Southern California Grassland Habitats

Climate Change Adaptation Actions Summary

An Important Note About this Document: *This document represents an initial effort to identify adaptation actions for grassland 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 grassland habitats in response to climate change.*


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Grassland Habitat Vulnerability

Moderate Vulnerability

The relative vulnerability of grassland 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 moderate adaptive capacity. Grassland habitats are critically sensitive to changes in precipitation, soil moisture, drought, and air temperature, as moisture availability and timing interact with temperature to influence grassland composition, productivity, and survival. Grasslands are also sensitive to wildfire and herbivory, which depending on timing, frequency, and intensity as well as local site conditions, can elevate grassland biodiversity and/or have negative impacts on perennial grasses and other grassland components. Grassland systems are very sensitive to invasive species – primarily non-native annual grasses – that compete with native species for limited resources, inhibit native regeneration, and may be able to respond more quickly to climatic variability than native species. Grasslands are also sensitive to land use conversion, which increases invasive species exposure and removes current habitat, limiting potential refugia and dispersal in the face of climate change. Grassland habitats occupy large portions of the southern California landscape, but species composition has been considerably altered and they are facing significant fragmentation and habitat loss. Moderate-high species diversity and variable responses to disturbance may enhance the capacity of this system to tolerate future climate changes, although perennial species may be less resilient than annual species, leading to future shifts in functional groups. Grassland habitats provide a variety of ecosystem services including biodiversity, grazing, recreation, and carbon sequestration.

Adaptation Strategies and Actions

Table 1 presents a summary of possible adaptation strategies and actions for grassland 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 are not currently implemented but 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 climatic 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 grassland habitats.

Adaptation Category	Adaptation Strategy	Specific Adaptation Action
Enhance resistance	Limit the impacts of urbanization on grasslands and oak woodlands and restore grassland fragments in urbanized areas in addition to larger, open space reserves	• Facilitate and build capacity in communities to protect/enhance/restore grasslands and oak woodlands[1]
	Manage non-native grasses to increase native grass diversity and cover, reduce fire risk, and reduce competition for soil moisture	• Implement seasonal grazing and/or reduce grazing practices that encourage spread of non-native species[1] • Tailor ground management techniques (fire, grazing, mowing) according to local conditions and goals[2,3] • Manage invasive species in priority areas[4]
	Increase proactive management to prevent weeds	• Apply invasive species early detection/rapid response and inventory/mapping[4] • Develop weed management areas and coordinate with multiple agencies, NGOs, public, etc.[4] • Include invasive species prevention strategies in all projects[4] • Ensure weed-free policies are included in all planning documents[4] • Inventory regularly to detect new invasive populations and species[4] • Maintain permits for aggressive treatment of invasive species[4] • Expand weed-free feed list to included additional non-native species[4]
Promote resilience	Increase native cover and diversity to increase habitat resiliency and quality	• Practice seasonal grazing to remove non-natives and control thatch[1] • Utilize seeding[1] • Plant perennial grass plugs and water as needed[4] • Identify and promote early-successional natives that may be able to compete with non-natives[4]

[1] Denotes adaptation action identified by workshop participants.
[2] Eviner, V. (2014). Effects of weather variation on species composition and production in California's grasslands. *Grasslands, Fall 2014*, 1-7.
[3] Mordecai, E. A. (2012). Soil moisture and fungi affect seed survival in California grassland annual plants. *PloS One, 7*(6), e39083
[4] Actions were sourced from the Climate Adaptation Project for the Sierra Nevada and/or the Northern Rockies Adaptation Partnership.

