Southern California Desert Habitats

Climate Change Adaptation Actions Summary

An Important Note About this Document: *This document represents an initial effort to identify adaptation actions for desert habitats in southern California based on stakeholder input and existing information. Specifically, the information presented below comprises stakeholder input during a two-day adaptation workshop, peer-review comments and revisions, and relevant examples from the literature or other similar efforts. The aim of this document is to expand understanding of possible adaptation actions for southern California desert habitats in response to climate change.*

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Desert Habitat Vulnerability

Moderate Vulnerability

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, increasing the vulnerability of 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.

Adaptation Strategies and Actions

Table 1 presents a summary of possible adaptation strategies and actions for desert habitats, and consists of stakeholder input during an adaptation workshop as well as additional options from the literature or other similar efforts. Stakeholders identified ways in which current management actions could be modified to reduce habitat vulnerabilities as well as future management actions that could be considered for future implementation.

Adaptation strategies and actions are grouped according to one of five categories:

1. **Enhance Resistance**. These strategies can help to prevent the effects of climate change from reaching or affecting a resource.
2. **Promote Resilience**. These strategies can help a resource withstand the impacts of climate change by avoiding the effects of or recovering from changes.
3. **Facilitate Transition (or Response)**. These strategies intentionally accommodate change and/or enable resources to adaptively respond to changing and new conditions.
4. **Increase Knowledge**. These strategies are aimed at gathering more information about climate changes, impacts, or the effectiveness of management actions in addressing climate change.

5. **Engage Coordination**. These strategies may help coordinate efforts and/or capacity across landscapes and agencies.

Table 1. Summary of possible adaptation options for desert habitats.

Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Enhance resistance	Manage ex-urban wildlife populations (e.g., raccoons)	• Lethally remove ex-urban wildlife[1] • Create exclosures in areas where wildlife is not desired[1]
	Design educational programs to limit non-climate stressors	• Create educational programs focused on encouraging positive actions that are already occurring, and providing information about additional no-regrets actions that could address pollution and invasive species[1] • Communicate with the public about access to roads and recreation areas through signage, visitor centers, and brochures[1]
	Manage invasive species, including non-native grasses	• Remove invasive species, focusing on palm oases, transportation corridors, and recreation sites[1] • Remove non-native grasses around potential ignition sites[1] • Create sterile weed pollen (GMO) and spray to reduce spread of invasives[1] • Identify the species that may colonize sprayed areas and develop a plan[1] • Treat Sahara mustard infestations near areas of high resource value (e.g., near threatened and endangered species)[2]
	Reduce possibility of severe wildfire	• Close access to roads and campgrounds during high fire hazard years or when site needs to recover; direct visitors to more resilient sites[1] • Reduce response time to fires in years following heavy Nov/Dec rain[2] • Remove non-native grasses around potential ignition sites[1]
	Prevent soil erosion and loss of biological crust	• Limit off-highway vehicle (OHV) use and livestock grazing in sensitive areas[2] • Evaluate the feasibility of inoculating soils for biological soil crust regeneration[2] • Use soil stabilization treatments (e.g., local mulch, native seeds)[2]
Promote resilience	Educate the public about the importance of desert ecosystems	• Develop citizen science projects to gather data and raise awareness of desert ecology[1]

[1] Denotes adaptation action identified by workshop participants.

[2] Comer, P. J., Young, B., Schulz, K., Kittel, G., Unnasch, B., Braun, D., … Hak, J. (2012). *Climate change vulnerability and adaptation strategies for natural communities: piloting methods in the Mojave and Sonoran deserts*. Arlington, VA: Report to the U.S. Fish and Wildlife Service. NatureServe.

Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Promote resilience (con't)	Increase water residence times	• Consider engineering modifications that increase residence time of water in a particular area (check dams, long and low berms)[2]
	Protect and enhance seeps and springs, as well as the source aquifer(s) that supply them[2]	• Discourage visitor use of sensitive spring areas[2] • Protect a buffer zone for natural vegetation around spring sites to minimize effects of storm runoff[2] • Protect aquifer recharge areas and their surface catchments to provide long-term insurance for continued recharge[2]
Facilitate transition	Identify and protect desert refugia	• Prioritize land acquisition to target areas with potential refugia, such as seeps and springs, foothills, and dunes[1] • Protect desert refugia through varied strategies such as land acquisition, land use planning, and land transfers[1]
	Determine whether plantings will be successful under future climate conditions	• Establish baseline conditions necessary for desert plant reproduction[1] • Conduct surveys to identify vulnerable species, as well as those that are thriving or may thrive under future conditions[1]
	Increase habitat connectivity to allow species migration in response to shifting climatic envelopes	• Create wildlife corridors to facilitate the movement of reptiles and amphibians across roads and other anthropogenic barriers[1]
Increase knowledge	Establish monitoring programs to detect changes in desert habitats over time	• Establish a program to monitor changes in the timing of plant blooms (e.g. saguaro cactus) and pollinator arrival[2] • Monitor the movement of desert sand and the relationship of sand movement to floral and faunal movement[1] • Map and monitor vulnerable communities, incorporating information about known/potential refugia, recharge zones, and land ownership/management[1] • Monitor desert biodiversity, including invertebrates and soil microbial communities[1] • Develop monitoring program for bats to detect changes in populations and work towards protecting habitats[2] • Map water sources and aquifers to understand spatial and temporal connections between surface flows and groundwater[2]
	Conduct research to better understand complex dynamics in desert habitats	• Identify the synergistic relationships between species to improve our understanding of these relationships in the desert[1] • Identify pollinators that serve a keystone role in desert ecological systems[2]

Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Increase knowledge (con't)	Investigate restoration techniques that establish resilient native plants quickly	• Conduct research and field trials into the use of techniques such as mycorrhizal inoculation, establishing water reservoirs, and planting native vegetation[1]
Engage coordination	Collaborate with decision-makers to create policies that support healthy desert ecosystems	• Encourage flexible policies that take into account changing climate conditions (e.g., grazing allotments could increase or decrease depending on precipitation)[1] • Promote policies that would value the ecosystem services provided by the habitat[3] • Identify current policies that could offer funding or logistical support for desert research and restoration projects[1]
	Work with other professionals to monitor changes in desert ecosystems	• Collaborate with ecologists, botanists, etc. to develop indicators of ecosystem health to assist adaptive management[2] • Bring together all managers that focus on an important species and hold a workshop to share information (e.g., phenology, abundance) and develop hypotheses of change[2]

Table 2 identifies the key desert habitat vulnerabilities that may be reduced and/or addressed by various adaptation actions. These linkages are based on expert opinion.

Linking vulnerabilities to adaptation options can help managers decide which actions to implement and aid prioritization based on multiple factors (e.g., habitat type, observed or projected changes, ecosystem service). However, when selecting adaptation actions for implementation it is also important to consider secondary effects on other resources, both positive and negative. For example, trail or road decommissioning may benefit aquatic systems by limiting erosion impacts but could also remove important access points to fire-prone areas. For more information about desert adaptation strategies and actions developed by participants during the workshop, including where and how to implement adaptation actions, implementation timeframe, collaborations and capacity required, and secondary effects on other resources (both positive and negative), please see the report *Climate Change Adaptation Strategies for Focal Habitats of Southern California*.

[3] Kershner, J. M. (Ed.). (2014). *A climate change vulnerability assessment for focal resources of the Sierra Nevada. Version 1.0*. Bainbridge Island, WA: EcoAdapt

Table 2. Key vulnerabilities of desert habitats linked to specific adaptation actions and management activities; implementation of adaptation actions (central column) may help to directly reduce and/or address the impacts of identified climate and non-climate stressors and disturbance regimes (right columns). Actions highlighted in **red** represent adaptation strategies that enhance resistance, those highlighted in **orange** promote resilience, and those highlighted in **green** facilitate transition. Adaptation actions aimed at increasing knowledge and engaging coordination are not included in this table as they address vulnerability indirectly. Adaptation actions listed in this table include those identified by participants, in the scientific literature, and in other similar efforts.

