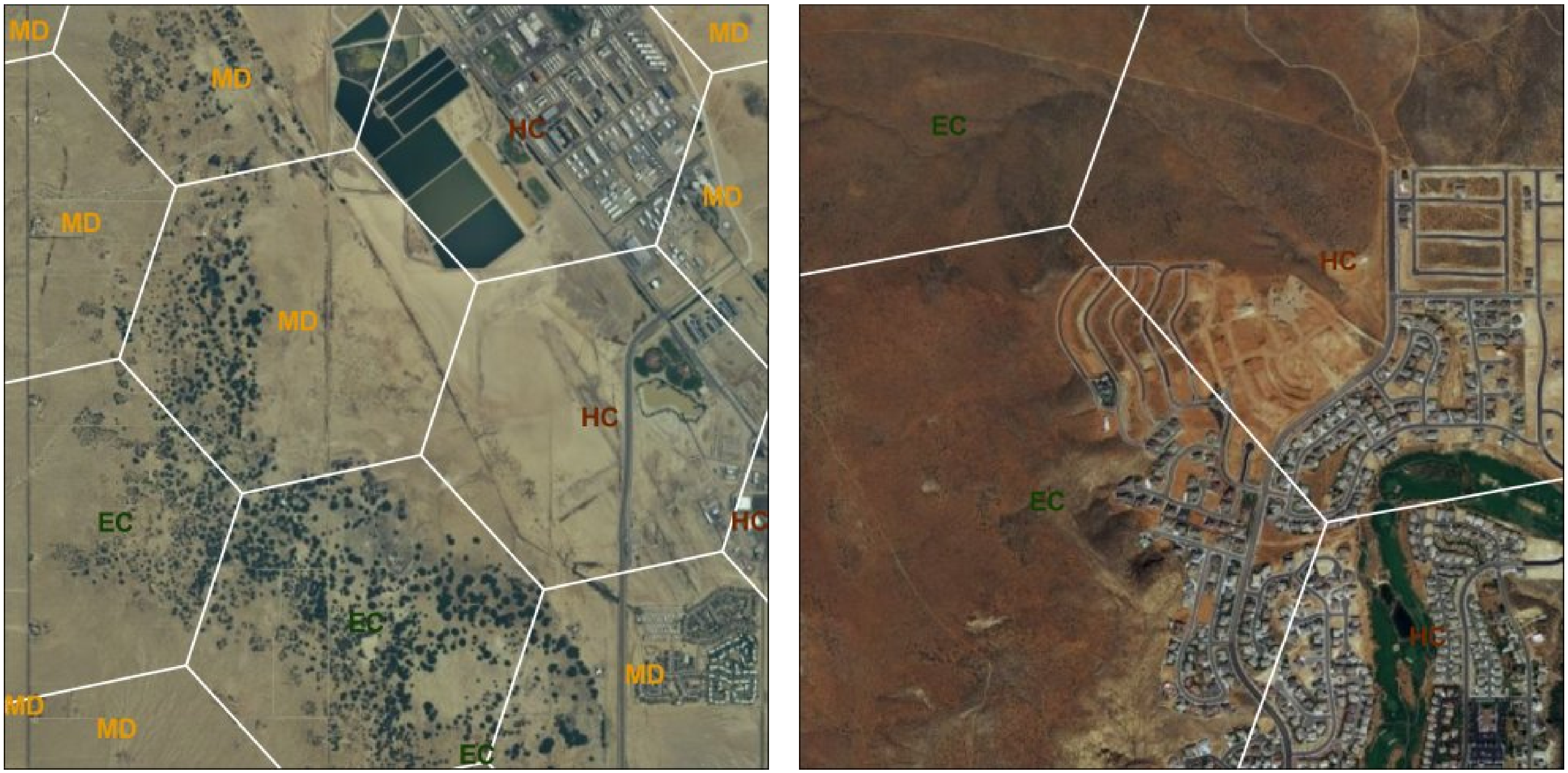

Figure A-1 (cont.) When important conservation targets, such as mesquite bosques (left), and chuckwallas, gila monsters, and rare plants (right), are in close proximity to development, we generally assigned the Moderately Degraded (MD) category to planning units adjacent to Highly Converted (HC) planning units. In some instances, however, the relatively high density or rarity of the conservation targets warranted inclusion of the planning units in the Ecologically Core (EC) or Ecologically Intact (EI) categories.

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Abronia villosa var. aurita	chaparral sand-verbena	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Abutilon parvulum	dwarf abutilon	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Acanthoscyphus parishii var. goodmaniana	Cushenbury oxytheca	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Achnatherum aridum	Mormon needle grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Aegialia knighti	aegialian scarab beetle	90%	all G1 and G2 species were given a goal of 90%
Aegialia magnifica	large aegialian scarab	90%	all G1 and G2 species were given a goal of 90%
Agave utahensis var. eborispina	ivory-spined agave	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Agelaius tricolor	Tricolored Blackbird	90%	all G1 and G2 species were given a goal of 90%
Ageratina herbacea	desert ageratina	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Aliciella ripleyi	Ripley's aliciella	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Aliciella triodon	coyote gilia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Ambrysus amargosus	Ash Meadows naucorid	90%	all G1 and G2 species were given a goal of 90%
Ambrysus funebris	Nevares Spring naucorid bug	90%	all G1 and G2 species were given a goal of 90%
Ammoselinum giganteum	desert sand-parsley	90%	all G1 and G2 species were given a goal of 90%
Amsonia jonesii	Jones blue star	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Anaxyrus californicus	arroyo toad	90%	all G1 and G2 species were given a goal of 90%
Anaxyrus exsul	black toad	90%	all G1 and G2 species were given a goal of 90%
Andrena balsamorhizae	Mojave gypsum bee	90%	all G1 and G2 species were given a goal of 90%
Androstephium breviflorum	small-flowered androstephium	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Angelica scabrida	rough angelica	90%	all G1 and G2 species were given a goal of 90%
Antennaria soliceps	Charleston pussytoes	90%	all G1 and G2 species were given a goal of 90%
Antrozous pallidus	pallid bat	60%	regional population trends are poorly known
Arabis dispar	pinyon rock-cress	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Arabis pulchra var. munciensis	Darwin rock-cress	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Arabis shockleyi	Shockley's rock-cress	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Arctomecon californica	Las Vegas bearpoppy	95%	G1 – endemic, dramatic population declines/habitat conversion
Arctomecon humilis	dwarf bearpaw-poppy	90%	all G1 and G2 species were given a goal of 90%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Arctomecon merriamii	Merriam's (white) bearpoppy	90%	all G1 and G2 species were given a goal of 90%
Arenaria congesta var. charlestonensis	Mount Charleston sandwort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Arenaria kingii ssp. rosea	King's rosy sandwort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Arenaria stenomeres	Meadow Valley sandwort	90%	all G1 and G2 species were given a goal of 90%
Argyrochosma limitanea var. limitanea	southwestern false cloak-fern	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Asclepias nyctaginifolia	Mojave milkweed	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Aspidoscelis tigris stejnegeri	coastal whiptail	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Assiminea infima	Badwater snail	90%	all G1 and G2 species were given a goal of 90%
Astragalus ackermanii	Ackerman milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus acutirostris	beaked milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus aequalis	Clokey milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus albens	Cushenbury milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus allochrous var. playanus	playa milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus amphioxys var. musimonum	Sheep Range milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus ampullarioides	Shivwits milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus ampullarius	Gumbo milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus atratus var. mensanus	Darwin Mesa milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus calycosus var. monophyllidius	One-leaflet Torrey milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus cimae var. cimae	Cima milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus cimae var. sufflatus	inflated Cima milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus ensiformis	Pagumpa milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus funereus	black woollypod	90%	all G1 and G2 species were given a goal of 90%
Astragalus geyeri var. triquetrus	threecorner milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus gilmanii	Gilman's milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus holmgreniorum	Holmgren (Paradox) milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus jaegerianus	Lane Mountain milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus lentiginosus var. ambiguus	freckled milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Astragalus lentiginosus var. antonius	San Antonio milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus lentiginosus var. micans	shining milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus lentiginosus var. sesquimetralis	Sodaville milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus lentiginosus var. stramineus	straw milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus mohavensis var. hemigyrus	halfring milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus mokiacensis	Mokiak milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus nyensis	Nye milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus oophorus var. clokeyanus	Clokey eggvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus phoenix	Ash Meadows milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus platytropis	broad-keeled milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus preussii var. laxiflorus	Littlefield milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus preussii var. preussii	Preuss' milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astragalus remotus	Spring Mountains milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus straturensis	Silver Reef Milkvetch	90%	all G1 and G2 species were given a goal of 90%
Astragalus tidestromii	Tidestrom's milkvetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Astrolepis cochisensis ssp. cochisensis	scaly cloak fern	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Athene cunicularia	Burrowing Owl	60%	G4/G5 species, same habitat loss as Desert tortoise, wider range
Atriplex argentea var. hillmanii	Hillman's silverscale	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Atriplex argentea var. longitrichoma	Pahrump silverscale	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Atriplex parishii	Parish's brittlescale	90%	all G1 and G2 species were given a goal of 90%
Balsamorhiza hookeri var. hispidula	a balsamroot	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Blepharidachne kingii	King's eyelash grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Boechera yorkii	Last Chance rockcress	90%	all G1 and G2 species were given a goal of 90%
Botrychium ascendens	upswept moonwort	90%	all G1 and G2 species were given a goal of 90%
Bouteloua trifida	three-awned grama	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Buddleja utahensis	Utah butterfly bush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Bufo microscaphus	Arizona toad	60%	Declining to stable (+/-10% fluctuation to 30% decline)

