MIXED GRASSLANDS

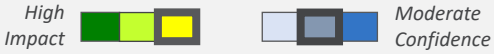
Climate Change Vulnerability and Adaptation Strategies for the Santa Cruz Mountain Region

Habitat Description

Mixed grasslands in the Santa Cruz Mountains region are primarily dominated by a mix of annual forbs and non-native annual grasses, and can occur across a range of soil types. This includes serpentine soils, which harbor distinct plant communities. Closely-associated species include butterflies, American badgers (*Taxidea taxus*), and western burrowing owls (*Athene cunicularia hypugea*).

Habitat Vulnerability

Sensitivity & Exposure



Projected Changes	Trend
Precipitation	▲▼
Soil moisture	▼
Wildfire	▲

Potential impacts:

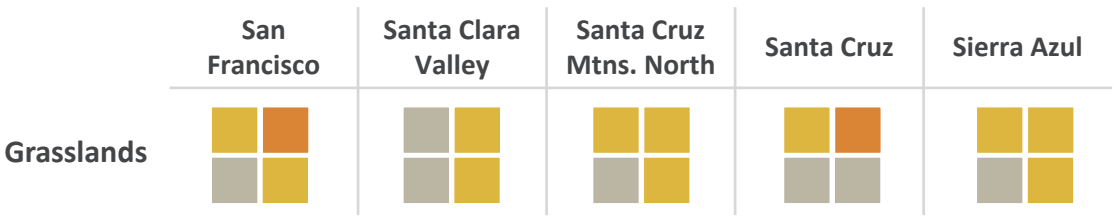
- Reduced water availability for native grasses and forbs, impacting plant productivity, species composition, and functional group dominance
- Likely expansion of invasive annual grasses due to increased precipitation variability and changes in wildfire regimes

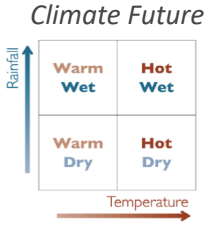
Non-climate stressors may interact with climate stressors and disturbance regimes:

- *Invasive plants* displace native species and increase the availability and continuity of fine fuels
- *Nitrogen deposition* increases invasive grass dominance in serpentine soils, displacing native species and associated pollinator specialists
- *Roads and highways* increase nitrogen deposition, fragment habitats, and spread invasive plants
- *Inappropriately-managed grazing* can negatively impact native species and increase the spread of invasive plants

Although mixed grasslands are less sensitive to water stress than many other habitat types, climate-driven changes in wildfire regimes may contribute to type conversion of adjacent woodlands and shrublands. However, any expanding grasslands will likely be dominated by invasive annual grasses as native species continue to decline.

Modeled Changes in Vegetation Distribution





Overall, mixed grassland vegetation is likely to decline, particularly under hotter and/or wetter scenarios.

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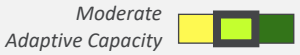
Adaptive Capacity



Intrinsic factors (i.e., inherent characteristics) that enhance or undermine adaptive capacity:

- ▲ Widely distributed in the region
- ▲ High physical and topographical diversity
- ▲ Greater resistance to climate-driven changes in serpentine grasslands
- ▼ Significant loss and fragmentation of native-dominated grasslands
- ▼ Habitat fragmentation/degradation reduces resilience and limits potential for distributional shifts

Extrinsic factors (i.e., management potential) that enhance or undermine adaptive capacity:

- ▲ High public and societal value
- ▲ Some regulatory support for management and protection
- ▼ Privately owned grasslands limit effective management at landscape scales
- ▼ Lack of institutional knowledge

Although mixed grasslands are widespread and may expand into adjacent burned areas, native-dominated areas are increasingly rare as invasive annual grasses displace native species.

