Southern California Grassland Habitats

Climate Change Vulnerability Assessment Summary

An Important Note About this Document: *This document represents an initial evaluation of vulnerability for grassland 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.*


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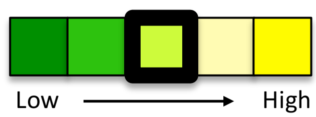
Habitat Description

Southern California has coastal prairie grasslands, which extend northward from the Channel Islands, warm desert grasslands in interior regions, and valley/south coastal grasslands, which extend south along the coastline from Santa Barbara.[1-3] Grasslands in southern California are typically dominated by high non-native annual cover, but still support a diversity of native annual and perennial species at low abundances.[4-6]

Habitat Vulnerability

Moderate Vulnerability



Moderate Confidence

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 affect grassland composition, productivity, and species survival. Grasslands are also sensitive to wildfire and herbivory, disturbance mechanisms that can elevate grassland biodiversity and/or have negative impacts on perennial grasses and other grassland components depending on timing, frequency, intensity, and local site conditions. Grassland systems are very sensitive to invasive species – primarily non-native annual grasses – which 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.

Sensitivity

Moderate Sensitivity

Low → High

High Confidence

Grassland habitats are sensitive to several climate drivers, including precipitation, drought, soil moisture, and air temperature. Seasonal and annual climatic variability play a key role in determining grassland composition, diversity, and productivity.[4,9] The interplay between temperature, precipitation, and seasonality may be particularly important by affecting the proliferation and abundance of non-native annual grasses.[3,28,18] Wildfire and herbivory have variable impacts on grassland communities and vegetation types (e.g., annuals, perennials),[19-26] while non-climate stressors such as overgrazing, invasive species, and land-use conversion affect grassland distribution and alter native grass survival, productivity, and recruitment.[2,4]

Habitat sensitivity factors and impacts[*]

CLIMATIC DRIVERS	Low-Moderate Sensitivity; Moderate Confidence
Precipitation	Fall and winter precipitation stimulate germination of native annual and perennial grasses and forbs,[2,4,6] but subsequent rainfall patterns influence species composition.[3,28] High inter-annual precipitation variability contributes to variable grassland productivity,[1,10-14] species composition, and species abundance.[1,4-6,14-17] Precipitation timing shifts may be more important than shifts in total volume[27,28] due to interactions with peak annual grass growth periods. Precipitation shifts may result in: • Altered annual and perennial species composition, biomass, and productivity; annuals favored by persistent wet conditions in fall or spring and/or above average annual rainfall; perennials favored by slightly drier conditions and/or higher precipitation variability[4,7,29] • Altered soil respiration; longer wet seasons and/or a later start to the wet season can cause carbon loss in annual grasslands[9] • Altered invasive and exotic species pressure, particularly with precipitation timing shifts[27,28]
Drought	Long-term drought periods negatively affect most grassland components, although perennial species may be slightly more resilient to short-term drought than annual species.[14] Shifts in drought frequency and severity may cause: • Altered plant physiology[14] • Increased mortality of seedlings and young plants leading to declines in perennial cover and productivity[14]
Soil moisture	Native grasses are typically associated with more mesic areas on the landscape,[30,31] and soil moisture also influences seed survival.[32] Shifts in soil

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

	moisture may cause: • Altered grassland distribution[30,31] • Altered seed survival; higher soil moisture may limit seed survival due to fungal pathogen exposure[32]
Air temperature	Air temperature influences grassland production, phenology, species composition,[33,34] and distribution[35] in conjunction with precipitation, nitrogen deposition, and other factors.[17,36] Increasing air temperatures, particularly increased winter air temperatures, may cause: • Accelerated phenology: accelerated senescence and flowering[33] and altered dormancy timing[17,39,40] • Altered grassland productivity, species composition, and distribution, including increased annual grass growth and productivity[9,38]
DISTURBANCE REGIMES	Low-Moderate Sensitivity — Moderate Confidence
Wildfire	Wildfire stimulates grass growth and reproduction, elevates biodiversity and spatial heterogeneity,[18,37] prevents woody species establishment, and can facilitate type conversion from shrub to annual grassland systems.[38] Post-fire species composition is moderated by moisture availability[15,19] and fire timing.[20-22] Shifts in wildfire regimes may cause: • Altered species composition post-fire[15,19-22] • Increased mortality of established perennial bunchgrasses[18] • Increased annual grassland extent via type conversion from shrub systems,[38,39] particularly when combined with drought and high nitrogen deposition[40]
Herbivory	Herbivory slows succession to coastal scrub,[38] mitigates high biomass and litter accumulation associated with non-native grass cover,[23] and contributes to a mosaic of species productivity and diversity.[37,41] However, herbivory impacts vary according to plant life history strategy,[4,23-26] as well as grazing frequency and timing,[26] requiring local analyses and species- and site-specific management.[1,4,38,25,26]
NON-CLIMATE STRESSORS	Moderate-High Sensitivity & Exposure — High Confidence
Livestock grazing (overgrazing)	Overgrazing, particularly during drought periods,[42] can remove apical meristems and limit root and foliar growth of perennial bunchgrasses,[37] and facilitate conversion to annual-dominated systems.[42] Cattle trampling can compact soil, increasing bulk density and runoff and reducing infiltration.[43]