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Bufo nelsoni	Amargosa toad	90%	all G1 and G2 species were given a goal of 90%
Buteo regalis	Ferruginous Hawk	60%	Local declines have been noted
Buteo swainsoni	Swainson's Hawk	60%	Numbers have declined in the western U.S.
California macrophylla	round-leaved filaree	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Callisaurus draconoides	Mojave zebra-tailed lizard	60%	Relatively stable (+/- 25% change)
Calochortus excavatus	Inyo County star-tulip	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Calochortus palmeri var. palmeri	Palmer's mariposa-lily	90%	all G1 and G2 species were given a goal of 90%
Calochortus plummerae	Plummer's mariposa-lily	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Calochortus striatus	alkali mariposa lily	90%	all G1 and G2 species were given a goal of 90%
Camissonia boothii ssp. boothii	Booth's evening-primrose	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Camissonia boothii ssp. intermedia	Booth's hairy evening-primrose	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Camissonia brevipes	golden suncup	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Camissonia exilis	slender evening-primrose	90%	all G1 and G2 species were given a goal of 90%
Canbya candida	white pygmy-poppy	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cardinalis cardinalis	Northern Cardinal	75%	found along Colorado River
Castela emoryi	Emory's crucifixion-thorn	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Castilleja stenantha	California indian paintbrush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Catharus ustulatus	Swainson's Thrush	60%	Relatively stable (+/- 25% change)
Catostomus clarkii ssp. 2	Meadow Valley Wash desert sucker	90%	limited to Meadow Valley
Catostomus latipinnis	flannelmouth sucker	75%	Declining (decline of 10-30%)
Centaurium namophilum	spring-loving centaury	90%	all G1 and G2 species were given a goal of 90%
Chaetadelpha wheeleri	Wheeler's dune-broom	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Chamaesyce abramsiana	Abrams' spurge	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Chamaesyce parryi	Parry's spurge	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Chamaesyce platysperma	flat-seeded spurge	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Charadrius alexandrinus nivosus	Western Snowy Plover	75%	uses alkali and mud flats for nesting away from coast
Charadrius montanus	Mountain Plover	90%	all G1 and G2 species were given a goal of 90%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Cheilanthes wootonii	Wooton's lace fern	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Chionactis occipitalis occipitalis	Mohave shovel-nosed snake	60%	some disagreement about distribution of subspecies
Chloroceryle americana	Green Kingfisher	75%	Stable
Chlosyne acastus robusta	Spring Mountains acastus checkerspot	90%	Declining to stable (+/-10% fluctuation to 30% decline)
Chrysothamnus eremobius	remote rabbitbrush	90%	all G1 and G2 species were given a goal of 90%
Chrysothamnus greenei	Greene's rabbitbrush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Chrysothamnus teretifolius	roundleaf rabbitbrush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cirsium arizonicum var. tenuisectum	desert mountain thistle	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cirsium eatonii var. clokeyi	Clokey thistle	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cirsium virginense	Virgin River thistle	90%	all G1 and G2 species were given a goal of 90%
Cistothorus palustris	Marsh Wren	60%	apparently stable
Cladium californicum	California saw-grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Clarkia xantiana ssp. parviflora	Kern Canyon clarkia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Coccyzus americanus occidentalis	Western Yellow-billed Cuckoo	75%	Very large decline (decline of >90%)
Coleonyx variegatus	banded gecko	60%	Stable
Coleonyx variegatus utahensis	Utah banded gecko	60%	unknown level of threat
Colubrina californica	Las Animas Colubrina	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cordylanthus parviflorus	small-flowered bird's-beak	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cordylanthus tecopensis	Tecopa birdsbeak	90%	all G1 and G2 species were given a goal of 90%
Corispermum americanum var. americanum	American bugseed	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Corynorhinus townsendii	Townsend's big-eared bat	60%	More data needed
Coryphantha alversonii	Alverson's foxtail cactus	75%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Coryphantha chlorantha	desert pincushion	90%	all G1 and G2 species were given a goal of 90%
Coryphantha vivipara var. rosea	viviparous foxtail cactus	75%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Crenichthys baileyi baileyi	White River springfish	90%	all G1 and G2 species were given a goal of 90%
Crenichthys baileyi grandis	Hiko White River springfish	90%	all G1 and G2 species were given a goal of 90%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Crenichthys baileyi moapae	Moapa White River springfish	90%	all G1 and G2 species were given a goal of 90%
Crossidium seriatum	rough fringemoss	90%	all G1 and G2 species were given a goal of 90%
Crotalus cerastes	desert sidewinder	60%	Relatively stable (+/- 25% change)
Crotalus cerastes cerastes	Mojave desert sidewinder	60%	less threatened
*Crotalus mitchellii pyrrhus**	southwestern speckled rattlesnake	60%	*not in natureserve, used Crotalus mitchellii
Crotalus scutulatus scutulatus	Mojave rattlesnake	60%	less threatened
Cryptantha clokeyi	Clokey's cryptantha	90%	all G1 and G2 species were given a goal of 90%
Cuniculotinus gramineus	Panamint rock-goldenrod	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cymopterus deserticola	desert cymopterus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cymopterus gilmanii	Gilman's cymopterus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cymopterus multinervatus	purple-nerve cymopterus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cymopterus ripleyi var. saniculoides	sanicle cymopterus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cynanchum utahense	Utah swallowwort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Cynomys parvidens	Utah prairie-dog	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon diabolis	Devils Hole pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon macularius	desert pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon nevadensis amargosae	Amargosa pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon nevadensis mionectes	Ash Meadows Amargosa pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon nevadensis nevadensis	Saratoga Springs pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon nevadensis pectoralis	Warm Springs Amargosa pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon nevadensis shoshone	Shoshone pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon radiosus	Owens pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon salinus milleri	Cottonball Marsh pupfish	90%	all G1 and G2 species were given a goal of 90%
Cyprinodon salinus salinus	Salt Creek pupfish	90%	all G1 and G2 species were given a goal of 90%
Dedeckera eurekensis	July gold	90%	all G1 and G2 species were given a goal of 90%
Deinandra arida	Red Rock tarplant	90%	all G1 and G2 species were given a goal of 90%
Deinandra mohavensis	Mojave tarplant	90%	all G1 and G2 species were given a goal of 90%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Dendroica petechia brewsteri	Yellow Warbler	75%	Substantial to moderate decline (decline of 25-75%)
Dendroica petechia sonorana	Sonoran Yellow Warbler	75%	less threatened, broad range but depends on riparian habitat
Dermatocarpon luridum	a foliose "umbilicate" lichen	90%	Streamside or lakeside rocks where frequently wetted
Dermatocarpon luridum	Stream Stippleback Lichen	90%	all G1 and G2 species were given a goal of 90%
Didymodon nevadensis	Gold Butte moss	90%	all G1 and G2 species were given a goal of 90%
Digitaria californica	Arizona cottontop	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Dipodomys microps celsus	a chisel-toothed kangaroo rat	60%	less threatened
Dipodomys panamintinus argusensis	Argus Mountains kangaroo rat	90%	entire range within China Lake
Dipsosaurus dorsalis	desert iguana	60%	G4, limited range, sandy habitat loss/solar energy development
Ditaxis serrata var. californica	California ditaxis	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Draba brachystylis	Wasatch draba	90%	all G1 and G2 species were given a goal of 90%
Draba jaegeri	Jaeger whitlowcress	90%	all G1 and G2 species were given a goal of 90%
Draba paucifructa	Charleston draba	90%	all G1 and G2 species were given a goal of 90%
Dudleya abramsii ssp. affinis	San Bernardino Mountains dudleya	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Dudleya pulverulenta ssp. arizonica	chalk liveforever	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Echinocactus polycephalus var. polycephalus	clustered barrel cactus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Echinocactus polycephalus var. xeranthemoides	Grand Canyon cottontop cactus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Echinocereus engelmannii var. howei	Howe's hedgehog cactus	75%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Elgaria panamintina	Panamint alligator lizard	90%	all G1 and G2 species were given a goal of 90%
Empetrichthys latos latos	Pahrump poolfish	90%	all G1 and G2 species were given a goal of 90%
Empidonax traillii extimus	Southwestern Willow Flycatcher	90%	Very large to large decline (decline of 75% to >90%)
Enceliopsis argophylla	silverleaf sunray	90%	all G1 and G2 species were given a goal of 90%
Enceliopsis nudicaulis	nudestem sunray	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Enceliopsis nudicaulis var. corrugata	Ash Meadows sunray	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Enneapogon desvauxii	nine-awned pappus grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Ephedra funerea	Death Valley Mormon tea	90%	all G1 and G2 species were given a goal of 90%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Epilobium nevadense	Nevada willowherb	90%	all G1 and G2 species were given a goal of 90%
Eremarionta rowelli bakerensis	Baker's desertsnail	90%	all G1 and G2 species were given a goal of 90%
Eriastrum densifolium ssp. sanctorum	Santa Ana River woollystar	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriastrum harwoodii	Harwood's eriastrum	90%	all G1 and G2 species were given a goal of 90%
Ericameria cervina	tawny turpentine bush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Ericameria compacta	Charleston goldenbush	90%	all G1 and G2 species were given a goal of 90%
Ericameria gilmanii	Gilman's goldenbush	90%	all G1 and G2 species were given a goal of 90%
Erigeron canaani	Canaan daisy	90%	all G1 and G2 species were given a goal of 90%
Erigeron ovinus	sheep fleabane	90%	all G1 and G2 species were given a goal of 90%
Erigeron parishii	Parish's daisy	90%	all G1 and G2 species were given a goal of 90%
Erigeron uncialis var. uncialis	limestone daisy	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Erigeron utahensis	Utah daisy	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriodictyon angustifolium	narrow-leaved yerba santa	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum bifurcatum	Pahrump Valley buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum concinnum	Darin buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum contiguum	Amargosa buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum corymbosum var. nilesii	Las Vegas buckwheat	75%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum darrovii	Darrow's buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum eremicola	Wildrose Canyon buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum gilmanii	Gilman's buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum heermannii var. clokeyi	Clokey buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum hoffmannii var. hoffmannii	Hoffmann's buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum hoffmannii var. robustius	robust Hoffmann's buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum intrafractum	jointed buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum mensicola	Pinyon Mesa buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum microthecum var. panamintense	Panamint Mountains buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum ovalifolium var. vineum	Cushenbury buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Eriogonum puberulum	downy buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum thompsoniae var. albiflorum	White-flow Thompson wild buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum thornei	Thorne's buckwheat	90%	all G1 and G2 species were given a goal of 90%
Eriogonum umbellatum var. juniporinum	juniper sulphur-flowered buckwheat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriogonum viscidulum	sticky buckwheat	90%	all G1 and G2 species were given a goal of 90%
Erioneuron pilosum	hairy erioneuron	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Eriophyllum mohavense	Barstow woolly sunflower	90%	all G1 and G2 species were given a goal of 90%
Eschscholzia minutiflora ssp. twisselmannii	Red Rock poppy	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Euderma maculatum	spotted bat	60%	Stable
Euphilotes ancilla giulianii	Giuliani's blue	90%	Inhabits ecological refugia, or specialized or unique habitats
Euphilotes ancilla purpura	Spring Mountains dark blue	90%	Few (1-3) occurrences appropriately protected and managed
Euphilotes bernardino inyomontana	Bret's blue (Spring Mtns phenotype)	90%	Very narrow range
Euphydryas anicia morandi	Morand's checkerspot	90%	Stable, very limited range
Fimbristylis thermalis	hot springs fimbristylis	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Galium bifolium	twoleaf bedstraw	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Galium hilendiae ssp. carneum	Panamint Mountains bedstraw	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Galium hilendiae ssp. kingstonense	Kingston Mountains bedstraw	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Galium hypotrichium ssp. tomentellum	Telescope Peak bedstraw	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Galium proliferum	desert bedstraw	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Galium wrightii	Wright's bedstraw	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Gila bicolor mohavensis	Mohave tui chub	90%	Declining (decline of 10-30%)
Gila bicolor snyderi	Owens tui chub	90%	Stable
Gila elegans	bonytail chub	90%	all G1 and G2 species were given a goal of 90%
Gila orcuttii	arroyo chub	90%	all G1 and G2 species were given a goal of 90%
Gila robusta jordani	Pahranagat roundtail chub	90%	all G1 and G2 species were given a goal of 90%
Gila seminuda	Virgin River chub	90%	all G1 and G2 species were given a goal of 90%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Gila seminuda pop. 2	Virgin River chub (Muddy River pop.)	90%	all G1 and G2 species were given a goal of 90%
Gilmania luteola	golden-carpet gilmania	90%	all G1 and G2 species were given a goal of 90%
Glossopetalon clokeyi	Clokey greasebush	90%	all G1 and G2 species were given a goal of 90%
Glossopetalon pungens	pungent glossopetalon	90%	all G1 and G2 species were given a goal of 90%
Glossopetalon pungens var. glabrum	smooth dwarf greasebush	90%	all G1 and G2 species were given a goal of 90%
Glossopetalon pungens var. pungens	rough dwarf greasebush	90%	all G1 and G2 species were given a goal of 90%
Gopherus agassizii	desert tortoise	50%	G4/G5, but experiencing major die-offs, multiple use mgmt across its limited range, federally listed as Threatened
Grimmia americana	American grimmia	90%	all G1 and G2 species were given a goal of 90%
Grindelia fraxinopratensis	Ash Meadows gumplant	90%	all G1 and G2 species were given a goal of 90%
Grusonia parishii	Parish's club-cholla	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Haliaeetus leucocephalus pop. 3	Bald Eagle - Sonoran Desert area population	90%	edge of range
Haplopappus crispus	Pine Valley goldenbush	90%	all G1 and G2 species were given a goal of 90%
Hedeoma drummondii	Drummond's false pennyroyal	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Helianthus deserticola	dune sunflower	90%	all G1 and G2 species were given a goal of 90%
Helminthoglypta mohaveana	Victorville shoulderband	90%	all G1 and G2 species were given a goal of 90%
Helminthoglypta taylori	Westfork shoulderband	90%	all G1 and G2 species were given a goal of 90%
Heloderma suspectum cinctum	banded gila monster	75%	Largely unknown range status, public lands multiple-use mgmt
Hesperia colorado mojavensis	Spring Mountains comma skipper	60%	Stable
Heterotheca jonesii	Jones golden-aster	90%	all G1 and G2 species were given a goal of 90%
Hubbardia shoshonensis	Shoshone Cave whip-scorpion	90%	all G1 and G2 species were given a goal of 90%
Hulsea vestita ssp. inyoensis	Inyo hulsea	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Hymenopappus filifolius var. eriopodus	hairy-podded fine-leaf hymenopappus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Hymenopappus filifolius var. nanus	little cutleaf	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Icaricia icarioides austinorum	Spring Mountains icarioides blue	90%	Stable; 5 or fewer metapopulations