Key Climate Vulnerabilities: ***Butterflies***

Butterflies may experience direct physiological impacts of climate-driven changes as well as indirect impacts due to changes in host plant and nectar resource availability:

- Warmer temperatures cause heat stress and contribute to phenological shifts that lead to mismatches between butterfly life stages and plant availability
- Wildfire increases direct mortality and can impact plant resource abundance and distribution
- Non-climate stressors (e.g., land-use conversion, pesticides/herbicides, invasive plants, grazing) increase mortality and impact habitat availability and connectivity

Factors that enhance or undermine adaptive capacity:

- ▲ Species group is varied and widely distributed
- ▲ Behavioral/phenotypic plasticity in response to change observed in some species
- ▲ High public/societal support
- ▼ Declining abundance and species richness due to a combination of stressors
- ▼ Small, isolated populations vulnerable to extirpation following disturbances

Key Climate Vulnerabilities: ***Badger and Burrowing Owl***

American badgers (*Taxidea taxus*) and western burrowing owls (*Athene cunicularia hypugea*) depend on open grasslands with abundant populations of burrowing small mammals, which provide prey for badgers and abandoned burrows for nesting owls. They are sensitive to factors that reduce prey availability (e.g., disease) or burrow suitability (e.g., temperature). Increases in mortality and habitat loss/fragmentation due to flooding or non-climate stressors can exacerbate population declines.

Factors that enhance or undermine adaptive capacity:

- ▲ Both are widespread species
- ▲ High variability and plasticity in badgers
- ▲ High societal support for burrowing owls
- ▼ Declining populations of both species in California
- ▼ Slow population recovery in badgers
- ▼ Badgers are underappreciated by the public

Adaptation Strategies for Mixed Grasslands

Lack of institutional knowledge is one of the primary impediments to effectively managing mixed grasslands under changing climate conditions, and many potential management tools are not well-understood. However, the potential for restoration and effective management in the context of climate change is high. Management strategies are likely to focus on maintaining frequent disturbances and promoting the persistence of native species through climate-informed grazing practices, increasing use of prescribed fire, and managing invasive species.

Management strategies for butterflies primarily focus on increasing the availability of host plants and nectar resources through habitat restoration, in addition to reducing the negative impacts of non-climate stressors such as pesticides.

Badgers and burrowing owls would benefit from further research on management strategies to increase resilience to climate change.

ADAPTATION APPROACH	ADAPTATION STRATEGIES
Resistance strategies: Maintain current conditions by limiting change *Near-term approach*	• Increase early detection rapid response to catch invasions more quickly (e.g., increase engagement with volunteers and research institutions that can contribute to invasive removal efforts) • Remove barriers to connectivity*
Resilience strategies: Accommodate some change while enabling a return to prior conditions *Near- to mid-term approach*	• Implement low-intensity prescribed burning, including finding ways to increase the pace and scale and/or frequency • Increase water availability for conservation grazing (e.g., drilling wells) to allow expansion of grazing into areas with no water • Improve connectivity between higher quality habitat patches by restoring degraded sites that may serve as corridors
Response strategies: Intentionally facilitate or direct change to adaptively respond to new conditions *Long-term approach*	• Collect and store seed from species and genotypes that are expected to be adapted to future conditions* • Prioritize and maintain sites that may be more resistant to changes in climate (e.g., cooler, wetter sites), harbor high biodiversity, and/or provide habitat for rare species*
Knowledge strategies: Gather information about climate changes, impacts, and/or management effectiveness *Near- to long-term approach*	• Identify and map wetter areas within grassland habitats as well as areas that are impacted by stressors • Identify and monitor moderate- and high-quality habitat areas* • Evaluate the vulnerability/resilience of invasive species (including potential new invaders) to different climate scenarios* • Develop post-disturbance event monitoring plan and strategy*
Collaboration strategies: Coordinate management efforts and/or capacity across boundaries *Near- to long-term approach*	• Improve regional collaboration and coordination with regard to data sharing and monitoring • Increase education and outreach to enhance appreciation of grasslands and public support for management activities such as prescribed fire, coyote brush removal, conservation grazing, and habitat protection

** Future management strategies (not currently occurring)*

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Further information and citations can be found in the source reports of the Santa Cruz Mountains Climate Adaptation Project, available online at http://ecoadapt.org/programs/awareness-to-action/santa-cruz-mountains.