Management Activity	Adaptation Actions	Climate Stressors		Disturbance Regimes		Non-Climate Stressors	
		↑Air temperature	Altered precipitation (timing & amount); ↓Soil moisture; ↑Drought; ↓Stream flows	↑Flooding & soil erosion	Altered wildfire regimes	Invasive & problematic species	Transportation corridors & recreation
Restoration Activities	Create educational programs focused on encouraging positive actions that are already occurring, and providing information about additional no-regrets actions that could address pollution and invasive species					✔	
	Remove invasive species, focusing on palm oases, transportation corridors, and recreation sites		✔		✔	✔	✔
	Create sterile weed pollen (GMO) and spray to reduce the spread of invasives					✔	
	Identify the species that may colonize sprayed areas and develop a plan					✔	
	Treat Sahara mustard infestations near areas of high resource value (e.g., near threatened and endangered species)					✔	
	Evaluate the feasibility of inoculating soils for biological soil crust regeneration			✔			
	Use soil stabilization treatments (e.g., local mulch, native seeds)			✔			
	Develop citizen science projects to gather data and raise awareness of desert ecology	✔	✔	✔	✔	✔	
	Establish baseline conditions necessary for desert plant reproduction	✔	✔	✔	✔		
	Conduct surveys to identify vulnerable species, as well as those that are thriving or may thrive under future conditions	✔	✔	✔	✔		
Fire/Fuels Management	Communicate with the public about access to roads and recreation areas through signage, visitor centers, and brochures			✔	✔		✔
	Remove non-native grasses around potential ignition sites				✔	✔	
	Close access to roads and campgrounds during high fire hazard years or when site needs to recover; direct visitors to more resilient sites				✔		✔
	Reduce response time to fires in years following heavy Nov/Dec rain				✔		
Watershed Improvement	Limit off-highway vehicle (OHV) use and livestock grazing to prevent soil erosion in sensitive areas			✔			✔
	Consider engineering modifications that increase residence time of water in a particular area (check dams, long and low berms)		✔				
	Discourage visitor use of sensitive spring areas		✔				
	Protect a buffer zone for natural vegetation around spring sites to minimize effects of storm runoff			✔			
	Protect recharge areas and their surface catchments to provide long-term insurance for continued recharge		✔				
Wildlife Management	Lethally remove ex-urban wildlife					✔	
	Create exclosures in areas where wildlife is not desired					✔	
	Prioritize land acquisition to target areas with potential refugia, such as seeps and springs, foothills, and dunes	✔	✔	✔	✔		
	Protect desert refugia through varied strategies such as land acquisition, land use planning, and land transfers	✔	✔	✔	✔		
	Create wildlife corridors to facilitate the movement of reptiles and amphibians across roads and other anthropogenic barriers						✔

In addition to directly reducing vulnerabilities (Table 2), some adaptation actions may indirectly address vulnerabilities. For example, using soil stabilization treatments such as local mulch and native seeds would reduce erosion, but may also increase the ability of the soil to hold moisture and support native plants that are better adapted to hot and dry conditions. Similarly, reducing non-native grasses around potential ignition sites may also reduce competition for soil moisture among plant communities; removing non-native grasses would also increase habitat suitability for desert wildlife such as kangaroo rats, which prefer areas with open spaces and patchy vegetation.

Two other important considerations when selecting adaptation actions for implementation include feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). An adaptation action with high feasibility has no obvious barriers and a high likelihood of implementation whereas an action with low feasibility has obvious and/or significant barriers to implementation that may be difficult to overcome. An adaptation action with high effectiveness is very likely to reduce associated vulnerabilities (listed in Table 2) and may benefit additional management goals or resources whereas an action with low effectiveness is unlikely to reduce vulnerability and may have negative impacts on other resources.

Figure 1 plots adaptation actions listed in Table 1 according to feasibility and effectiveness. This figure can help managers prioritize actions for implementation (e.g., actions with high feasibility and high effectiveness), better target management efforts toward specific challenges (e.g., actions with low or moderate feasibility but high effectiveness), and/or evaluate whether to proceed with implementation (e.g., actions with high feasibility but low effectiveness). For the latter two purposes, managers may consider the following questions:

- **Low or Moderate Feasibility/High Effectiveness Actions**: What steps can be taken to increase the likelihood of this action being implemented in the future?
    - *Example*: Would improving public outreach and education or enhancing public/private collaboration facilitate the removal of dikes or recharge basins with the goal of restoring fluvial processes?
- **High Feasibility/Low or Moderate Effectiveness Actions**: Does this action still make sense given projected climate changes and impacts?
    - *Example*: If conditions are projected to become drier, should grazing continue in areas with drought-sensitive vegetation?

Alternatively, there may be some actions that do not reduce vulnerability directly but could provide important information, tools, or support to address vulnerability down the line. For example, actions aimed at increasing knowledge through monitoring or modeling could provide key information for future restoration activities (e.g., creating detailed species genetic profiles to select genetically and ecologically suitable plant species for future conditions). Managers may want to weigh the costs and benefits of implementing actions with the timeframe required to reduce vulnerability directly. Additionally, actions focused on coordination and collaboration may not directly address vulnerabilities, but these remain important steps toward better planning and management.