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Icaricia shasta charlestonensis	Spring Mountains blue	90%	Severely declining to declining (decline of 50% to >70%); very possibly extinct
Idionycteris phyllotis	Allen's big-eared bat	60%	Relatively stable (+/- 25% change)
Imperata brevifolia	California satintail	90%	all G1 and G2 species were given a goal of 90%
Ionactis caelestis	Red Rock Canyon aster	90%	all G1 and G2 species were given a goal of 90%
Ipnobius robustus	robust tryonia	90%	all G1 and G2 species were given a goal of 90%
Ivesia arizonica var. arizonica	yellow ivesia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Ivesia cryptocaulis	hidden ivesia	90%	all G1 and G2 species were given a goal of 90%
Ivesia jaegeri	Jaeger ivesia	90%	all G1 and G2 species were given a goal of 90%
Ivesia kingii var. eremica	Ash Meadows mousetails	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Ivesia patellifera	Kingston Mountains ivesia	90%	all G1 and G2 species were given a goal of 90%
Ixobrychus exilis	Least Bittern	75%	Declining to stable (+/-10% fluctuation to 30% decline)
Junco hyemalis caniceps	Gray-headed Junco	75%	less threatened, broad range but depends on riparian habitat
Juncus interior	inland rush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Juncus nodosus	knotted rush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Lampropeltis pyromelana infralabialis	Utah Mountain Kingsnake	75%	broader range than state rankings indicate: also found in NV & UT
Lasionycteris noctivagans	silver-haired bat	60%	Presumed stable; trends are poorly known.
Lasiurus cinereus	hoary bat	60%	Widespread throughout the Americas
Lathyrus hitchcockianus	Bullfrog Hills sweetpea	90%	all G1 and G2 species were given a goal of 90%
Lepidomeda mollispinis	Virgin spinedace	90%	all G1 and G2 species were given a goal of 90%
Lepidomeda mollispinis mollispinis	Virgin River spinedace	90%	all G1 and G2 species were given a goal of 90%
Leymus salinus ssp. mojavensis	hillside wheat grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Limenitis weidemeyerii nevadae	Nevada admiral	90%	Stable, not surveyed recently in 1 of 2 ranges where found
Limnocoris moapensis	Warm Springs naucorid	90%	all G1 and G2 species were given a goal of 90%
Linanthus maculatus	Little San Bernardino Mtns. linanthus	90%	all G1 and G2 species were given a goal of 90%
Linum puberulum	plains flax	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Lithobates onca	relict leopard frog	90%	all G1 and G2 species were given a goal of 90%
Lithospermum incisum	plains stoneseed	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Loeflingia squarrosa var. artemisiarum	sagebrush loeflingia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Lomatium foeniculaceum var. macdougalii	Macdougal's lomatium	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Lotus argyraeus var. multicaulis	scrub lotus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Lupinus holmgrenianus	Holmgren's lupine	90%	all G1 and G2 species were given a goal of 90%
Lupinus latifolius ssp. leucanthus	broadleaf lupine	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Lupinus magnificus var. magnificus	Panamint Mountains lupine	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Lycium torreyi	Torrey wolf-berry	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Machaeranthera bigelovii var. bigelovii	Bigelow's tansy-aster	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Macrobaenetes kelsoensis	Kelso giant sand treader cricket	90%	all G1 and G2 species were given a goal of 90%
Macrotus californicus	California leaf-nosed bat	60%	less threatened, with broad range
Matelea parvifolia	spear-leaf matelea	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Maurandya antirrhiniflora ssp. antirrhiniflora	violet twining snapdragon	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Maurandya petrophila	rock lady	90%	all G1 and G2 species were given a goal of 90%
Megandrena mentzeliae	red-tailed blazing star bee	90%	all G1 and G2 species were given a goal of 90%
Melanerpes uropygialis	Gila Woodpecker	60%	non-significant decline, needs more monitoring
Menodora scabra	rough menodora	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Mentzelia inyoensis	Inyo blazing star	90%	all G1 and G2 species were given a goal of 90%
Mentzelia leucophylla	Ash Meadows blazingstar	90%	all G1 and G2 species were given a goal of 90%
Mentzelia polita	polished blazing star	90%	all G1 and G2 species were given a goal of 90%
Mentzelia pterosperma	wing-seed blazing star	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Mentzelia tridentata	creamy blazing star	90%	all G1 and G2 species were given a goal of 90%
Micrathene whitneyi	Elf Owl	60%	Declining in California
Microcylloepus formicoideus	Furnace Creek riffle beetle	90%	all G1 and G2 species were given a goal of 90%
Microdipodops megacephalus albiventer	desert valley kangaroo mouse	90%	all G1 and G2 species were given a goal of 90%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Microtus californicus mohavensis	Mohave river vole	90%	endemic to San Bernardino Co., CA
Microtus californicus scirpensis	Amargosa vole	90%	Most of known occupied habitat is privately owned
Microtus californicus vallicola	Owens Valley vole	90%	endemic to Inyo and Mono Co., CA
Microtus montanus fucosus	Pahranagat Valley montane vole	90%	endemic to Lincoln Co, NV
Miloderes nelsoni	Nelson's miloderes weevil	90%	all G1 and G2 species were given a goal of 90%
Miloderes sp. 1	Big Dune miloderes weevil	90%	all G1 and G2 species were given a goal of 90%
Mimulus mohavensis	Mojave monkeyflower	90%	all G1 and G2 species were given a goal of 90%
Mirabilis coccinea	red four o'clock	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Moapa coriacea	Moapa dace	90%	all G1 and G2 species were given a goal of 90%
Monarda pectinata	plains bee balm	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Monardella robisonii	Robison's monardella	90%	all G1 and G2 species were given a goal of 90%
Muhlenbergia alopecuroides	wolftail	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Muhlenbergia arsenei	tough muhly	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Muhlenbergia fragilis	delicate muhly	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Muhlenbergia pauciflora	few-flowered muhly	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Munroa squarrosa	false buffalo-grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Myiarchus tyrannulus	Brown-crested Flycatcher	75%	less threatened, broad range but depends on riparian habitat
Myotis californicus	California myotis	60%	Secure
Myotis ciliolabrum	western small-footed myotis	60%	Population trend data are not available
Myotis thysanodes	fringed myotis	60%	Widespread but abundance is low
Nama dichotomum var. dichotomum	forked purple mat	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Nama pusillum	littleleaf nama	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Neivamyrmex nyensis	endemic ant	90%	all G1 and G2 species were given a goal of 90%
Nemacaulis denudata var. gracilis	slender cottonheads	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Neotamias palmeri	Palmer's chipmunk	90%	all G1 and G2 species were given a goal of 90%
Neotamias umbrinus nevadensis	Hidden Forest Uinta chipmunk	90%	possibly extinct; endemic to Clark Co., NV
Nitrophila mohavensis	Amargosa niterwort	90%	all G1 and G2 species were given a goal of 90%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Nyctinomops femorosaccus	pocketed free-tailed bat	60%	fairly common through range
Nyctinomops macrotis	big free-tailed bat	60%	widespread throughout range but not contiguous
Oenothera californica ssp. eurekensis	Eureka Dunes evening-primrose	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Oenothera cavernae	cave evening-primrose	90%	all G1 and G2 species were given a goal of 90%
Oenothera longissima	long-stem evening-primrose	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Onychomys torridus tularensis	Tulare grasshopper mouse	60%	extirpated from much of historical range
Opuntia basilaris var. brachyclada	short-joint beavertail	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Opuntia curvispina	curved-spine beavertail	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Opuntia whipplei var. whipplei	Whipple cholla	75%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Oreohelix hemphilli	Whitepine mountainsnail	90%	Terrestrial snail, very limited range
Oryctes nevadensis	Nevada oryctes	90%	all G1 and G2 species were given a goal of 90%
Ovis canadensis nelsonii	desert bighorn sheep	50%	Landscape scale species, common, widespread, G4/G5
Oxytheca watsonii	Watson's oxytheca	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Paronychia jamesii	James Whitlow wort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Pediomelum castoreum	Beaver Dam scurf pea	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Pellaea truncata	spiny cliff-brake	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Pelocoris shoshone amargosus	Amargosa naucorid	90%	all G1 and G2 species were given a goal of 90%
Pelocoris shoshone shoshone	Pahranagat naucorid bug	90%	all G1 and G2 species were given a goal of 90%
Penstemon albomarginatus	White-margined beardtongue	90%	all G1 and G2 species were given a goal of 90%
Penstemon ammophilus	Canaan Mountain beardtongue	90%	all G1 and G2 species were given a goal of 90%
Penstemon arenarius	Nevada Dune beardtongue	90%	all G1 and G2 species were given a goal of 90%
Penstemon bicolor ssp. bicolor	yellow twotone beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Penstemon bicolor ssp. roseus	rosy two-toned beardtongue	75%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Penstemon calcareus	limestone beardtongue	90%	all G1 and G2 species were given a goal of 90%
Penstemon fruticiformis var. amargosae	Amargosa beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Penstemon leiophyllus var. keckii	Charleston beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Penstemon pahutensis	Pahute beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Penstemon petiolatus	Sheep Range beardtongue	90%	all G1 and G2 species were given a goal of 90%
Penstemon stephensii	Stephens' beardtongue	90%	all G1 and G2 species were given a goal of 90%
Penstemon thompsoniae	Thompson's beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Penstemon thompsoniae ssp. jaegeri	Jaeger beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Penstemon utahensis	Utah beardtongue	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Perdita meconis	Mojave poppy bee	90%	all G1 and G2 species were given a goal of 90%
Perityle villosa	Hanaupah rock daisy	90%	all G1 and G2 species were given a goal of 90%
Perognathus alticolus inexpectatus	Tehachapi pocket mouse	90%	all G1 and G2 species were given a goal of 90%
Petalonyx nitidus	shiny-leaved sandpaper plant	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Petalonyx parryi	Parry sandpaper plant	90%	all G1 and G2 species were given a goal of 90%
Petalonyx thurberi ssp. gilmanii	Death Valley sandpaper-plant	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Peteria thompsoniae	spine-noded milk vetch	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia anelsonii	Aven Nelson phacelia	90%	all G1 and G2 species were given a goal of 90%
Phacelia barnebyana	Barneby's phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia coerulea	sky-blue phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia constancei	Constance caterpillar weed	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia filiae	Clarke phacelia	90%	all G1 and G2 species were given a goal of 90%
Phacelia geraniifolia	Geranium-leaf scorpionweed	60%	Dry rocky habitats, usually with carbonate substrate, cliff walls
Phacelia inyoensis	Inyo phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia monoensis	Mono County phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia mustelina	weasel phacelia	90%	all G1 and G2 species were given a goal of 90%
Phacelia nashiana	Charlotte's phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia parishii	Parish phacelia	90%	all G1 and G2 species were given a goal of 90%
Phacelia perityloides var. jaegeri	Jaeger's phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia perityloides var. laxiflora	nodding-flower scorpion-weed	90%	all G1 and G2 species were given a goal of 90%
Phacelia pulchella var. goodingii	Goodding's phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Phacelia rafaelensis	a phacelia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Phainopepla nitens	Phainopepla	75%	Secure riparian species
Phlox cluteana	Navajo Mountain phlox	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Physalis lobata	lobed ground-cherry	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Physaria chambersii	Chambers' physaria	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Physocarpus alternans	Nevada ninebark	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Pipilo crissalis eremophilus	Inyo California Towhee	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Piptatherum micranthum	small-flowered rice grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Piranga flava	Hepatic Tanager	75%	less threatened, broad range but depends on riparian habitat
Piranga rubra	Summer Tanager	75%	Has declined along lower Colorado River w/ loss of native habitat
Plagiobothrys parishii	Parish's popcorn-flower	90%	all G1 and G2 species were given a goal of 90%
Plagiobothrys salsus	desert popcorn-flower	90%	all G1 and G2 species were given a goal of 90%
Plagopterus argentissimus	Woundfin	90%	all G1 and G2 species were given a goal of 90%
Plebulina emigdionis	San Emigdio blue butterfly	90%	all G1 and G2 species were given a goal of 90%
Plegadis chihi	White-Faced Ibis	75%	fairly common through range
Polygala acanthoclada	thorny milkwort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Polygala heterorhyncha	notch-beaked milkwort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Polyphylla anteronivea	Saline Valley snow-front June beetle	90%	all G1 and G2 species were given a goal of 90%
Polyphylla erratica	Death Valley June beetle	90%	all G1 and G2 species were given a goal of 90%
Populus angustifolia	narrow-leaved cottonwood	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Porophyllum pygmaeum	pygmy poreleaf	90%	all G1 and G2 species were given a goal of 90%
Prunus eremophila	Mojave Desert plum	90%	all G1 and G2 species were given a goal of 90%
Pseudocotalpa giulianii	Giuliani's dune scarab	90%	all G1 and G2 species were given a goal of 90%
Pseudocrossidium crinitum	bearded screwmoss	90%	Two populations in the Mojave Desert, more common in Sonoran and Chihuahuan
Psorothamnus arborescens var. pubescens	Mohave indigo bush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Puccinellia parishii	Parish's alkali grass	90%	all G1 and G2 species were given a goal of 90%
Purshia glandulosa	waxy bitterbrush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Pyrgulopsis avernalis	Moapa pebblesnail	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis bacchus	Grand Wash springsnail	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis carinifera	Moapa Valley pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis conica	Kingman springsnail	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis crystalis	Crystal Spring pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis deaconi	Spring Mountains pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis deserta	desert springsnail	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis erythropoma	Ash Meadows pebblesnail	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis fairbanksensis	Fairbanks pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis fausta	Corn Creek pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis hubbsi	Hubbs pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis isolata	elongate-gland pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis merriami	Pahranagat pebblesnail	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis micrococcus	Oasis Valley springsnail	90%	Found in springs in the Amargosa River drainage and in the Death, Panamint, and Saline Valleys
Pyrgulopsis nanus	Distal-gland pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis pisteri	median-gland Nevada pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis turbatrix	southeast Nevada pyrg	90%	all G1 and G2 species were given a goal of 90%
Pyrgulopsis wongi	Wong's springsnail	90%	all G1 and G2 species were given a goal of 90%
Pyrocephalus rubinus	Vermilion Flycatcher	75%	decline in southwestern U.S.
Rallus longirostris yumanensis	Yuma Clapper Rail	90%	Recent surveys indicate a total population of 1700-2000 along lower Colorado River
Rana draytonii	California red-legged frog	90%	Substantial decline (decline of 50-75%)
Rana onca	relict leopard frog	90%	all G1 and G2 species were given a goal of 90%
Ranunculus andersonii var. juniperinus	Juniper buttercup	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Rhinichthys osculus moapae	Moapa speckled dace	90%	endemic to Clark Co., NV
Rhinichthys osculus nevadensis	Ash Meadows speckled dace	90%	Now protected in the Ash Meadows National Wildlife Refuge

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Rhinichthys osculus ssp. 1	Amargosa Canyon speckled dace	90%	Very small range in the Amargosa River and tributaries
Rhinichthys osculus ssp. 11	Meadow Valley speckled dace	90%	Small range in Meadow Valley Wash, Nevada; fewer than 10 occurrences
Rhinichthys osculus ssp. 6	Oasis Valley speckled dace	90%	endemic to Nye Co., NV
Rhinichthys osculus velifer	Pahranagat speckled dace	90%	Occurs only in the White River Valley system, Nevada
Rhopalolemma robertsi	Roberts' rhopalolemma bee	90%	all G1 and G2 species were given a goal of 90%
Robinia neomexicana	New Mexico locust	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Saltugilia latimeri	Latimer's woodland-gilia	90%	all G1 and G2 species were given a goal of 90%
Salvia greatae	Orocopia sage	90%	all G1 and G2 species were given a goal of 90%
Salvia pachyphylla ssp. eremopictus	Arizona rose sage	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sanvitalia abertii	Abert's sanvitalia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sarcocornia utahensis	Utah glasswort	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sauromalus ater	chuckwalla	60%	Commercially collected, declining, limited distribution, G4
Schkuhria multiflora var. multiflora	many-flowered schkuhria	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Schoenus nigricans	black bog-rush	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sclerocactus johnsonii	Johnson's bee-hive cactus	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Scleropogon brevifolius	burro grass	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Selaginella leucobryoides	Virgin Narrows spike moss	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Selaginella utahensis	Utah spikemoss	90%	all G1 and G2 species were given a goal of 90%
Selaginella watsonii	alpine spike moss	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Selinocarpus nevadensis	desert wing-fruit	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Senna armata	desert cassia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sidalcea covillei	Owens Valley checkerbloom	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sidalcea neomexicana	Salt Spring checkerbloom	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Silene clokeyi	Clokey catchfly	90%	all G1 and G2 species were given a goal of 90%
Sisyrinchium funereum	Death Valley blue-eyed grass	90%	all G1 and G2 species were given a goal of 90%
Solidago spectabilis	remarkable goldenrod	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

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Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Solorina spongiosa	a lichen	90%	lichen species; rare in moss mats with calcareous seepage
Solorina spongiosa	fringed chocolate chip lichen	90%	all G1 and G2 species were given a goal of 90%
Sorex tenellus	Inyo shrew	60%	Trend is not definitely known but probably stable
Spermophilus mohavensis	Mohave ground squirrel	90%	Only 9% of habitat within the historical range is protected
Speyeria carolae	Carole's silverspot	90%	all G1 and G2 species were given a goal of 90%
Sphaeralcea gierischii	Gierisch globemallow	90%	all G1 and G2 species were given a goal of 90%
Sphaeralcea rusbyi var. eremicola	Rusby's desert-mallow	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Sphaeromeria compacta	Charleston tansy	90%	all G1 and G2 species were given a goal of 90%
Sphaeromeria ruthiae	Zion tansy	90%	all G1 and G2 species were given a goal of 90%
Stenelmis calida calida	Devils Hole warm spring riffle beetle	90%	Found only in Devil's Hole
Stenelmis lariversi	Ash Springs riffle beetle	90%	all G1 and G2 species were given a goal of 90%
Stenelmis moapa	Moapa Warm Spring riffle beetle	90%	all G1 and G2 species were given a goal of 90%
Stenelmis occidentalis	Nearctic riffle beetle	60%	widespread range
Swallenia alexandrae	Eureka Valley dune grass	90%	all G1 and G2 species were given a goal of 90%
Symphyotrichum defoliatum	San Bernardino aster	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Synthyris ranunculina	Charleston kittentails	90%	all G1 and G2 species were given a goal of 90%
Tadarida brasiliensis	Brazilian free-tailed bat	60%	suitable sites for large colonies are extremely limited
Tetracoccus ilicifolius	holly-leaved tetracoccus	90%	all G1 and G2 species were given a goal of 90%
Tetradymia argyraea	silver felt thorn	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Tetradymia axillaris var. longispina	Longspine cotton thorn	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Tetradymia stenolepis	Owens Valley cotton thorn	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Teucrium cubense ssp. depressum	dwarf germander	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Texella kokoweef	Kokoweef Crystal Cave harvestman	90%	all G1 and G2 species were given a goal of 90%
Texella shoshone	Shoshone Cave harvestman	90%	all G1 and G2 species were given a goal of 90%
Thamnophis hammondii	two-striped garter snake	75%	Stable G3
Thelypodium integrifolium ssp. complanatum	foxtail thelypodium	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Townsendia smithii	blackrock ground daisy	90%	all G1 and G2 species were given a goal of 90%
Tricardia watsonii	three hearts	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Trichostomum sweetii	sweet trichostomum	90%	all G1 and G2 species were given a goal of 90%
Trifolium dedeckerae	Dedecker's clover	90%	all G1 and G2 species were given a goal of 90%
Trifolium kingii ssp. macilentum	King clover	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Tripterocalyx micranthus	small-flowered sand-verbena	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Tryonia angulata	sportinggoods tryonia	90%	all G1 and G2 species were given a goal of 90%
Tryonia clathrata	grated tryonia	90%	all G1 and G2 species were given a goal of 90%
Tryonia elata	Point of Rocks tryonia	90%	all G1 and G2 species were given a goal of 90%
Tryonia ericae	minute tryonia	90%	all G1 and G2 species were given a goal of 90%
Tryonia margae	Grapevine Springs elongate tryonia	90%	all G1 and G2 species were given a goal of 90%
Tryonia rowlandsi	Grapevine Springs squat tryonia	90%	all G1 and G2 species were given a goal of 90%
Tryonia variegata	Amargosa tryonia	90%	all G1 and G2 species were given a goal of 90%
Vermivora luciae	Lucy's Warbler	75%	less threatened, broad range but depends on riparian habitat
Vermivora virginiae	Virginia's Warbler	75%	positive survey-wide population trends
Viola aurea	golden violet	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Vireo bellii arizonae	Arizona Bell's Vireo	75%	less threatened, broad range but depends on riparian habitat
Vireo bellii pusillus	Least Bell's Vireo	90%	Has declined dramatically in both numbers and distribution
Vireo vicinior	Gray Vireo	75%	significant survey-wide population declines
Vulpes macrota	kit fox	60%	Same habitat loss as Desert tortoise, but wider range
Wislizenia refracta ssp. refracta	jackass-clover	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Woodsia plummerae	Plummer's woodsia	60%	all G3-G5 plants with S1 or S2 ranking were given a goal of 60%
Xanatusia vigilis vigilis	desert night lizard	60%	No evidence of a significant overall decline has been reported
Xyrauchen texanus	razorback sucker	90%	all G1 and G2 species were given a goal of 90%
Ecological System	alkali seep	90%	rare water-dependent community
Ecological System	Annual Grassland	60%	large patches of this community exist within the Ecoregion
Ecological System	Aspen Forest and Woodland	40%	large patches of this community exist within the Ecoregion

