Sage Scrub Habitats
Climate Change Vulnerability, Adaptation Strategies, and Management Implications in Southern California National Forests

Habitat Description
Sage scrub habitats feature an open, drought-deciduous shrub canopy and an herbaceous understory of annual and perennial grasses and forbs. Typically in foothills and valleys, but found up to 900 m (2952 ft), sage scrub is classified into three different groupings. Coastal sage scrub occurs from Santa Barbara to northwestern Baja California. Inland sage scrub occurs in western Riverside and San Bernardino Counties, northeastern San Diego County, and northern Los Angeles County. Maritime succulent sage scrub occurs in select areas of coastal southern California (e.g., Cabrillo National Monument), with core distribution in Baja California.

Habitat Vulnerability
Increasing temperatures may affect germination and abundance of some species, while cold sensitivity limits the distribution of others. A majority of sage scrub vegetation exhibits plasticity in response to drought and precipitation variability, but altered precipitation timing, soil moisture, and drought severity/timing may affect composition, distribution, and survival. Increasing fire frequencies may facilitate shifts to exotic annual grassland, a process exacerbated by increased nitrogen deposition. Invasive species compete for resources, alter ecosystem processes, and limit sage scrub regeneration, while land use conversion destroys and fragments habitat. Many sage scrub species are projected to experience a >50% decline in suitable habitat in southern California by mid-century.

Projected Climate and Climate-Driven Changes

<table>
<thead>
<tr>
<th>Variable precipitation, reduced soil moisture, increased drought Variable annual precipitation; increased climatic water deficit; increased drought frequency and length</th>
<th>Potential Impacts on Sage Scrub Habitats</th>
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<tbody>
<tr>
<td>• Altered distribution, species composition, survival, recruitment, germination, productivity, and phenology; potential conversion to more xeric shrub communities and/or non-native annual grassland</td>
<td>• Less frequent/larger rainfall events: sage scrub may gain competitive advantage over chaparral and invasive grasses</td>
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<th>Increased temperatures and heat waves +2.5 to +9°C by 2100; increased heat wave frequency and length</th>
<th>• Altered distribution and species composition</th>
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<tbody>
<tr>
<td>• Decreased germination success for some species</td>
<td>• Altered susceptibility to exotic invasion</td>
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<th>Altered fire regimes Increased fire size, frequency, and severity</th>
<th>• Native species declines via resprout mortality and reduced seedbank</th>
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<td>• Increased exotic species establishment and abundance, potentially exacerbating shifting fire regimes and leading to habitat conversion</td>
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Factors that enhance adaptive capacity:
+ Fairly high plasticity in response to drought and precipitation variability
+ Typically recovers quickly post-disturbance
+ Moderate-high species and functional group diversity; has many rare and imperiled species
+ Provides variety of ecosystem services: biodiversity, recreation, and carbon sequestration

Factors that undermine adaptive capacity:
- 70-90% of historical habitat area has been lost
- Landscape barriers, continued development pressure, and existing habitat fragmentation inhibit seed dispersal, gene flow, and migration
- Short dispersal distances (<5 m) may undermine ability of habitat to track shifts in climate
- Non-climate stressors undermine resilience

Drivers of Sage Scrub Habitats
- Climate sensitivities: Air temperature, precipitation, soil moisture, extreme high and low temperature events
- Disturbance regimes: Wildfire, biotic disturbance
- Non-climate sensitivities: Invasive & problematic species, pollution & poisons, land use conversion

Photo by Noah Elhardt (Public Domain)
### Adaptation Strategies for Sage Scrub Habitats

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<tr>
<th>Adaptation Category</th>
<th>Adaptation Strategy</th>
<th>Specific Management Actions</th>
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| **Enhance Resistance** | Restore disturbed areas with native species to limit erosion and prevent non-native species | • Remove non-native species as soon as they are detected  
• Create a seed collection for disturbance-adapted species  
• Immediately plant/seed with native species after disturbance |
| **Promote Resilience** | Practice rapid, effective fire suppression to minimize fire frequency and restore appropriate fire return intervals | • Conduct patrols during high wind events for early detection of fire  
• Practice effective types of fuels management in strategic locations (e.g., at-risk human communities, near key resources) |
| **Facilitate Transition** | Consider limiting recreational use to decrease disturbance and risk of wildfire | • Consider whether limits on recreational trails/roads and OHV use are appropriate  
• Collaborate with law enforcement to regulate and enforce recreational and access restrictions |
| **Increase Knowledge** | Restore/manage habitat to reflect future climate conditions while still benefitting native species and mirroring current ecological function | • During restoration activities, focus resources on resilient species and possibly incorporate species that are not currently on site (assisted migration)  
• Reseed/replant disturbed sites with species expected to do well under future climate conditions |
| **Engage Collaboration** | Identify vulnerable species and natural resources to inform protection efforts | • Conduct spatial analysis to identify vulnerable species, incorporating observed mortality, climate and non-climate threats and functional diversity |
| | Determine risk of type-conversion to exotic annual grasslands | • Model impact of changes in climate and fire regime on risk of type-conversion and possible rate of conversion |
| | Coordinate with other groups to reduce wildfire risk | • Engage land use planners to reduce leapfrog development |

*Actions presented are those evaluated as having higher effectiveness and/or feasibility.

### Management Implications

This information can be used in a variety of ways:

✔ Forest Plan Revisions
✔ U.S. Forest Service Climate Change Performance Scorecard: Element 6 - “Assessing Vulnerability” and Element 7 - “Adaptation Actions”
✔ Bureau of Land Management Resource Management Plan Revisions

Further information and citations can be found in source reports, *Climate Change Vulnerability Assessment for Focal Habitats of Southern California* and *Climate Change Adaptation Strategies for Focal Habitats of Southern California*, available online at the EcoAdapt Library: [http://ecoadapt.org/library](http://ecoadapt.org/library).