Adaptation Category	Adaptation Strategy	Specific Adaptation Action
Promote resilience (con't)	Maintain and/or increase resilience	• Manage fire for natural resource benefits and utilize fire management techniques appropriate for specific species[4] • Manage livestock grazing by developing site-specific triggers for moving animals[4] • Revise grazing policies, and review and evaluate grazing allotment plans[4] • Evaluate grazing practices and implement appropriate practices given likely future conditions[4]
	Promote species and genetic diversity	• Plant potential microsites with mix of species[4] • Interplant to supplement natural regeneration and genetic diversity[4]
	Maintain carbon onsite to encourage moisture retention for grasslands	• Apply biochar in grasslands to improve soil organic content[4]
	Mitigate consequences of large disturbance by planning ahead	• Develop a gene conservation plan for *ex situ* collections for long-term storage[4] • Identify areas important for *in situ* gene conservation[4] • Maintain a seed inventory with high-quality seed for a range of species, particularly species that may do well in the future under drier and hotter conditions[4] • Increase production of native plant materials for post-disturbance plantings[4]
Facilitate transition	Identify and protect refugia for use as priority conservation and restoration areas	• Control and/or remove non-native grasses and forbs in identified refugia to reduce[4] competition for declining water resources in the future[4] • Designate conservation easements[4] • Identify areas where relict plants could be established[4]
Increase knowledge	Increase knowledge base to enhance restoration success	• Identify regional drought-adapted ecotypes to enhance/restore mesic areas[1] • Map risk areas for drought, monitor drought-prone areas, and vegetate with drought-hardy genotypes[4]
	Improve ability to source plants of shrublands and grasslands in southern California ("the right plant in the right place at the right time")	• Increase research on provenance testing of foundation species from common garden experiments in multiple parts of a taxon's range, and increase the availability of data and equations that relate plant fitness to environment for incorporation into detailed species distribution models[1]
	Increase knowledge of patterns, characteristics, and rates of change in species distributions	• Expand long-term monitoring programs[4] • Focus monitoring on sensitive locations, at-risk species, and on plant phenology[4] • Use feedback from monitoring in implementation of adaptive management

Adaptation Category	Adaptation Strategy	Specific Adaptation Action
Engage coordination	Work across jurisdictions	• Align budgets and priorities for program of work with neighboring lands[4] • Communicate about projects adjacent to other lands, and coordinate on the ground activities[4] • Coordinate invasive species management, funding, and support between agencies[4]

Table 2 identifies the key grassland 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 grassland 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*.

Table 2. Key vulnerabilities of grassland habitats linked to specific adaptation actions; 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	Altered wildfire regimes	Invasive & problematic species	Livestock grazing (overgrazing)	Land use conversion
Habitat Management & Restoration Activities	Tailor ground management techniques (fire, grazing, mowing) according to local conditions and goals		✔	✔	✔	✔	
	Manage invasive species in priority areas	✔	✔	✔	✔		
	Increase proactive management to prevent weeds[5]				✔		
	Facilitate and build capacity in communities to protect/enhance/restore grasslands and oak woodlands						✔
	Utilize seeding	✔	✔	✔			
	Plant perennial grass plugs and water as needed		✔				
	Plant potential microsites with mix of species	✔	✔				
	Interplant to supplement natural regeneration and genetic diversity	✔	✔				
	Develop a gene conservation plan for *ex situ* collections for long-term storage		✔	✔			
	Identify areas important for *in situ* gene conservation	✔	✔	✔			
	Maintain a seed inventory with high-quality seed for a range of species, particularly species that may do well in the future under drier and hotter conditions	✔	✔				
	Identify and promote early-successional natives that may be able to compete with non-natives			✔	✔		
	Increase production of native plant materials for post-disturbance plantings			✔	✔		
	Manage fire for natural resource benefits and use fire management techniques appropriate for specific species			✔			
	Identify areas where relict plants could be established	✔	✔	✔			
	Control and/or remove non-native grasses and forbs in identified refugia to reduce competition for declining water resources in the future		✔		✔		
	Designate conservation easements	✔	✔	✔			✔
Grazing Activities	Implement seasonal grazing and/or reduce grazing practices that encourage spread of non-native species	✔	✔	✔	✔		
	Practice seasonal grazing to remove non-natives and control thatch		✔	✔	✔		
	Evaluate grazing practices and implement appropriate practices given likely future conditions		✔			✔	
	Manage livestock grazing by developing site-specific triggers for moving animals		✔			✔	
	Revise grazing policies, and review and evaluate grazing allotment plans		✔			✔	

In addition to directly reducing some vulnerabilities (Table 2), some adaptation actions may indirectly address other vulnerabilities. For example, mitigating invasive species introductions (e.g., by including invasive species prevention strategies in all projects) can help reduce the risk of shifting fire regimes, since many invasive species have shorter fire return intervals than native vegetation. Similarly, seeding may also indirectly reduce vulnerability to increased air temperatures if plants with higher heat thresholds are utilized in seeding efforts.

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)

[5] This adaptation strategy includes multiple adaptation actions (Table 1).

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.