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Ecological System	Barren	60%	large patches of this community exist within the Ecoregion
Ecological System	Blackbrush Shrubland	25%	matrix community
Ecological System	Chaparral	40%	large patches of this community exist within the Ecoregion
Ecological System	Cliff and Canyon	40%	large patches of this community exist within the Ecoregion
Ecological System	Coastal Scrub	50%	large patches of this community exist within the Ecoregion
Ecological System	Creosotebush-White Bursage Desert Scrub	25%	matrix community
Ecological System	Crucifixion Thorn Woodland	60%	relatively small, isolated locations
Ecological System	Curl-leaf Mountain Mahogany Woodland and Shrubland	40%	large patches of this community exist within the Ecoregion
Ecological System	Desert Pavement	80%	large patches of this community exist within the Ecoregion
Ecological System	Dunes	80%	relatively small, isolated locations
Ecological System	Gambel Oak-Mixed Montane Shrubland	50%	large patches of this community exist within the Ecoregion
Ecological System	Greasewood Flat	60%	large patches of this community exist within the Ecoregion
Ecological System	Marsh	80%	rare water-dependent community
Ecological System	Meadow	80%	rare water-dependent community
Ecological System	Mesquite Bosque	60%	relatively small, isolated locations
Ecological System	Mesquite Upland Scrub	80%	small patches of this community exist within the Ecoregion
Ecological System	Mixed Conifer Woodland and Forest	60%	large patches of this community exist within the Ecoregion
Ecological System	Mixed Salt Desert Scrub	50%	large patches of this community exist within the Ecoregion
Ecological System	Mojave Mid-Elevation Mixed Desert Scrub	30%	matrix community
Ecological System	Mojave Mixed Steppe	50%	relatively small, isolated locations
Ecological System	Montane Woodland and Chaparral	40%	large patches of this community exist within the Ecoregion
Ecological System	Mountain Mahogany Woodland and Shrubland	40%	large patches of this community exist within the Ecoregion
Ecological System	Open Water	60%	rare water-dependent community

Table A-3 Conservation Targets of the Mojave Desert Ecoregion

Scientific Name	Common Name	Marxan Goal	Reasoning/Notes
Ecological System	Pinyon-Juniper Woodland	40%	large patches of this community exist within the Ecoregion
Ecological System	Playa	80%	relatively small, isolated locations
Ecological System	Riparian Woodland and Shrubland	85%	rare water-dependent community
Ecological System	Sagebrush Shrubland and Steppe	20%	matrix community
Ecological System	Scrub Oak-Mixed Montane Shrubland	80%	small patches of this community exist within the Ecoregion
Ecological System	Semi-Desert Grassland	80%	small patches of this community exist within the Ecoregion
Ecological System	Semi-Desert Shrub-Steppe	50%	large patches of this community exist within the Ecoregion
Ecological System	Sonoran Mid-Elevation Desert Scrub	25%	matrix community
Ecological System	Sonoran Paloverde-Mixed Cacti	50%	large patches of this community exist within the Ecoregion
Ecological System	Southern Rocky Mtn Mixed Conifer Savanna-Woodland-Forest	50%	large patches of this community exist within the Ecoregion
Ecological System	Southern Willow Scrub	25%	matrix community
Ecological System	Sparsely Vegetated	80%	small patches of this community exist within the Ecoregion
Ecological System	Subalpine Limber-Bristlecone Pine Woodland	80%	small patches of this community exist within the Ecoregion
Ecological System	Subalpine-Montane Mesic Meadow	80%	rare water-dependent community
Ecological System	Transmontane Alkali Marsh	80%	small patches of this community exist within the Ecoregion
Ecological System	Valley Needlegrass Grassland	90%	small patches of this community exist within the Ecoregion
Ecological System	Valley Oak Woodland	60%	small patches of this community exist within the Ecoregion
Ecological System	Wildflower Field	90%	Small patches of this community exist within the Ecoregion
Ecological System	Seeps and Springs	90%	Provide habitat for many of the Ecogregions animals

Appendix B Methods for Calculating the Landscape Resilience Index

The International Panel on Climate Change defines resilience as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning (IPCC 2007). The features of a landscape can enhance the resilience of species and ecosystems by providing access to relatively cool areas during extended heat waves and surface water during drought (Dobroski 2010, Beier and Brost 2010). Although many features of the landscape can provide refuge, the Landscape Resilience Index for California focused on those that are likely to endure for hundred of years and can be mapped. It was calculated as the summation of the five equally-weighted factors:

- Coastal Proximity: The ocean heats and cools more slowly than the land, so as air flows from the ocean over land it tends to moderate the coastal climate. Coastal proximity was calculated as described in a recent climate publication (Daly et al. 2008) using an advection model that incorporates the prevailing wind patterns and minimizes the number of mountains and the distance air must traverse as it flows from the ocean to the land.
- Elevation Gradients: Elevation has a direct affect on temperatures and often influences precipitation patters. A diversity of elevations in a small area will give species access to different climatic zones as climate changes. We calculated the elevation range in a 10-kilometer moving window using the ~30-meter National Elevation Dataset (USGS 2008b).
- Topographic Diversity: North-facing slopes receive less solar radiation during the day and tend to be cooler and have more soil moisture than their south-facing counterparts. Areas with a diversity of slopes and aspects will provide a diversity of micro-climates for species as the climate changes. We calculated the incoming solar radiation using the ~30-meter National Elevation Dataset (USGS 2008b) and ArcGIS. We then calculated the range in solar radiation values in each ~800-meter grid cell.
- Distance to Water: Droughts may become more frequent and severe as the climate changes, so species will need reliable sources of fresh water to survive. We identified all of the seeps and springs and large perennial water bodies (>100 hectares) as the water sources that are most likely to persist even in a drought. We calculated the straight-line distance to these water sources as mapped in the National Hydrology Dataset (USGS 2009b) using ArcGIS.
- Riparian Corridors: For many species, rivers provide low gradient habitat connections between different climate zones. In addition, riparian vegetation tends to be more dense than the surrounding vegetation and provides ample shade on hot days. To map riparian corridors, we calculated the maximum elevation in each stream system and then subtracted the lowest elevation that stream system flows to (either the ocean or a landlocked lake or salt flat) using the National Hydrology Dataset (USGS 2009b).

Landscape resilience features in the Mojave Desert Ecoregion include some of same features as mapped in the California index, such as sources of freshwater (seeps, springs, and riparian corridors) and/or features of terrain (north-facing slopes, narrow shaded canyons, and steep elevational gradients). Other enduring features that may be more important for the resilience of species in the Mojave Desert Ecoregion that are not included in the California index include large rock outcrops and areas of loose soil for burrowing and accessing ground water. Spatial data on these features were not readily available for the Mojave Desert Ecoregion, but should be considered in future analyses.

We assessed the landscape resilience features that are included in the various areas of conservation value identified through the Marxan analysis. To do this, we focused only on the areas of the California Landscape Resilience index that fall in the Mojave Desert Ecoregion. This covered 76% of the ecoregion, and does not include the northeast portion of the ecoregion (Figure B-1). We then identified the top quartile (top 25% by area) of the ecoregion with the highest resilience index scores (Figure B-1) and compared these areas with the four categories of conservation value. The Ecologically Core areas cover 37% of the ecoregion, but they capture 52% of the areas of highest landscape resilience. On the other hand, areas that are identified as Degraded and Converted cover 14% of the ecoregion, but they only cover 5% of the areas of highest landscape resilience. Thus, the Ecologically Core areas do a proportionally better job at capturing areas of high landscape resilience than areas of low landscape resilience.

The Landscape Resilience Index is designed to be used at a large scale such as a state or an ecoregion. It provides a simple metric for comparing landscape-scale projects and to support initial thinking on climate change adaptive strategy development. However, the Landscape Resilience Index cannot inform decisions about where or how to engage in specific locations. It is designed to be one element to consider in a longer climate change adaptation planning process. In general, a climate change adaptation planning process involves setting goals, determining target species and systems, projecting the climate change impacts to those target species and systems, and developing strategies to help abate those impacts.

The Landscape Resilience Index is meant as a coarse and general screening tool to quickly assess resilience for a large suite of species. However, some important caveats are needed in interpreting the landscape resilience index to help develop climate change adaptation strategies. For example, an area of high landscape resilience does not guarantee that all the species found in that area will be able to successfully adapt to climate change at this location. In particular, species with narrow climate tolerances or low dispersal ability, as well as species already approaching ecological tipping points, may still be stressed by climate change and may not be able to access refugia such as north-facing slopes and seeps and springs. Other species may be dependent on other landscape features such as mountain meadows or rare soils so they cannot move to other areas offering more resilience.

Figure B-1

Mojave Desert Landscape Resilience

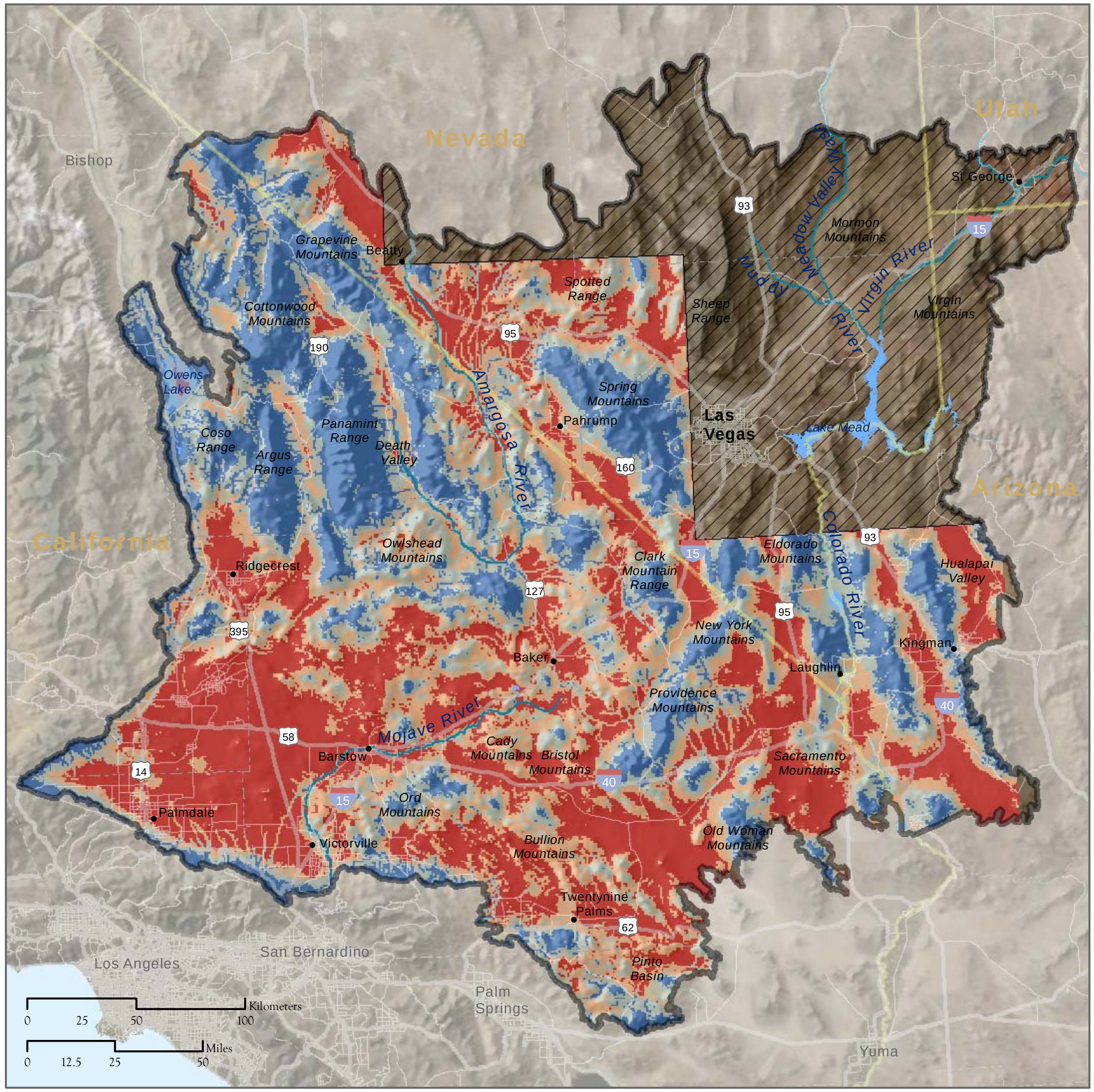
Project Area
- Mojave Desert

Boundaries
- State
- County

Transportation
- Major Road
- Other Road

Hydrology
- Major River

Landscape Resilience Index
- Low
- Moderate
- High
- Highest
- Not Mapped



Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Appendix C List of Experts Interviewed

Table C-1 Experts interviewed in 2009 and 2010. Inclusion on this list in no way signifies that the interviewee or their organization endorses The Nature Conservancy's Mojave Desert Ecoregional Assessment

	Name	Affiliation
1.	Edith Allen	University of California, Riverside
2.	Ileene Anderson	Center for Biological Diversity
3.	Jim André	University of California Natural Reserve System
4.	David Austin	United States Forest Service
5.	John Baker	PRBO Conservation Science
6.	Cameron Barrows	University of California, Riverside
7.	Jill Bays	Transition Habitats Conservancy
8.	Roxanne Bittman	California Department of Fish and Game
9.	Ashleigh Blackford	United States Fish and Wildlife Service
10.	Pete Bloom	University of Idaho; private consultant
11.	Mark Borchert	United States Forest Service
12.	Ray Bransfield	United States Fish and Wildlife Service
13.	Patricia Brown	Brown-Berry Biological Consulting
14.	Mike Connor	Western Watersheds
15.	Brian Croft	United States Fish and Wildlife Service
16.	Neal Darby	Mojave National Preserve
17.	Catherine Darst	United States Fish and Wildlife Service
18.	Danielle Dillard	United States Fish and Wildlife Service
19.	Clinton Epps	Oregon State University
20.	Julie Evens	California Native Plant Society
21.	Patricia Flanagan	Mojave Desert Land Trust
22.	Rick Freidel	Utah Division of Wildlife Resources
23.	Geoffrey Geupel	PRBO Conservation Science
24.	Frazier Haney	The Wildlands Conservancy
25.	Cody Hanford	Shelton Douthit Consulting
26.	Suzanne Harmon	California Native Plant Society
27.	Scott Harris	California Department of Fish and Game
28.	Chrissy Howell	PRBO Conservation Science
29.	Brian Hobbs	Nevada Department of Wildlife
30.	Brendan Hughes	Shelton Douthit Consulting
31.	Debra Hughson	Mojave National Preserve
32.	Nicholas Jensen	California Native Plant Society
33.	Rebecca Jones	California Department of Fish and Game

Table C-1 Experts interviewed in 2009 and 2010. Inclusion on this list in no way signifies that the interviewee or their organization endorses The Nature Conservancy's Mojave Desert Ecoregional Assessment

	Name	Affiliation
34.	Nancy Karl	Mojave Desert Land Trust
35.	Todd Keeler-Wolf	California Department of Fish and Game
36.	Tasha La Doux	Joshua Tree National Park
37.	Larry LaPre	Bureau of Land Management
38.	Philip Leitner	private consultant
39.	Steven Loe	United States Forest Service
40.	Michael Long	Los Angeles County Department of Parks and Recreation
41.	Carl Lundblad	Ash Meadows National Wildlife Refuge
42.	Margaret Margosian	Bureau of Land Management
43.	Tonya Moore	California Department of Fish and Game
44.	Kristeen Penrod	Science and Collaboration for Connected Wildlands
45.	Philip Rundel	University of California, Los Angeles
46.	Connie Rutherford	United States Fish and Wildlife Service
47.	April Sall	The Wildlands Conservancy
48.	Kelly Schmoker	California Department of Fish and Game
49.	Gregory Suba	California Native Plant Society
50.	Kirk Waln	United States Fish and Wildlife Service
51.	Stephanie Weigel	Sonoran Institute

