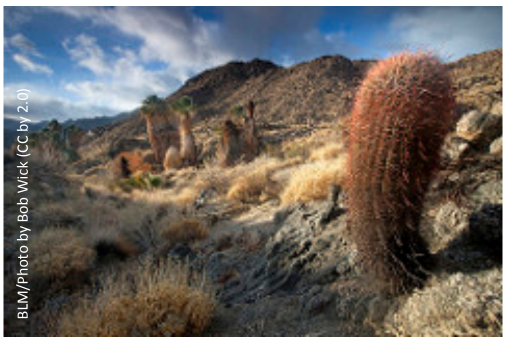
Southern California Desert Habitats

Climate Change Vulnerability Assessment Summary

An Important Note About this Document: *This document represents an initial evaluation of vulnerability for desert habitats based on expert input and existing information. Specifically, the information presented below comprises habitat expert vulnerability assessment survey results and comments, peer-review comments and revisions, and relevant references from the literature. The aim of this document is to expand understanding of habitat vulnerability to changing climate conditions, and to provide a foundation for developing appropriate adaptation responses.*



Habitat Description

There are three deserts in southern California: the Mojave Desert, the Colorado Desert (a subdivision of the larger Sonoran Desert), and the less well-known San Joaquin Desert, which historically encompassed 28,493 km^2 and included much of the San Joaquin Valley, Carrizo Plain, and Cuyama Valley. These desert ecosystems contain the highest temperature extremes in the United States; topographical relief in these desert ecosystems ranges from 86 m below sea level in Death Valley up to 3300 m above sea level in the Panamint Range.[1]

Habitat Vulnerability

Moderate Vulnerability

Low → High

High Confidence

The relative vulnerability of desert habitats in southern California was evaluated to be moderate by habitat experts due to moderate sensitivity to climate and non-climate stressors, moderate-high exposure to projected future climate changes, and low-moderate adaptive capacity. Desert habitats are sensitive to climate drivers that exacerbate the already hot and dry conditions, enhancing vulnerability for many species that already exist close to their physiological limits. Climate drivers and disturbances (e.g., changes in precipitation, flooding, wildfire) have the potential to significantly alter species survival and composition. Slow-growing vegetation makes deserts particularly vulnerable to invasive grasses, which provide fine fuels for wildfire; ultimately, the cycle of invasive species and wildfire can cause type conversion to grasslands. Non-climate stressors (e.g., invasive species) have already disturbed and/or fragmented many desert habitats. Although desert habitats remain less fragmented than many other habitats in the state, factors such as land-use conversion, agriculture, and energy production and mining have created significant landscape barriers in some areas. In general, desert environments are slow to recover from disturbance, in part because species exist close to their physiological limits. However, many species have developed adaptive traits to minimize water loss and resist adverse impacts from high air and soil temperatures. Because of this, desert species may be able to expand their ranges where barriers do not limit habitat migration. Due in part to extreme climatic conditions, desert habitats harbor an extraordinary amount of biodiversity, including many rare, endemic, and threatened/endangered species; however, the value of desert habitats can sometimes be overshadowed by their perceived value for energy and agricultural development.

Sensitivity

Moderate Sensitivity

Low → High

High Confidence

Desert habitats are sensitive to multiple climate drivers, including precipitation, soil moisture, low stream flows, drought, and extreme heat events. Although the harsh conditions found in deserts drive speciation, resulting in high levels of biodiversity, they also cause many species to persist close to their physiological thermal and water stress thresholds.[2] These factors limit growth, survival, and geographic distribution for both plant and animal species, leaving many vulnerable to extirpation or extinction.[3–5] Deserts are also sensitive to frequent disturbances, such as flooding and wildfire, and to non-climate stressors that create additional disturbance and habitat fragmentation.