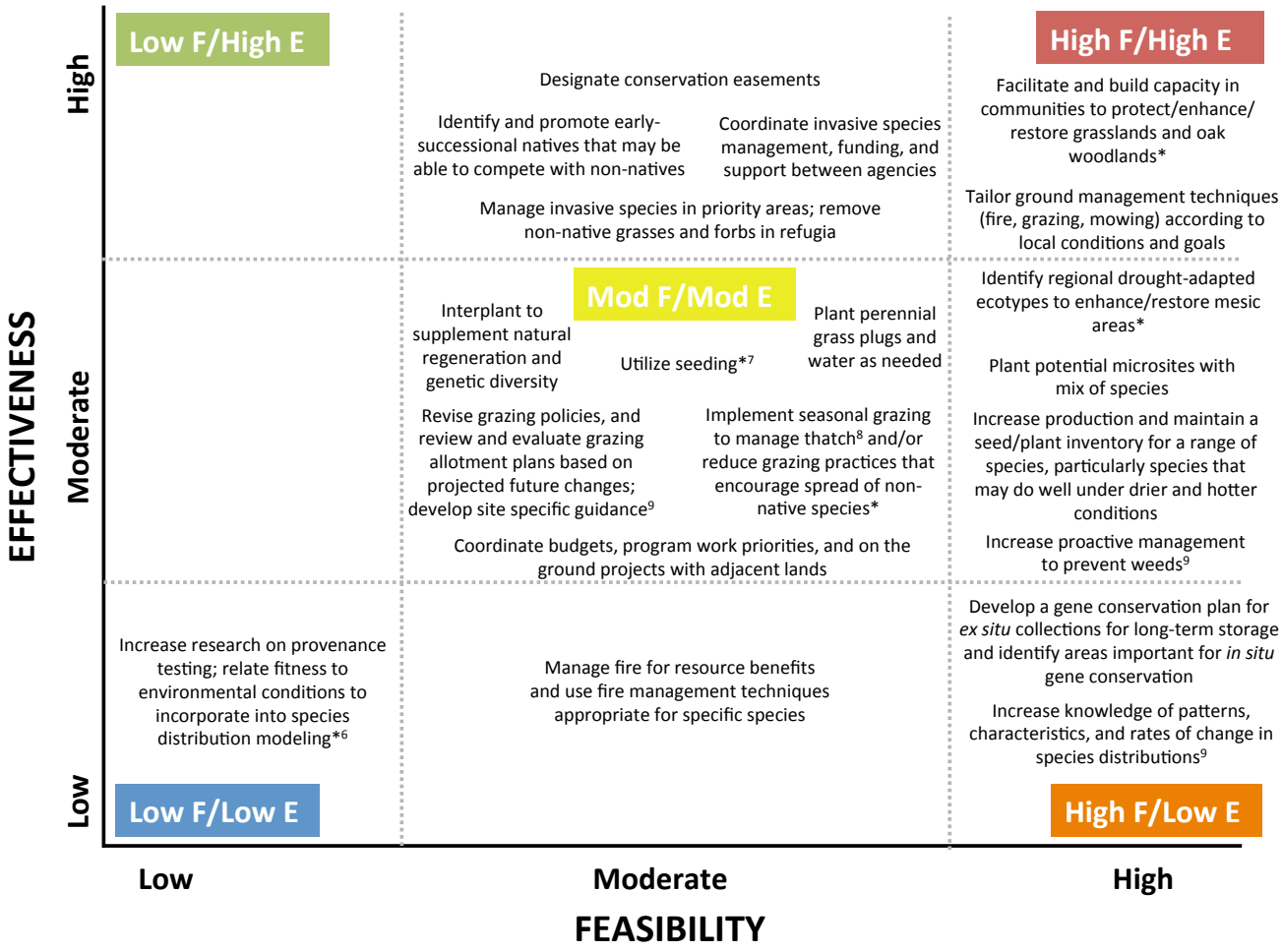

Figure 1. Grassland adaptation actions plotted according to implementation feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). Those actions having high feasibility and effectiveness appear in the upper right corner and low feasibility and effectiveness 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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[6] Workshop participants indicated that the feasibility of this action could increase with increased funding and staffing.

[7] Workshop participants indicated that the effectiveness of this action may be variable depending on seasonal and annual conditions. Workshop participants also noted that the feasibility of this action may be variable depending on cost and seed availability.

[8] Workshop participants indicated that the effectiveness of this action may change in the future if shifting climate conditions impact available livestock forage, grazing season length, herd numbers, and the need for grazing management (e.g., thatch height). Workshop participants also indicated that the feasibility of this action may change if livestock transportation and management costs increase.

[9] This adaptation strategy includes multiple adaptation actions (Table 1).