Appendix D Expert Interview Information Table

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Afton Canyon		s					Bat populations
Afton Canyon					t		Bedrock forces river to flow aboveground; once full of Mojave Tui chub, but now dominated by hitch (invasive fish sp. from Sac. River)
Algodones Dunes to Death Valley		s			t		Irreplaceable Cresent; most intact ecosystem in North America; lack of development; high biodiversity
Aliso Creek		s					California red-legged frog
Amargosa Creek (West Mojave)	h	s		m			Mitigation opportunity for Alkalai Mariposa Lily; residual floodplain areas
Amargosa Creek (West Mojave)	h			m			Private property could be aqcuired for mitigation, Alkali Mariposa Lily in residual floodplain areas
Amargosa Creek (West Mojave)					t		Different from Amargosa River in East Mojave, non-navigable and therefore not under ACOE regulation; IRWMP has called for water diversion of creek to recharge groundwater, but this is problematic because the water delivers silt to Edwards AFB, and because Piute ponds are a significant wetland that would be affected
Amargosa River Area (Eastern Mojave)	h	s					Chicago Valley mesquite bosque; Resting springs ranch; Willow Creek Southwestern Willow Flycatcher, Vireos (could be LB), speckaled dace, snails, Amargosa vole, Shoshone springs pupfish (Don Sada at the Desert Research Institute has been working on this)
Amargosa River Area (Eastern Mojave)	h						In good condition
Amargosa River Area (Eastern Mojave)		s					Amargosa River: voles, birds
Amargosa River Area (Eastern Mojave)				m			Private property could be aqcuired for mitigation

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Amargosa River Valley to Mojave National Preserve			c				Connectivity needs protection
Amargosa River Valley to Mojave National Preserve			c				Connectivity needs protection
Amargosa Valley					t		Millennium Solar proposed project; reliance on wet cooling is bad
Antelope Valley	h	s			t		Joshua Tree woodland, little protection
Antelope Valley	h	s			t		Joshua tree woodland, threatened by ag clearing; higher elevation populations found near Tejon and 5 Fwy, clonal and perhaps more fire adapted
Antelope Valley		s					High density of burrowing owls
Antelope Valley				m			Antelope Valley Conservancy is a new entity which is not state designated like the Santa Monica Mountains Conservancy, but may be able to take mitigation lands and manage them.
Antelope Valley						o	Santa Monica Mountains Conservancy and LA Parks and Rec in conjunction with Co. Assessor's Office look for properties in Antelope Valley that are in tax default status and prioritizes these for acquisition.
Antelope Valley (higher elevations)	h	s					California Juniper woodland
Anza-Borrego		s					Long-eared owls nest in trees
Apple Valley Ridge		s					Bat populations
Argus Canyon	h						Good habitat
Argus Range	h						In good condition
Ash Meadow				m			Mitigation opportunity: inholdings would be nice to acquire
Baker Sink				m			Private property could be aqcuired for mitigation, contains mostly state lands
Barstow		s			t		Proposed development in fringe-toed lizard habitat

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Bats	h				t		BLM land: a lot of effort on abatement, but mining can start up again b/c land not withdrawn from ineral entry
Bats	h				t		Prior to mining, bats were more evenly distributed throughout the area, roosting separately rather than together. Once mines were created, all bat "eggs" went into one basket, and mine closures can eliminate an entire population
Bats	h						Abiotic features are important for bats: cliffs, caves, mines, bridges, dams, reservoirs, bouder outcrops
Bats	h						Anywhere with riparian areas + roosting = good bat habitat
Bats	h						Desert bats don't necessarily need water, and springs and seeps are often buried in vegetation and not accessable to bats
Bats	h						Mines are important for bats, but the importance of mines to bats has not been mapped
Bats	h						Snags are important biotic features for bats
Bats	h						When mapping bat habitat, vegetation is not as important as abiotic features
Bats					t		Migratory pathways of bats are not well-klnown
Bats					t		Wind and solar affect migratory bats - feathering windmill blades at low wind speed can help avoid bat impacts
Big Rock Wash	h	s					Mountain lions use this area, some riparian habitat is left
Big Rock Wash	h				t		Bulldozed by Caltrans for decades
Big Rock Wash	h				t		Good habitat, little protection
Big Tujunga		s			t		Suckers and dace trapped and relocated in anticipation of mudslides following Station Fire
Bighorn Sheep		s					Populations straddling I-40: culverts under I-40 have a ridged metal bottom, difficult for hooved animals, looks like it is only being used by predators (bobcats and coyotes), area could be good for building an overpass; bridge with wash underneath it might be used as passage as well
Bighorn Sheep		s	c				Cushenbury herd is linked to San Gorgonio herd, but not Newbury herd

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Bighorn Sheep		s	c				populations south of I-40, north-south connection
Bighorn Sheep	h				h		Dry lakebeds and large flat areas are less important for sheep movement
Bighorn Sheep		s	c				Newberry herd is expanding, blocked by I-40 from moving north
Bighorn Sheep		s					Populations to the north of I-15: Clark mountain herd may be moving south, but this is unknown
Bighorn Sheep		s					Populations in and around Joshua tree
Bighorn Sheep		s	c				Highway 62: old evidence of sheep movement, but blocked by barrier in the middle of the highway
Bighorn Sheep			c				No obvious place for connectivity
Bighorn Sheep			c				Canal is complete barrier but still some movement between populations
Bighorn Sheep			c				Any population could have a positive influence on any other
Bighorn Sheep			c				Bighorn sheep move over larger areas in the winter, onto bajadas that give them green forage later into the dry season
Bighorn Sheep		s					CDFG moved sheep from #53 to #80, and from there they recolonized #74
Bighorn Sheep					t		Higher elevation sites can be problematic for bighorn because of higher tree cover and risk of predation, introduced deer and mountain lions, diseases with insect vectors
Bighorn Sheep			c				Movement models in Epps paper based on microsatellite data, so map shows what males are willing to do; female movement is more conservative
Bighorn Sheep			c				Some uncertainty exists about how traffic affects sheep's willingness to cross roads: behavioral barriers can be mitigated (i.e. sound buffers) to help crossing
Bighorn Sheep		s					Status of polygons (from Cons Bio paper) in regards to bighorn populations has changed in several cases due to recolonizations and extinctions
Bighorn Sheep			c	m			Translocation of individuals is too expensive to be sustainable in the long-term; it would be better to plan for natural connectivity

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Bighorn Sheep			c		t		Transmission lines don't hinder movement once they are in place (sheep on Old Dad move underneath lines); problem is disturbance when lines are going in, and increased human access via roads
Bighorn Sheep					t		Lower elevation sites are prone to drought
Blythe				m		o	Some good options for siting on abandoned ag areas
Brisbane Valley				m			Private property could be aqcuired for mitigation; between Mojave River and I-15
Brisbane Valley		s			t		Brisbaine Valley: threatened by development, solar plants, has desert tortoise and Mohave ground squirrel habitat, rare plants
Bristol Mountains		s	c				Bighorn sheep and new species of buckwheat, sheep try to cross freeway, fenced area, good place for Banff-style overpass
Broadwell Dry Lake		s					Crucifixion thorn, flower fields, new species of lupine, bighorn, Brightsource project got pulled
Burros					t		round-up started in 1999, about 3000 captured; 2004 and 2005 helicopter round-ups; burrows are widespread, actively managed in Clark Mts., Woods Mt., Midhills, Cima Volcanic Area; some burro damage to springs, but most of impact is due to cattle
Cactus Flat	h						Good habitat, publically owned
Cadiz					t		Stalled water pumping project, general draw-down of water-table, raven subsidies would have been the result
Cadiz				m	t		Checkerboard of inholdings at eastern edge of Mojave National Preserve; proposed pumped storage of water project; trading land for conservation here could be a good option
Cadiz Dunes	h	s					Every dune has endemics (particularly beetles); fast track solar site in this area
Cady Mountains to Bristol Mountains			c				Bighorn movement across road, dirt road there should not be paved or improved
Cady Mountains to Fort Irwin			c		t		Bighorn sheep are moving because of drought

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Cajon Pass			c				Important migratory bird pathway
Cajon-SB Mt. to San Gabriel			c				Connectivity, with freeways, powerlines, railroad, and future wind development as threats
Camp Cady		s					Mojave tui chub
Camp Cady		s					Mojave Tui Chub; USFS is considering putting Mojave Tui Chub into headaters of the Mojave River @ Deep Creek and Juniper Springs
Castle Mountain Keyhole				m		o	Private property could be aqcuired for mitigation, significant investment in restoration when mine went in, a lot of plant salvage, set standard for a number of years, plantted a variety of species on overburden piles, but not a lot of recontouring of site
Castle Mountain Mine				m		o	Inholding in Mojave Preserve, proposed for inclusion in Preserve, reclaimation and cactus rehab for solar development mitigation
Castle Mountain Mine				m			Limited restoration success
Castle Mountains		s					Bighorn Sheep population
Centennial Flat	h						Good habitat, publically owned
Charleston Peak		s					Good bat location
Chemehuevi	h				t		Microphyll woodland, OHV problems, PRBO surveys, Lazy Daisy cattle allotment is biggest problem
Chemehuevi/Whipple Mountain Area	h	s			t		Sonoran saguaro and gila monster population, rare influx of sonoran desert in CA, burros are problematic, could be a good strategy to have them removed or reduced, Sahara Mustard is a problem, leaf-nosed bat research by Gary Bell
China Lake		s					Low nesting density of Golden Eagles, Priarie Falcons, few burrowing owls near Inyokern in housing areas
China Lake (checkerboard area to the southwest)				m			Private property could be aqcuired for mitigation
Chuckwalla					t		Invasive plants (Sahara mustard); problematic if tortoises eat them
Chuckwalla Bench					t		no longer grazed

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Cima Dome Volcanic Area	h				t		Livestock grazing bought out in 2001, recovering Shrub Steppe, not too many invasive species
Cima Dome Volcanic Area					t		Burros; round-up started in 1999, about 3000 captured; 2004 and 2005 helicopter round-ups; burrows are widespread, actively managed; some burro damage to springs, but most of impact is due to cattle
Clark Mountain		s					Big Horn sheep lambing (Jaeger study)
Clark Mountain		s					Bighorn Sheep population - managed with 1 guzzler
Clark Mountain		s					Gila monster occurrence
Clark Mountain		s					Good bat location
Clark Mountain					t		Burros; round-up started in 1999, about 3000 captured; 2004 and 2005 helicopter round-ups; burrows are widespread, actively managed; some burro damage to springs, but most of impact is due to cattle
Clark Mountain (and area to the northeast)	h					o	Wilderness only to toe of slope, need to go further into bajada to capture foraging area for sheep
Coachella Valley	h	s	c				50 km radius circle around Coachella Valley, 30+ lizards, 5-6 species more than anywhere else in US, linkages are critical because of 3 or 4 biogeographical provences overlapping here
Coachella Valley		s					Burrowing owls (30 pairs)
Coachella Valley			c	m			planning that occurred to take into account linkages, habitat conservation areas, riparian areas is a good example of what should happen in the future
Coachella Valley					t		Sahara mustard first found here in 1927, spreads in wet years
Coachella Valley to Joshua Tree National Park	h	s			t	o	Coachella Valley/ JTNP highest priority for conservation based on threat and resources; 2nd priority would be Chemiwevi/Whipple area in great need of threat abatement, ag development by river, OHV, weeds; all others in good condition (Argus Range, Panamint Mountains/Death Valley, Granite Range in Mojave Preserve, Kingstons/Ash Meadows/Amargosa River Valley and Watershed)

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Colorado Desert		s				o	In the Colorado Desert, eastern population and northern Colorado population of desert tortoise are somewhat similar, but are recognized as separate units at this point
Coolgardie Mesa		s					Lane Mountain Milkvetch- Army and Connie have thousands of plants mapped
Copper City		s			t		Copper city: problems with OHV, good Mohave ground squirrel and desert tortoise habitat
Copper Mountain				m			Private property could be aqcuired for mitigation; between Joshua tree and Twentynine Palms
Coyote Dry Lake (to the south)		s					Parish's phacelia, only known occurrence in CA
Coyote Hole		s					Genetically distinct population of flat-tailed horned lizard
Dagget Ridge		s			t		On top of tortoise long-term disease study area
Dagget Ridge		s					Desert tortoise
Dagget Ridge		s			t		Wind project in bighorn sheep habitat
Death Valley Junction		s					Ash meadows gum plant, Amargosa niterwort
Death Valley to Mojave National Preserve				m			Private property could be aqcuired for mitigation
Death Valley to wilderness further south			c		t		Congrentris renewable energy project planned, good connectivity will be threatened
Deep Creek	h	s		m			Mojave River headwaters area, includes horse thief canyon and the west fork of the Mojave, Arroyo toad; confluence of Deek Creek and Mojave important for Southwestern Willow Flycatcher; private land desireable for acquisition
Deep Creek		s					Swainson's hawks found here
Desert Center	h	s			t		Good bat location; disruption of drainage and foraging habitat for bats in ironwoods and paloverde
Desert Tortoise	h			m		o	To effectively conserve tortoise, we should put effort into Desert Tortoise Conservation Areas, not elsewhere

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Desert Tortoise	h				t	o	Food is critical to Desert Tortoise success, and this depends on rainfall and invasive species presence (get Mustard maps from Connie)
Desert Tortoise	h				t	o	Important desert tortoise areas could have been missed when Desert Tortoise Conservation Areas were designated
Desert Tortoise		s	c				Habitat for tortoise through Nevada used to be very well-connected all the way to Beaver Dam Slope
Desert Tortoise		s					Desert Tortoise genetics: each recovery unit has a genetically distinct population
Desert Tortoise		s					Long lags in genetic effects on desert tortoise populations- some places are a population sink
Desert Tortoise				m			Desert Tortoise Reserve Committee: expanding/funding a group like this would be useful
Desert Tortoise				m			Habitat restoration could be good, but it is not a well-defined concept
Desert Tortoise					t	o	Biggest problem for desert tortoise is human access; treat with environmental education, signs, kiosks, etc.; need to figure out patterns of human use and adapt areas to enhance gentle use
Desert Tortoise					t		Cattle grazing- most of desert tortoise habitat
Desert Tortoise					t		DTRO has a lot of data on threats, not on species occurrence; threats data comes from a variety of sources
Desert Tortoise					t		Renewable energy: how wind development affects tortoises is unknown, but solar development is incompatable, and there will be edge effects
Desert Tortoise						o	Management of Desert Tortoise Conservation Areas will depend on $ spent and policies of the entity managing them (NPS or BLM)
Desert Tortoise						o	Tortoise movement and geneflow is SLOW, and happens over long timescale, genetic similarity of tortoise populations varies with distance (Bridget Haggerty, Ken Dossier, Todd Esque UNR)
Desert Tortoise						o	USGS desert tortoise model

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Desert Tortoise Natural Area	h				t		ACECs in area NW of DTNA have high biodiversity by no better land management than anywhere else BLM
Desert Tortoise Natural Area	h						Whole area is fenced
Desert Tortoise Natural Area				m			Desert Tortoise Preserve Committee has been purchasing private land near DTNA
Desert Tortoise Natural Area				m			Currently purchasing small lots at 2.5 acres at a time to expand the reserve
Desert Tortoise Natural Area				m			Private property could be aqcuired for mitigation, includes California City and OHV areas
Desert Tortoise Natural Area					t		Offroad staging area "Camp C" that has been retired is nearby
Desert Tortoise Natural Area						o	TNC was originally involved in setting up DTNA, now it is an ACEC
Dinosaur trackway ACEC					t		Wind proposal
Dos Palmas	h						Example of where BLM is trying to manage well
Dumont Dunes	h				t		Near Ibex wilderness, Amargosa River may be the source of sand, impacted by OHV users
Dumont Dunes		s					Genetically distinct population of flat-tailed horned lizard
Dumont Dunes		s					Has a unique subspecies of fringe-toed lizard
Eagle Mountain (Kaiser Mine)		s					Good bat location
East Mesa		s					flat-tailed horned lizard habitat
Eastern Mojave	h					o	30-40% higher genetic biodiversity in eastern vs. western desert
Eastern Mojave					t	o	Resource values in central/eastern Mojave are not well-studied enough to recommend good places for siting
Eastern Mojave					t	o	The farther east we go in the desert, the less we know about occurrences of anything
Eastern Mojave						o	Denning of tortoise: more than one per burrow as you move east
Eastern Sierra through Bishop					t		Urban development threat