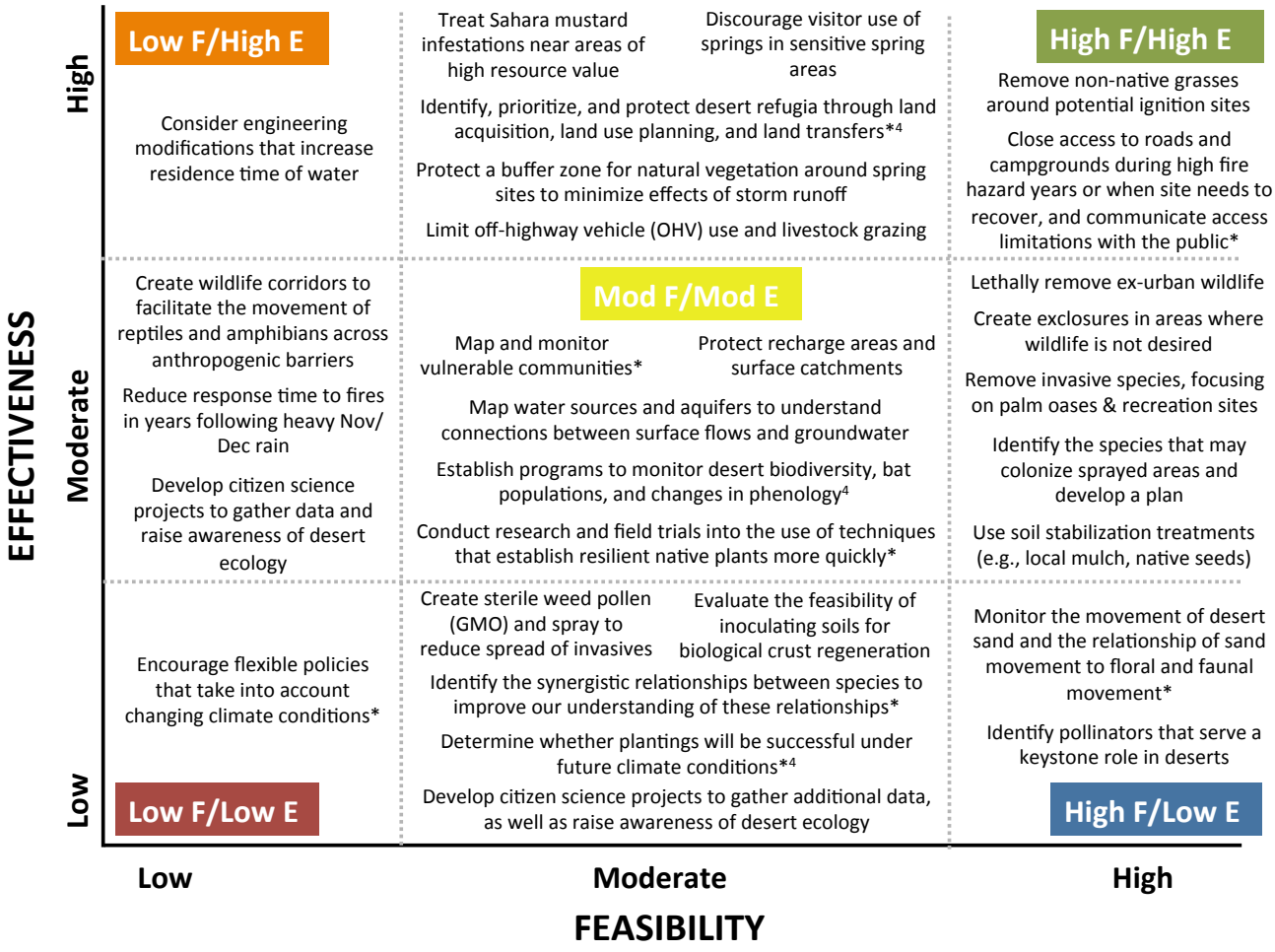

Figure 1. Desert habitat adaptation actions plotted according to implementation feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). Those actions having high feasibility and effectiveness appear in the upper right corner and low feasibility and effectiveness in the bottom left corner. An asterisk (*) denotes adaptation actions evaluated for feasibility and effectiveness by workshop participants, although in some cases the ranking was shifted based on expert opinion. All other adaptation action evaluations are based on expert opinion.

Recommended Citation

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[4] This overall goal includes several specific adaptation actions (see Table 1).