Invasive & problematic species	Non-native annual grasses have displaced native grassland taxa since being introduced in the 1880s.[37,44] Invasive species compete for limited resources,[23,45] limit native species regeneration and seedling establishment, and alter grassland physical structure[23] and fire return intervals.[33,37,46] Mediterranean herbaceous species are the most common invaders[20] (e.g., genera *Avena*, *Bromus*, *Erodium*, *Hirschfeldia*, *Sonchus*, *Centaurea*, and *Lactuca)*. Invasive exotics may be better than native species at responding to changes in climate via phenotypic plasticity and/or rapid genetic changes,[47] and invasion and invasive grass productivity is enhanced by high nitrogen deposition.[11,33]
Land-use conversion	Human land use has destroyed large portions of native perennial grassland habitat.[37] Altered land use may reduce future potential refugia areas, minimize gene flow and dispersal opportunities via habitat destruction and fragmentation, contribute to invasive species spread and local air pollution, and increase the risk of novel species introduction.[48]

Exposure[†]

Moderate-High Exposure

Low → High

Moderate Confidence

Under future climate conditions, grassland habitats are likely to be exposed to precipitation changes, increased drought, and increased air temperature. Experts believe that north-facing slopes, slope bases, shaded areas, valley bottoms with deep soils, coastal areas, runoff accumulation areas (e.g., roadsides, train track edges), and higher elevations may all serve as moisture refugia, particularly for native perennial grasses. Clay soils could serve as refugia for native annuals if combined with grazing to manage exotic annual grasses. Grassland habitat is projected to increase in southern California at the expense of scrub habitats,[39,49] but it is unknown to what extent these type-converted grasslands will support native perennial grassland species. Some species currently dominant in grasslands, particularly native perennials, may experience range reductions by 2065.[35]

Projected climate and climate-driven changes for Southern California

CLIMATIC DRIVERS	PROJECTED CHANGE
Precipitation	Variable annual precipitation volume and timing, with wetter winters and drier summers; increased climatic water deficit
Drought	Longer, more severe droughts with drought years twice as likely to occur
Air temperature	+2.5 to +9°C by 2100

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

Adaptive Capacity[‡]

Moderate Adaptive Capacity

Low → High

High Confidence

Southern California native grasslands have been extensively altered since pre-colonial times in extent, integrity, and species composition. Moderate-high diversity enhances resilience, but functional group shifts may occur due to highly variable responses amongst life history groups to climate, disturbance, and non-climate stressors.[35,41] Annual seedbank dynamics[4,28] may make annual species more resilient than perennial species, particularly since annual species represent such a high percentage of relative grassland cover in the study region.[2]

Habitat adaptive capacity factors and characteristics[§]

FACTORS	HABITAT CHARACTERISTICS
Habitat extent, integrity, & continuity Low-Moderate High Confidence	+ Private ranches and conservation easements enhance and protect habitat continuity;[4] unconventional agricultural lands (i.e., orchards with understory) may provide refugia or migration opportunities - Significantly altered species composition; for example, perennial grasslands occur in remnant patches and represent only a small percentage of relative cover[37] - Human land use and development fragment habitat,[37] altering grassland ability to support wildlife
Landscape permeability Low-Moderate High Confidence	- There are significant barriers to grassland habitat/species dispersal, including land use and agriculture
Resistance & recovery Moderate High Confidence	+ Annuals may be more resilient as seedbanks can persist from decades to centuries[4] and many annual forbs can enter prolonged dormancy[28] +/- Highly variable responses to stressors and disturbance amongst life history groups will likely cause functional group changes[35,41] - Small and sparse populations limit native grass recovery - Perennials may be less resilient due to small seedbanks, low annual recruitment, limited recovery in invaded areas,[28] and low disturbance tolerance

‡ 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 High Confidence	+ Moderate-high species diversity: grasslands are floristically diverse[50] with high inter-annual and spatial variability in species composition[2-4] - Perennial bunchgrasses represent only a small percent of cover and have low functional group diversity[2]
Management potential Moderate Moderate Confidence	+ Moderate societal value: valued for aesthetics and wildlife habitat provisioning + Grassland habitats, even disturbed systems,[28] provide a variety of ecosystem services: biodiversity, grazing, recreation, carbon sequestration, flood and erosion protection, water supply/quality/sediment transport, fire regime controls, public health benefits, and nitrogen retention

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