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Edwards AFB	h	s					Mariposa Lily requires sheet flow of water to create the habitat it grows in
Edwards AFB	h	s			t		Alkalai mariposa lily (CNPS IB):requires flat alkaline salt pan soils which are also highly valued for development. Much of habitat lies within the city of Lancaster, or is soon to be annexed by Lancaster. Also found on Edwards, but protection there is not assured.
Edwards AFB (Buttes to the north)				m			Private property could be aqcuired for mitigation
Edwards AFB (east and northeast)				m			Private property could be aqcuired for mitigation
Edwards AFB (east and south)				m			Mitigation opportunity for Alkalai Mariposa Lily; residual floodplain areas
Edwards AFB (north edge)			c				Losing corridors because of renewable energy project and solar development; Mohave ground squirrel present
El Paso Mountains		s			t		State Park and nearby ORV area, threateneing tar plant, red rock poppy, and Charlotte's phacelia, eagle nests (key raptor area designated by BLM)
Elizabeth Lake		s					Southwestern pond turtle
Fenner					t		Last active remaining grazing allotment, contains Colton Hills and Gold Valley, lots of cattle; 2005 Hackberry fire burned fences and cattle roamed into preserve
Fort Irwin	h				t		Very disturbed in low-lying areas when tanks can go, higher elevation habitats are in better condition
Fort Irwin Expansion Area		s			t		On west, desert tortoise and Mohave ground squirrel, CBI sued to prevent tortoise movement until plan was completed. On east side, higher desert tortoise populations than expected, tortoises not moved
Freemont Peak					t		Unauthorized OHV use; critical habitat for desert tortoise and habitat for Mohave ground squirrel
Goffs and Essex road					t		Sahara mustard invasion from east off railroad and from recreation entry points from south

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Golden Valley Wilderness Extension		s					Black hills lava chain- boundary between central and western desert tortoise popualtions
Gorman Triangle			c				Important for movement of wildlife through region
Granite Range in Mojave National Preserve	h						In good condition
Grass Valley		s		m			Desert Cymopterous +/-600 plants, resotration is more successful when you do it on a small scale, i.e. camoflaging of road or removing water tanks and bollards
Hackberry Canyon		s					Bighorn Sheep population
Halloran Summit		s					Improve connectivity for Bighorn sheep
Harper dry lake		s					Swainson's hawks- supported by ag
Harper Lake	h	s			t		Burrowing owls in empty lots in urban areas, clumping due to loss of habitat
Harper Lake		s			t		Short-eared Owls: Harper Dry lake prior to 1978, this is no longer a nesting site
Harper Lake					t		Solar development was supposed to add a certain # of acreft of water to the lake, this didn't happen after first year and lake is now dry
Hinkley		s					Good species diversity
Holiday Lake	h	s					Tri-colored blackbird- found in areas with seasonal water
Hwy 395 corridor		s	c				Connectivity along 395 is important to desert tortoise- threatened by ag and urban development
I-10 (to the north)	h		c				Giant ironwood forest, deer move across I-10 from Chuckwalla mountains, forest in good condition
I-10 corridor			c				Mountain range connections for bighorn
I-40 (sand dunes nearby)		s					Dune systems south of 40 Fwy might have fringed-toed lizard
Ibex Dunes		s					Genetically distinct population of flat-tailed horned lizard
Imperial Valley		s					Burrowing owls, no big colonies that need protection
Imperial Valley		s					Highest density of burrowing owls in desert

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Iron Mountains	h				t		Very intact, solar east study area, very remote
Iron Mountains	h				t		Iron Mt. Solar Study Area should go away b/c it is a very intact area with good conservation value
Ivanpah	h	s			t		No analysis of impact to birds, and Ivanpah is hear an IBA
Ivanpah	h	s					Desert tortoise + rare plants + bighorn sheep + high water recharge
Ivanpah	h						Water features of nearby golf course attracts birds
Ivanpah				m			Mitigation strategy: buy out grazing allotments, water, and mineral rights, fill in preserve lands
Ivanpah					t		No surveys for rare insects
Ivanpah					t		Power towers kill a lot of birds @ Dagget, which is 1/500th size of Ivanpah
Ivanpah Valley	h	s		m			Whole Ivanpah area should be desert tortoise DWMA
Ivanpah Valley	h	s			t		Recommended as part of the DWMA, lots of rare plants, succulents; Renewable Energy proposals from Optisolar (First Solar); Desert Xpress HSR
Ivanpah Valley	h	s			t		Bighorn sheep (only known white herd), gila monsters, desert tortoise (unique population in CA), 12 species of rare plants, 2 proposed solar developments, high-speed train alignment from Victorville-Las Vegas
Ivanpah Valley		s	c				highest elevation breeding population is in Ivanpah Valley because this area gets some monsoon
Ivanpah Valley			c				Connectivity for desert tortoise into Ivanpah Valley
Ivanpah Valley			c				Solar plants- proposed for both sides of I-15, concern about adequate connectivity for Desert Tortoise
Ivanpah Valley				m			Private property could be aqcuired for mitigation, should be DWMA, so if solar development goes forward the rest should be conservation
Ivanpah Valley and Shadow Valley	h	s			t		Desert tortoise habitat, large desert tortoise population, not in a state of collapse, not included in critical habitat, powerline corridor from Hoover Dam to LA, raven problems, railroad/roads avenues for weed invasion

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Jackass Canyon		s					Bighorn Sheep population - managed with 4 guzzlers at Old Dad
Jawbone Canyon	h		c		t		City of Vernon wind proposal; Cottonwood creek stop-over point for migratory birds
Johnson Valley OHV Area		s		m			Private property could be aqcuired for mitigation; King Clone, Mojave Yucca Rings, not to hammered to date
Joshua Tree National Park					t		Climate Change: reduction of Joshua Tree forest habitat
Joshua Tree National Park (Covington Flat)					t		Fire in 1999; dirt road btwn Black Rock campground and main road into JTNP
Joshua Tree National Park (Pinto Basin)	h		c				Good desert tortoise population in the middle of it, good habitat to the NE and NW for movement of the tortoise with climate change
Joshua Tree National Park (Pinto Basin)					t		Surprisingly invaded by exotic grasses: fertile island effect causes growth of grass under shrubs
Joshua Tree National Park (Quail Springs Rd)		s					Lananthis occurrences, along Quail Springs Rd in northern Joshua Tree Park
Joshua Tree National Park (southeast corner)					t		Solar field site; Probably OK as long as it is not blocking the sand source for Palen Dunes
Joshua Tree National Park (to the east)		s					Large desert tortoise population
Joshua Tree National Park to San Bernardino National Forest		s					Bighorn, bobcats, tortoises
Joshua tree to 29 Palms					t		Urban expansion, distrubance, OHV use. Corridor plan done by Mojave Land Trust.
Juniper Woodlands near Hwy 14					t	o	Where they burn, they do not recover well; caused by change in fire regime: more frequent, more intense, more often during cooler season
Kelso Dunes	h					o	Star dunes, wind pushing sand from 3 or more directions, not as process-dependent as unidirectionally formed dunes, not as threated as other dunes, but sand could be coming from outside the Mojave Preserve

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Kings Canyon	h						Behind CA Poppy Preserve
Kingston Mountains	h						In good condition
Kingston Mountains		s					Gila monster occurrence
Kingston Wash	h						Important for movement of sand
Kramer Junction		s					Rare plants: Barstow wooly sunflower, some on public land near Kramer Junction; Alkalai Mariposa Lily, mostly on private land
Lancaster	h						Conserving Joshua Tree Woodland for years, ask Ray for contact
Lancaster				m			City of Lancaster has begun to begrudingly acknowledge CDFG authority over streambed alteration, and require mitigation for this.
Lancaster				m			City of Lancaster has collected fees of $750/acre for mitigation, but has deferred using the funds for 20+ years; CDFG has asked for an audit of this and gotten no response.
Lancaster					t		Suffers from urban sprawl, and little to no mitigation has been done to compensate for urban growth. Survey efforts required under CEQA can be done without serious effort (i.e. during the summer)
Lanfair Valley		s			t		More tortoises that expected, private land is being purchased for development (talk to Annie Kearns about this 760-252-6144)
Lanfair Valley		s					Mountain plovers
Lanfair Valley		s					Possible Burrowing owls
Lanfair Valley		s					Swainson Hawk's used to nest in entire Joshua tree forest around Lanfair Valley; now only found in 2 locations and nowhere else in Mojave
Lanfair Valley					t		Grazing allotment
Las Flores Ranch		s					Arroyo toad (most northernly location)
Little Rock Wash	h						Riparian vegetation all the way to the north side of 138
Little Rock Wash	h						good habitat, little protection
Little Rock Wash		s					Arroyo toad

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Los Angeles County					t	o	Level of survey effort is low, and sitings are often not put into CNDDB
Lucerne Valley		s					Mountain plovers
Lucerne Valley					t		Free-roaming dogs
Marble and Clipper Mts.		s					Bighorn Sheep populations
Mayflower Park	h						In Riverside County, nice habitat
Mescal Creek	h						Headwater protection for Mojave River
Mesquite Springs				m			Private property could be aqcuired for mitigation
Mexico Borderlands Area		s			t		Sempra wind plants proposed; only 14 condors left
Military bases					t		Development associated with these is an issue
Mission Creek	h	s					California Fringetoed Lizard HCP
Mojave Narrows	h	s					Location of Lewis Center School, in 2008 got a grant to relocate 500 Mojave Tui chub fry from China Lake to pond on campus
Mojave Narrows		s					Mojave Narrows: Mojave shoulderband
Mojave National Preserve	h	s					Largest clutches of eggs (5) observed anywhere in southern California, may be caused by high density of raptor food sources, cycle is different from that on the coast
Mojave National Preserve		s					Many raptors
Mojave National Preserve				m			Inholdings in MNP for acquisition
Mojave National Preserve (Henry Springs)		s					Good soil crusts; near Henry Springs; 17 mile point north, near Henry springs on western side of Preserve
Mojave National Preserve (north side, near Primm)	h	s			t		Site of Brightsource Proposed Renewable Energy Development; high quality tortoise habitat, viewshed for Mojave Preserve; first solar development that will probaby get underway, would have been critical habitat if not for poitics in 1994
Mojave National Preserve (northern edge)				m	t		AT&T fiberoptic cable; mitigation opportunity: has been asked to build a research station for desert tortoise, 15-year project, mitigation $ could be funneled into this facility

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Mojave National Preserve (private inholdings)				m			Mitigation opportunity: many restrictions of buying private land for preserve but area is already prioritized for acquisition and could be a good opportunity for mitigation funds; tortoise habitat, rare plant species; some parcels are not worth buying because they are too small and/or there is no easy access to them; cattle enter preserve from here, but also has unburned patch of Great Basin sage
Mojave National Preserve (southeast portion)	h						Sonoran desert influence
Mojave National Preserve (throughout)				m	t		Mitigation opportunity: abandoned mines could be secured/restored
Mojave National Preserve (throughout)				m	t		Mitigation opportunity: denuded areas where cattle grazing has be concentrationed around water troughs- each area has taken a different recovery trajectory; funds could help restore these areas
Mojave National Preserve (to the north)				m	t		Molycorp Mine: mitigation opportunity: has been asked to build a research station for desert tortoise, 15-year project, mitigation $ could be funneled into this facility
Mojave National Preserve to Joshua Tree National Park			c	m			Private property could be aqcuired for mitigation; important for connectivity
Mojave River	h	s			t		Taken over by tamarisk east of Barstow, Victorville wants to clear entire riparian area for flood control: least Bell's vireo, Southwestern willow flycatcher, and arroyo toad are there
Mojave River	h	s					Fringed-toed lizard in dry areas; Camp Cady; Afton Canyon
Mojave River	h				t		Mohave ground squirrel vs. roundtail ground squirrel: have overlapping terrritories, but roundtail likes more friable soil, some isolated cases of interbreeding could be occurring
Mojave River		s			t		Mojave River dry-up: more roundail habitat, less Mohave ground squirrel habitat
Mojave River		s			t		Mojave river pond turtle, and Mojave River vole: threatened by dewatering
Mojave River					t		Many invasive species from the Sacramento River- pumped in through aqueducts, escape from reservoirs to river in wet years
Mojave River Headwaters		s					Southwestern Willow Flycatcher, Southwest pond turtle, Arroyo toad

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Mojave River/Deep Creek	h				t		Needs a coordinated plan because of multiple uses and important species in the area
Morongo Valley					t		Schismus growth is leading to burning, especially in "desert chaparral"
Mountain Pass Mine					t		Owned by Molycorp Minerals to mine rare earth lanthonite series elements, found in missiles and hybird vehicles; pipeline on northern part of preserve burst, clean up should occur when pipeline is removed; license in place to expand the mine for 30 more years
New BLM Wilderness	h						Part of omnibus legislation passed in 2009
New York Mountains		s			t		Relict patch of white fir, threatened by global warming, rare plant associations report by Jim Andre (have Brian get this file from NPS personnel)
New York Mountains		s					Gila monster occurrence
New York Mountains		s					Good bat location
New York Mountains to Lanfair Valley					t		Livestock grazing retired and some recovery
Newberry Mountains	h			m			Bighorn, no weeds all the way down to the freeway, alluvial fans area really nice, private holdings could be cleaned up, key raptor area designated by BLM
Nitrogen Deposition, Fire, and Weeds				m	t		Mitigation: clean up the air is easier than battling invasives on the ground; when a fertilized area is left alone, it "cleans itself up" over time
Nitrogen Deposition, Fire, and Weeds					t		BNSF rail line + wind promote Sahara mustard invasion
Nitrogen Deposition, Fire, and Weeds					t		1000 kg/ha enough fuel to carry a fire
Nitrogen Deposition, Fire, and Weeds					t		Erodium: in CA since the 1800's, spread by small mammals, will responde to a decrease in N deposition
Nitrogen Deposition, Fire, and Weeds					t		Fire is occuring even without continuous cover- spreads on wind through cinders

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Nitrogen Deposition, Fire, and Weeds					t		Herbicide use: cattle or sheep for weed control, effective in wet years but narrow window
Nitrogen Deposition, Fire, and Weeds					t		If exotic species were not around, natives could benefit from increased N
Nitrogen Deposition, Fire, and Weeds					t		Increased precip in the Mojave is a potential threat that could increase invasive species and fire: summer precip has neg correlation with fire, winter precip has positive correlation with fire
Nitrogen Deposition, Fire, and Weeds					t		Rich Minnich- fires historically occurred in desert every 500-1000 years
Nitrogen Deposition, Fire, and Weeds					t		Sahara mustard does not appear to be linked to N, very dense, grows large in wet years, spread by small mammals uphill
Nitrogen Deposition, Fire, and Weeds					t		Schismus: seedbank becomes depleted in dry years, above 1000m, what is schismus habitat becomes dominated by Bromus
Northern Colorado Recovery Unit					t		Lazy Daisy cattle allotment is a threat
Novaris springs		s					Nochorid bug (candidate species, Doug Treeloff has information)
Oak Creek		s					Southwestern Willow Flycatcher
Old Dad Mountains		s					Bighorn Sheep population - managed with 4 guzzlers at Old Dad
Old Woman Mountains		s					Bighorn sheep area
Old Womans / Ward Valley	h						Good habitat
Ord Mountains					t		Grazing allotment
Ord Rodman to Central Mojave			c				Connectivity between Ord Rodman and Central Mojave DPS of Desert Tortoise- connectivity along foothills at edge of Cady Mts.
Ord Rodman to Joshua Tree National Park			c		t		Not much connection between Ord Rodman and Joshua Tree