Habitat sensitivity factors and impacts[*]

CLIMATIC DRIVERS	Moderate-High Sensitivity and Exposure High Confidence
Precipitation & soil moisture	Precipitation amount and timing affects soil moisture, stream flow, and groundwater recharge within desert habitats.[1] In water-limited desert habitats, vegetation is adapted to very dry conditions and seasonal variability.[2] Changes in precipitation and soil moisture may result in: • Changes in plant phenology driven by precipitation and soil moisture, including earlier seed germination and blooming[6,7] • Decreased seedling recruitment in California fan palms (*Washingtonia filifera*) • Greater variability in seasonal streamflow • Greater scouring, sediment erosion, and/or streambed alterations after more intense storms • Increased herbaceous cover during wet years (e.g., invasive grasses)[8]
Drought	Drought intensifies the already-extreme levels of water stress present in desert habitats, and increases in the severity or duration of drought may result in: • Extended periods between aquifer recharge • Loss of critical surface water sources in the form of streams and springs, as well as associated microclimate refugia (e.g., palm oases) • Reduced seedling establishment, leading to low plant recruitment and a shift towards older age classes • Decreased abundance of invasive grasses that act as fine fuel for

[*] Factors presented are those ranked highest by habitat experts. A full list of evaluated factors can be found in the Desert Habitats Climate Change Vulnerability Assessment Synthesis.

	wildfires • Increased abundance of drought-adapted species, such as succulents • Increased impact of disease on wildlife[9]
Extreme heat events	Desert vegetation is less sensitive to high temperatures than most plant species, and has some ability to acclimate and survive extremes without severe injury.[4] However, heat stress can still damage vegetation and severely limit wildlife.[3–5] Increased extreme heat may cause: • Increased evapotranspiration and associated loss of soil moisture[4] • Damaged ability of plants to photosynthesize, through injury to either physical leaf structures or altered chemical reactions[3,4] • Increased dependence of wildlife on underground thermal refugia, reducing opportunities to forage[5]
Low stream flows	Desert habitats rely heavily on surface water and aquifers (e.g., springs, ephemeral streams), many of which are ephemeral.[1] Lower flows and/or longer durations of low- or no-flow conditions may cause: • Elevated soil salinity along riverbanks, reducing seedling establishment[10] and increasing invasive plants adapted to such conditions[11] • Increased invasive plants, reducing plant species diversity and habitat suitability for wildlife[12]
DISTURBANCE REGIMES	Low-Moderate Sensitivity High Confidence
Wildfire	Historically, wildfires in southern California desert ecosystems were small and low-intensity due to a lack of ignition sources and low fuel continuity.[1] Changes in the wildfire regime may contribute to: • Altered species composition and population structure[1] • Delayed vegetation recovery as a result of more frequent or more severe fires[1,13] • Increased presence of fire adapted species (e.g., *Tamarix*) • Increased invasive annual grasses and associated increases in availability of fine fuels, leading to more fire and further loss of desert species[1] • Direct mortality, reduced survival, and reduced reproductive success in wildlife (e.g., desert tortoises, western yellow bats)[14,15]
Flooding	Flooding is an important part of the natural disturbance regime in desert habitats, and water erosion and soil deposition are constantly reshaping desert geomorphology. Soil structure and soluble minerals also drive plant species distribution. Shifts in flooding regimes may cause: • Altered species distribution and composition • Decreased dispersal and propagation of woody riparian species and increases in *Tamarix*, an invasive competitor[12]

NON-CLIMATE STRESSORS	Moderate-High Sensitivity & Exposure · High Confidence
Invasive & problematic species	Invasive grasses and forbs (e.g., *Bromus* spp. and *Schismus* spp.) are a threat to desert habitats, especially in disturbed areas and during periods of increased precipitation.[8,16] The impacts of these species include: • Increased availability of fine fuels for wildfire, contributing to more frequent and/or more severe fires[17] • Type conversion to annual grasslands, especially in post-burn areas[16] • Reduced native plant cover, flowering, and seed set[16] • Increased competition with native plants for water resources • Reduced habitat suitability for desert vertebrates such as lizards and kangaroo rats[8]

Exposure[†]

Moderate-High Exposure

Low → High

Moderate Confidence

Under future climate conditions, desert habitats are likely to be exposed to increased air temperature, changes in precipitation, decreased soil moisture, more extreme high temperature events, and increased wildfire over the coming century. Although predictions of monsoon activity in North America are highly uncertain,[18] more frequent and/or more intense tropical storms could alter desert stream geomorphology and riparian vegetation communities, particularly those in dry washes or floodplains. Desert habitat is expected to shift westward and upward in elevation over the coming century,[19,20] and, in some areas, may replace upslope vegetation that is less suited to increasingly hot and dry conditions.[21–23]