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Orocopia Wilderness (to the north)			c				Connectivity
Owens Valley		s			t		Seeps around valley feed lake and have rare plants, proposed for development but could be restored
Owens Valley		s					Swainsons 10 pairs
Owen's Valley (Cabin Bar Ranch spring)	h						Important wetlands
Palen Dry Lake		s					Could have unique population of fringe-toed lizards that may be different from Coachella Valley lizards
Palen Dunes	h						Very dependent on physical processes, OK as long as source is not blocked
Palisades Ranch				m			Fish and Game has Section 6 $ to acquire this
Palm Canyon					t		Hydroelectric power on NFS land; green path north
Palm Oases		s					Good bat location
Palm Springs to Yucca Valley			c				Connectivity for bighorn sheep, mt. lions; opportunity for private land acquisition
Palmdale					t		Suffers from urban sprawl, and little to no mitigation has been done to compensate for urban growth. Survey efforts required under CEQA can be done without serious effort (i.e. during the summer)
Panamint Dunes	h						Good habitat
Panamint Mountains		s					Good bat location; canyons with streams important
Panamint Valley	h	s					Riparian canyons, Panamint lizard, possible Inyo towhee, panamint daisy
Panamint Valley	h			m			Great views, linkage between Death Valley and China Lake, Gabrytch- land owner/speculator purchasing privately owned land for mitigation
Panamint Valley		s		m			Private property could be aqcuired for mitigation, state lands in checkboard, good for Mohave ground squirrel and other species

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Panamint Valley				m			Indian Ranch, Ballarat, Post Office Springs, Hall Canyon all privately owned and worth acquiring
Panamint Valley (south end)					t		Briggs Mine is a threat
Paradise Spring	h	s					Near Ft. Irwin, lukewarm spring, alkali Mariposa lily, wetland orchids, tules, privately owned
Peace Valley			c				Important for movement of wildlife through region
Pinyon Pine Forest					t		Burned, cheatgrass invasion; pinyon takes 30-40 years to get restarted
Pioneertown					t		Schismus growth is leading to burning, especially in "desert chaparral"
Pisgah		s					Bighorn sheep
Piute Gorge	h	s					Bird breeding areas; includes riparian bird species and/or habitats such as Arizona Bell's vireo, SW willow Flycatcher (habitat), Least Bell's Vireo (habtitat); Gooding's willow and elf owls
Piute Mountains		s					Bighorn Sheep population - managed with 1 guzzler
Poison Canyon		s					Many Mohave ground squirrel and desert tortoise sightings in area where they are not expected to be
Primm Valley					t		Multiple threats
Providence Mountains		s					Gila monster occurrence
Quail Mtns Watershed	h						good habitat
Rabbit Springs	h	s			t		Parish's alkalai grass, only known occurrence in CA; type locality for several plants; dead vole observed by Ray (Mojave vole?); bisected by road and proposed development by Edison Mission
Rabbit Springs		s					In Lucerne Valley, Plagiobothrys parishii
Rand Mountains	h	s			t		Good desert tortoise habitat, ACEC, DTNA, proposed wind
Rand Mountains					t		Rand Mountain ACEC, was an OHV area, closed 10 years ago, some routes re-opened and then closed again by court order

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Razor OHV Area	h				t		Near designated wilderness, boundary is uncertain on ground, would like fence to be built, Sahara mustard invasion from the west
Red Pass		s					Genetically distinct population of flat-tailed horned lizard
Red Rock Canyon (north side)			c		t		Proposed PV solar development, narrow corridor for wildlife movement north of there
Red Rock Canyon to Desert Tortoise Natural Area			c				Loss of connectivity between DTNA and Rand Mt./Red Rock Canyon is minimal
Resting Springs	h						Near Amargosa River and Chicago Valley, has extensive mesquite bosque and water
Rice Valley			c		t		Proposed project, connectivity for bighorn and plants
Rice Valley Dune System	h		c				All dunes- where is sand coming from?
Ridgecrest		s			t		Solar Millennium project proposed; desert tortoise + Mohave ground squirrel
Ridgecrest area	h						Northern Jawbone ACEC, tortoise and Mohave ground squirrel
Ridgecrest tortoise populations		s					69 tortoises on 1700 acres, good ground squirrel corridor
Ritter Ranch	h						Good habitat; needs protection
Ritter Ranch		s					California red-legged frog
Ritter Ranch		s					Southwestern pond turtle
Rodman Mountains	h	s					Bighorn, no weeds all the way down to the freeway, alluvial fans area really nice, private holdings could be cleaned up, key raptor area designated by BLM
Rose Valley		s			t		Mix of public and private land, geothermal power purchased much of the land, Mohave ground squirrel habitat
Rose Valley		s					Ground squirrel sitings
Rose Valley		s					Rose Valley- northern-most population of desert tortoise on West Side of Mojave
Saddleback Butte State Park			c				Good connection to Edwards Air Force Base, could create corridor for ground squirrel and desert tortoise

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Salt Creek ACEC/ lost of good bat habitat				m			Private property could be aqcuired for mitigation
Salton Sea		s					Good bat location
Salton Sea		s					Peregrines, some wintering osprey
San Andreas Fault	h		c				Ecotone
San Andreas Rift	h			m			Wetlands important for migratory birds; Lori Lisle is Palmdale city planner working to acquire wetland areas
San Bernardino Mountains to Granite Mountains			c		t		Corridor for sheep movement here is not functional, only a corridor in theory, lots of rural development in Lucerne and Apple Valley, big powerline keeps houses away
San Bernardino Mts. to desert mts.			c		t		Connectivity for bighorn sheep, coyotes, fox, badgers, probably less important for plants; undeveloped private land with a power corridor as a threat
San Bernardino Mts. to desert mts.			c				Another linkage
San Bernardino National Forest (north side)		s					Carbonate endemic plants
San Bernardino National Forest (north side)		s			t		Carbonate plants, information in plan, bighorn sheep herd, spotted owls; threatened by mining, but plan helps to reduce threat
San Bernardino National Forest (north side)				m	t		Mining exploration can be mitigated using the USFS permitting process
San Gabriel Mts. To Baldy Mesa	h	s	c		t		Coastal-most Joshua tree population, important meeting place of 2 ecoregions; across hwy 138, concerned about fire and OHV's
San Gorgonio Pass			c				Important migratory bird pathway
San Gorgonio Peak		s					Limber pine and Clark's nutcrackers confined to this high elevation locatoin
San Sebastian Marsh/ San Felipe Creek	h	s					Pupfish area west of Salton Sea, state/federal checkerboard with private lands interspersed, has permanent water, ACEC
San Sebastian Wash	h	s					ACEC, flat-tailed horn lizard, archaeological resources

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Santa Clara River		s					Many important species
Searchlight wind project	h				t		In donut-hole of DWMA
Searles Valley (east side)			c				Essential corridor for groundsquirrel movement/linkage, metapopulation dynamics allow them to disperse in good years
Senator Mine: near Senator wash south of Ferguson Lake (Colorado River)		s					Good bat location
Shadow Valley		s					Desert tortoise population
Shadow Valley					t		Grazing allotment
Sheep Creek	h						headwater protection for Mojave River
Sheep Creek	h						More vegetation than other washes nearby, typically does not have surface water, more silty sediment
Sierra Foothills		s					Sierra Foothills have rare plants
Silurian Valley			c				Linkage between Avawatz and Kingstons
Silver Mountain				m			Private property could be aqcuired for mitigation; desert tortoise and Mojave monkeyflower, unprotected areas outside of ACEC
Sky Islands throught desert					t		Heavily threatened by climate change
Sleeping Beauty Mountains (west side)		s					Dark morph of side-blotched lizard, desert tortoise, bighorn sheep, crucifixion thorn, white-margined beard-tongue
Soda Mountains		s					Desert Tortoise occurrence
Soda Spring		s					Includes MC Spring and Lake Tuende (natural pond); populations of the Mojave Tui chub
Solar 2		s					Pennisular bighorn sheep unknown prior to surveys
Spangler Hills OHV Area		s					Desert tortoise and lots of wildflowers
State Line and I-15		s					Gila monsters

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Station Fire					t		Burned 160,000 acres, approximately 1/2 of Angeles NF, concern about recovery of bigcone douglas fir
Sterling Solar phase 1			c				Important for connectivity between DWMA and other habitats
Stirling Solar 2		s					Flat-tailed horned lizard and newly documented ewe group of Penninsular bighorn sheep
Stoddard Valley OHV Area		s		m			Private property could be aqcuired for mitigation; Mojave Monkeyflower
Tecopa Hot Springs	h						Amargosa Vole Habitat
Tehachapi Foothills		s					Native grassland
Tehachapi Mountains		s					Search for Tehachapi Slender Salamander is underway
Tehachapi-San Gabriel Linkage			c				Includes Tejon Ranch, linkages across Angeles NF to Los Padres NF
Throughout Desert	h			m			Mitigation opportunity: pretty much all BLM that is not Wilderness is desert tortoise habitat
Throughout Desert	h				t	o	Valleys in between Mountains - haven't been included in protected areas, yet they have high value
Throughout Desert	h						Alfalfa fields are important foraging areas for burrowing owls; patchwork of actively farmed and temporarily fallow land is best
Throughout Desert		s			t		Barsow woolly sunflower locations may not be in CNDDB
Throughout Desert		s			t		Low elevation species (coachwhip snakes, chuckwallas) CC may not have an overly negative effect because they are already adapted to hot conditions, but other species that are living at higher elevations along the edges of valleys may have a more difficult time because they may have to move over rough terrain along slopes to survive CC
Throughout Desert		s				o	Both plants and wildlife can exist in very small locations- may be underprotected by landscape-scale conservation

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Throughout Desert		s				o	Golden Eagles: nests have existed in place for centuries; USFWS is using the bald eagle act to protect golden eagles and make stiff siting regulations for wind farms; some eagles can nest in Edison towers that have the appropriate structure, so we could modify towers and build nests for the eagles, or create large poles that could serve as nest sites; but eagles will fly from nest when people are 400 yards away (most likely because of decades of being shot at)
Throughout Desert		s				o	Redtail hawks: Fledge and then head north into the desert from the coast
Throughout Desert		s					Raptor nesting: Larry LaPre has this information, Ray may have it on a disk
Throughout Desert		s					Burrowing owls nest in low density throughout the desert valleys: 1 pair in 10-5 square miles
Throughout Desert			c	m	t		Mitigation opportunity: Bighorn sheep corridors, building and or fencing them up to allow movement across roads
Throughout Desert			c			o	Desert tortoise is moving up in elevation due to shift in climate
Throughout Desert			c				Birds of prey move from north to south through valleys
Throughout Desert			c				Desert Connectivity Analysis- Mojave and Sonoran Deserts; 23 different connections, formal evaluation using biological irreplacability and threats, based on size of blocks and other criteria; 43 species- suitability models; Focal species list- kept species modeled before, took expert input, eliminated some based on small home range, used species with good genetic data from Pendergase study
Throughout Desert				m	t	o	TWC will be releasing a document soon that states that 200,000 acres of disturbed land is available in Cal for renewable energy siting
Throughout Desert				m	t		Mitigation opportunity: make powerline corridors less hospitable to ravens
Throughout Desert				m	t		Mitigation opportunities: Retiring of grazing rights should be an option
Throughout Desert				m	t		Mitigation opportunity: better ORV enforcement by BLM rangers
Throughout Desert				m	t		Mitigation opportunity: fencing of major roads , providing culverts to prevent fragmentation

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Throughout Desert				m	t		Mitigation opportunity: Highway fencing for desert tortoise
Throughout Desert				m	t		Mitigation opportunity: Identifying highways, fencing them off, would help restore dead zone, tortoises will recover in areas that have been fenced
Throughout Desert				m	t		Mitigation opportunity: invasive species control
Throughout Desert				m	t		Mitigation opportunity: Rangers/enforcement
Throughout Desert				m	t		Mitigation opportunity: Raven management
Throughout Desert				m	t		Mitigation opportunity: removing livestock grazing- some allotments are available for buy-out
Throughout Desert				m	t		Mitigation opportunity: Retire grazing allotments
Throughout Desert				m	t		Mitigation opportunity: route closures
Throughout Desert				m	t		Mitigation opportunity: Vertical mulching to close illegal OHV routes
Throughout Desert				m	t		Mitigation: fencing and wildlife crossings: it is easier to get a fence approved when the highway is at complete build-out (i.e. the eastern portion of the 15 and 40)
Throughout Desert				m	t		No good examples of restoration on a large scale exisit; the scale of the threats is too large to address on the ground
Throughout Desert				m	t		Retiring of grazing allotments needs to be part of development, but is not proposed yet
Throughout Desert				m		o	Suing wind industry is the best tactic because it delays their production schedule, which is the only way they will participate in negotiations
Throughout Desert				m			Active translocation: make and maintain burrows, capture birds just prior to breeding season, pult them into new nest location and feed them until they lay eggs, must do 12-30 pairs at a time; works somewhat better, but groundsquirrel populations must be sufficient to support burrowing owl populations
Throughout Desert				m			Department of Fish and Game is shifting to have more on-the-ground land management, and could be a long-term holder of mitigation lands

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Throughout Desert				m			Mitigation opportunity in Critical Habitat: resotration is often required to make these areas suitable for the species that use them; "critical habitat" is not always the best habitat for a species
Throughout Desert				m			Mitigation opportunity: ACEC status is not good enough protection
Throughout Desert				m			Mitigation opportunity: Acquisition of private inholdings- need massive amt of replacement habitat for solar plants
Throughout Desert				m			Mitigation opportunity: Allow focused, scientifically-based research from mitigation funds to answer specific questions that could help guide species recovery
Throughout Desert				m			Mitigation opportunity: BLM operates differently in NV than in CA; in NV, some BLM land is set aside for conservation use only; changing how BLM operates in CA could be helpful
Throughout Desert				m			Mitigation opportunity: Clean up illegal dumping grounds
Throughout Desert				m			Mitigation opportunity: Concept of a new designation of land could be a good idea for BLM lands
Throughout Desert				m			Mitigation opportunity: Cross-prosecution rights across BLM/DFG land
Throughout Desert				m			Mitigation opportunity: DFG land: benign neglect, not good info about where these lands even are located
Throughout Desert				m			Mitigation opportunity: DWMAs should be signed
Throughout Desert				m			Mitigation opportunity: Employ educators rather than expensive rangers on OHV routes
Throughout Desert				m			Mitigation opportunity: initial effort should be for acquisition, and then look at endowment/mitigation funds for rehabilitation
Throughout Desert				m			Mitigation opportunity: Land acquisition of private checkerboard is highest priority in areas where there is private land
Throughout Desert				m			Mitigation opportunity: Preservation of natural water flow
Throughout Desert				m			Mitigation opportunity: Sign entrances to DWMAs

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
Throughout Desert				m			Mitigation: DFG mitigation of 2:1 could be used for management activites rather than just land acquisitions
Throughout Desert				m			Mitigation: First need to do land acquisition to prevent development in the future
Throughout Desert					t	o	6-9% of desert plants are undescribed
Throughout Desert					t	o	A thorough inventory of desert species cannot happen on such a short time-scale
Throughout Desert					t	o	Need greater protection for ecosystem function- how do we do this when we can't enforce what is already in place
Throughout Desert					t	o	Probabilities for success are not considered in mitigation plans
Throughout Desert					t	o	The term "avoidance" is being misused by renewable developers
Throughout Desert					t	o	There are some species that are not listed which should be
Throughout Desert					t	o	Translocation has poor success for plants
Throughout Desert					t		Burrowing owls: Passive relocation doesn't work very well
Throughout desert					t		Invasive species are a threat, particularly in riparian areas
Throughout Desert					t		Siting criteria document that TNC was also a signatory on: prevent siting in remote areas
Throughout Desert					t		Water table overdraft
Throughout Desert					t		Windfarms are a huge issue; because seasonality of movement varies from species to species, it may be difficult to plan for migrations to avoid bird strikes
Throughout Desert						o	Bitner and Linser surveys are a good source of information
Throughout Desert						o	BLM has a map of eagle nest locations (ask Larry LaPre)
Throughout Desert						o	Burrowing owls are not diurnal, they eat beetles and crickes at night in the fields
Throughout Desert						o	Density of smaller nesting raptors is very light
Throughout Desert						o	Improving long-term protection should be a high priority
Throughout Desert						o	Main objectives should be to conserve wintering habitat and nesting habitat

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Throughout Desert						o	Prairie Falcons nest throughout the Mojave
Throughout Desert						o	Processes are important, and can be crucial for supporting species in an ecosystem (i.e. hydrology)
Throughout Desert						o	Range extensions of plants (see Andre's inventories: burned area response and vascular plant inventory);
Throughout Desert						o	Rough-legged Hawks: Don't come this far south anymore
Throughout Desert						o	USGS has done studies at Newberry Springs, Death Valley of the hydrological flow systems (Wayne Belcher, Dan Bright)
Throughout Desert (desert valleys)	h						Places where raptors forage, and these are proposed areas for solar development
Throughout Desert (mountain tops)		s					Good bat locations
Throughout Desert (sand dunes)		s					Dunes: most have their own species of flies
Throughout Desert (sand dunes)		s					Mojave fringe-toed lizard
Throughout Desert (sky islands)	h				t		Each has its own pair of Golden Eagles, and every mountain has a wind farm planned for it- this is a huge problem that could result in a loss of all of these eagles
Tributary on north side of Bouquet Canyon		s					Red-legged frog
Troy Dry Lake					t		proposed renewable energy development
Twentynine Palms	h					o	Twentynine Palms is more trashed than Ft. Irwin because of training with tanks for decades
Twentynine Palms			c				Important for future movement of tortoise with climate change
Una Lake	h	s		m			Least Bell's Vireo, located behind lake Palmdale, mitigation work on retention basins

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
Viceroy Mine/Castle Mt. Mine				m	t		Revegetation standards are close to being met, interested in them selling their land; wind and solar proposed, but NPS would like to annex the area
Victorville Vulcan Mine				m			Limited restoration success
Victorville-Lancaster			c				Urban development and loss of habitat are huge threats, and will isolate desert transition from floor to peak on north side of mountain ranges
Virgin River			c			o	Virgin River prevents dispersal dispersal to the west
Ward Valley	h				t		Microphyll woodland, OHV problems, PRBO surveys
West Mojave	h	s					Swainson's hawks and other raptors; alfalfa can provide good foraging habitat for Swainson's
West Mojave		s			t		Pronghorn antelope; found near Tejon Centenial project
West Mojave		s			t		Sierra Sun Tower (E Solar): was built despite presence of Alkalai Mariposa Lily
West Mojave		s				o	Mohave ground squirrel is found as far north as Olancha and as far south as Victorville/Hesperia
West Mojave		s					Mohave ground squirrel only found west of a certain line through central Mojave Desert
West Mojave		s					Burrowing owls: found all over western Mojave, mapped by consultant when school land was slated for development. Old ag fields and irrigation pipes can be good havitat, but LA Co. Sanitation district removes these
West Mojave		s					California fillary
West Mojave		s					Desert tortoise
West Mojave		s					Mohave ground squirrel
West Mojave		s					Mountain plovers
West Mojave		s					Spiny hopsage: decrease because of either drought and/or high temps, used by Mohave ground squirrel
West Mojave		s					Swainson's hawks- supported by ag
West Mojave				m	t		Clearing of native vegetation for agriculture- not subject to CEQA and is not mitigated.

Name of Place or Subject of Discussion	Category of Information: notable habitat	notable species	connectivity	mitigation	threats	other notes	Expert Information, Opinions, and other Notes
West Mojave				m	t		Private property could be aqcuired for mitigation; Areas with desert cymopterus, occurs to the east of dry lakes, hard-hit by parcelization and other development/ good potential for ESA protection
West Mojave				m			Opportunities for land acquisition
West Mojave				m			CDFG priority acquisition areas are defined by a confidential "bubble map" that is partially based on the Significant Ecological Areas of Los Angeles County
West Mojave				m			CEQA has no "teeth", and someone needs to file lawsuits in the west Mojave to ensure that CEQA is being followed; CDFG has tried to write letters, but mitigation requirements are not enforced.
West Mojave				m			Good areas of mitigation in LA County are identified in the West Mojave Plan, and include a big area north of the San Bernardino Mountains to Edwards Air Force Base, with Big Rock Wash as the eastern boundary.
West Mojave				m			Lake and streambed modification: CDFG requires mitigation occur in county, some use of Santa Monica Mountains Conservancy land for this, but little follow-up; due diligence anaysis is required for long-term management of these projects
West Mojave				m			Private property could be aqcuired for mitigation; LA County significant ecological areas, updated about 5 years ago
West Mojave					t		395 expansion
West Mojave					t		58 expansion
West Mojave					t		E22: new expressway 395-14 won't happen soon, 395-15 will happen soon
West Mojave					t		The Los Angeles Sanitation District uses wastewater to irrigate alfalfa fields, which can negatively impact resources
West Mojave					t		Threats to desert habitat: increased fire frequency, predators (coyotes, raves), dumping, water shortages, climate change, N deposition
West Mojave						o	Environmental groups are not fully engaged in the area, but this seems to be changing as of late

Name of Place or Subject of Discussion	Category of Information						Expert Information, Opinions, and other Notes
	notable habitat	notable species	connectivity	mitigation	threats	other notes	
West Mojave (county line and Hwy 14)	h						Dune habitat; source of sand is unknown
West Mojave (Intersection of Hwy's 138 and 18)	h						Joshua tree woodland, very good habitat near intersectin of 138 and 18
West Mojave (LA County land)				m		o	LA County Parks and Recreation management strategy has been to fly "below the radar" of the public to avoid OHV/illegal dumping/etc., now working to acquire land within the LA County Significant Ecological Areas
West Mojave to NE Mojave Recovery Unit			c				Connectivity between west Mojave and Northeast Mojave Recovery Unites is along I-15, ACEC is small
Whitewater Canyon	h						California Fringetoed Lizard HCP
Whitewater Canyon		s					Desert lananthis occurance
Woods Mountain					t		Burros; round-up started in 1999, about 3000 captured; 2004 and 2005 helicopter round-ups; burrows are widespread, actively managed; some burro damage to springs, but most of impact is due to cattle
Yucca Valley			c				Important for future movement of tortoise with climate change
Yuha Desert	h						Archaeological resources, ACEC
Zyzzx		s					Bighorn Sheep population - attracts a lot of visitors to the Preserve
Zyzzx		s					Mojave tui chub

Appendix E Acronyms Used

Acronym	Meaning
AFB	Air Force Base
ACEC	Area of Critical Environmental Concern
AGFD	Arizona Game and Fish Department
ACOE	Army Corps of Engineers
BMPs	Best Management Practices
NECO	BLM Northern and Eastern Colorado Desert/CDCA Plan Amendment
NEMO	BLM Northern and Eastern Mojave Desert/CDCA Plan Amendment
WEMO	BLM West Mojave Desert/CDCA Plan Amendment
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CBC	California Biodiversity Council
CDFG	California Department of Fish and Game
CDPR	California Department of Parks and Recreation
CDWR	California Department of Water Resources
CDCA	California Desert Conservation Area
CESA	California Endangered Species Act
CEC	California Energy Commission
CEQA	California Environmental Quality Act
Cal-IPC	California Invasive Plant Council
CNPS	California Native Plant Society
CNDDB	California Natural Diversity Database
CRWQCB	California Regional Water Quality Control Board
CTTC	California Turtle and Tortoise Club
CBD	Center for Biological Diversity
CCB	Center for Conservation Biology at UC Riverside
CVAG	Coachella Valley Association of Governments
CBI	Conservation Biology Institute
DOC	Department of Conservation (California)
DOD	Department of Defense
DOE	Department of Energy
DMG	Desert Managers Group
DRECP	Desert Renewable Energy Conservation Plan
DTC	Desert Tortoise Council
DTDSS	Desert Tortoise Decision Support System
DTNA	Desert Tortoise Natural Area
DTPC	Desert Tortoise Preserve Committee
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
eVeg	Existing vegetation data (U.S. Forest Service)

Acronym	Meaning
FMMP	Farmland Mapping and Monitoring Program
FLPMA	Federal Land Policy and Management Act
fVeg	Forestry-Vegetation Management Concentration
GAP	Gap Analysis Program
HCP	Habitat Conservation Plan
IBA	Important Bird Area
ITP	Individual Take Permit
INRMP	Integrated Natural Resource Management Plan
IRWMP	Integrated Regional Water Management Plan
IPCC	Intergovernmental Panel on Climate Change
MOU	Memorandum of Understanding
MBTA	Migratory Bird Treaty Act
MS(H)CP	Multiple Species (Habitat) Conservation Plan
MRLC	Multi-Resolution Land Characteristics Consortium
NDOW	Nevada Department of Wildlife
NEPA	National Environmental Policy Act
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWR	National Wildlife Refuge
NCCP	Natural Community Conservation Planning
NRCS	Natural Resource Conservation Service
NDOW	Nevada Department of Wildlife
OHV	Off-highway Vehicle
PRBO	Point Reyes Bird Observatory
PEIS	Programmatic Environmental Impact Statement
PCTL	Public Conservation and Trust Lands
QSA	Quantification Settlement Agreement
RAMP	Recreation Area Management Plan
RWQCB	Regional Water Quality Control Board
REAT	Renewable Energy Action Team
RETI	Renewable Energy Transmission Initiative
RPS	Renewable Portfolio Standard
RCD	Resource Conservation District
RMP	Resource Management Plan (BLM)
SRTM	Shuttle Radar Topography Mission
SCW	South Coast Wildlands
TNC	The Nature Conservancy
TWC	The Wildlands Conservancy
UNESCO	United Nations Educational, Scientific, and Cultural Organization
(US)EPA	(United States) Environmental Protection Agency

Acronym	Meaning
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
USGS	United States Geological Survey
DTRO	USFWS Desert Tortoise Recovery Office
UDWR	Utah Department of Wildlife Resources
WMA	Weed Management Area
WHBMA	Wild Horse and Burro Management Area

Appendix F Mojave Desert Ecoregional Assessment (2001) Expert Polygons

Figure F-1
Conservation Value and
2001 Portfolio Areas

Project Area
- Mojave Desert

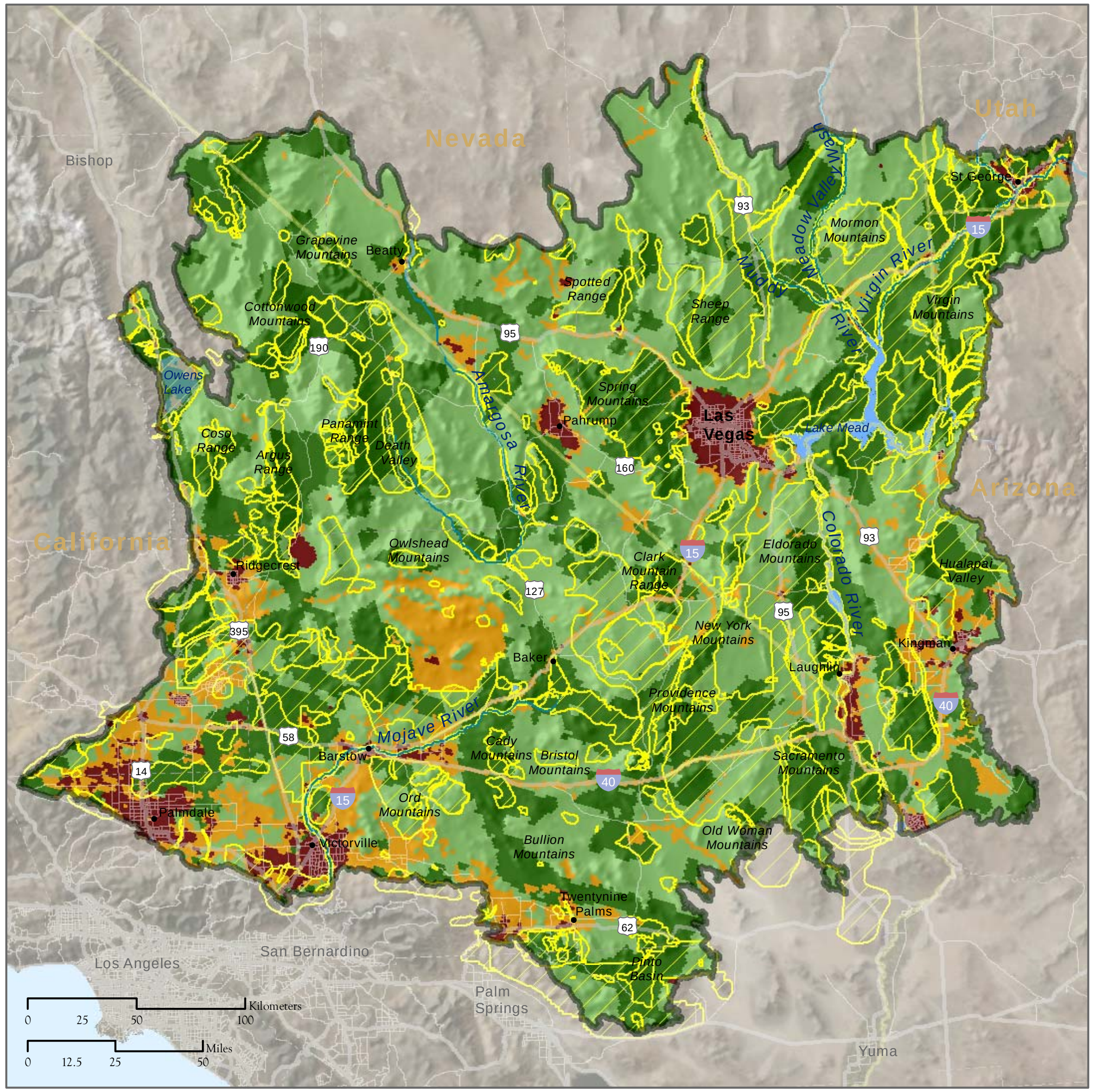
Boundaries
- State
- County

Transportation
- Major Road
- Other Road

Hydrology
- Major River

Conservation Value
- Ecologically Core
- Ecologically Intact
- Moderately Degraded
- Highly Converted

Ecoregional Assessment 2001
- Conservation Portfolio Area



Produced by The Nature Conservancy
California South Coast & Deserts Program
Map Date: July 1, 2010
See Table A.1 for sources

Appendix G Errata

The following changes were made in this version of the Assessment to address errors or omissions in the original document.

Deleted *Charadrius alexandrinus nivosus* Western Snowy Plover from Table 3-1 (page 24). Only the Pacific coastal population is federally listed as Threatened.

Added references for data sources on Figure 5-7 Nitrogen Deposition (Pages 62-63). The two reports, Weiss 2006 and Tonnesen et al. 2007, are cited elsewhere in the Assessment and were already included in the References section.

Added the data source for Figure 5-7 Nitrogen Deposition to Table A-1 (page A-5): CMAQ model dataset all_ca_n_02. Produced by University of California Riverside Center for Conservation Biology (CCB).