Seeps and springs, riparian habitats, deep canyons, north/northeast-facing slopes, and higher-elevation areas may offer refugia for many species. However, as vegetative structure is lost due to wildfire or other causes, microclimate refugia for many organisms may disappear due to lack of shade, decreased soil moisture, and increased air and soil temperatures.[1]

Projected climate and climate-driven changes for Southern California

CLIMATIC DRIVERS	PROJECTED CHANGE
Air temperature	+2.5 to +9°C by 2100
Extreme heat events	Heat waves, particularly nighttime heat events, will occur more frequently, last longer, and feature hotter temperatures
Precipitation & soil moisture	Variable annual precipitation volume and timing, decreased soil moisture
Wildfire	Increased fire size, frequency, and severity

[†] Relevant references for regional climate projections can be found in the Southern California Climate Overview (http://ecoadapt.org/programs/adaptation-consultations/socal).

Adaptive Capacity[‡]

Low-Moderate Adaptive Capacity

Low → High

High Confidence

Although desert habitats remain less fragmented than many other habitats in the state, fragmentation has occurred as a result of land-use conversion, agriculture, energy production and mining, transportation corridors, and wildfire.[1] In general, desert environments are slow to recover from disturbance, and species exist close to their physiological limits. However, many species have developed adaptive traits to minimize water loss and resist adverse impacts from high air and soil temperatures.[3] These traits may allow some desert species to expand their ranges, though geological and anthropogenic barriers often limit habitat migration.

Habitat adaptive capacity factors and characteristics[§]

FACTORS	HABITAT CHARACTERISTICS
Habitat extent, integrity, & continuity Low-Moderate High Confidence	+ Desert ecosystems extend across the southernmost third of the state, and are less fragmented than most other habitats[1] + Species adapted to drought and heat may be able to expand their range - The San Joaquin Desert is the smallest and most disturbed desert in southern California, primarily because of human activities (e.g., agriculture, petroleum extraction, urbanization)[24] - Increasingly extensive water delivery systems associated with the conversion of desert to agriculture further fragments habitat
Landscape permeability Low-Moderate High Confidence	+ Rivers and associated riparian habitats can act as corridors to facilitate the movement of fish and wildlife - Barriers to species dispersal/migration and habitat shifts include land-use conversion, agriculture, and energy production and mining
Resistance & recovery Low High Confidence	+ Desert vegetation is already adapted to survive in warm, arid habitats, exhibiting traits such as waxy cuticles and drought deciduousness[3] + Generalist shrub species will likely be the most resilient to climate change impacts, especially creosotebush (*Larrea tridentata*)[25] - Desert habitats are slow to recover from disturbance and species exist close to their physiological limits, making them vulnerable to increasingly harsh conditions

‡ Please note that the color scheme for adaptive capacity has been inverted, as those factors receiving a rank of "High" enhance adaptive capacity while those factors receiving a rank of "Low" undermine adaptive capacity.

§ Characteristics with a green plus sign contribute positively to habitat adaptive capacity, while characteristics with a red minus sign contribute negatively to habitat adaptive capacity.

FACTORS	HABITAT CHARACTERISTICS
Habitat diversity Moderate-High Moderate Confidence	+ Very high biodiversity, including many rare, endemic, or endangered and threatened species + Keystone species include Joshua tree, honey mesquite, blue palo verde, ironwood, and California fan palm + Specific vegetation assemblages characterize the Mojave, San Joaquin, and Sonoran Deserts
Management potential Low Moderate Confidence	+ Desert habitats provide many ecosystem services, including public health, biodiversity, recreation, grazing, and carbon sequestration + Valued for research potential, which include studies of desert biotic communities and the unique adaptations of extremophile species) - Low societal value: Little commercial value for the public; offers opportunities for recreation, agricultural, and energy development, but these may have significant negative impacts on the habitat

Recommended Citation

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This document is available online at the EcoAdapt website (http://ecoadapt.org/programs/adaptation-consultations/socal).

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