OAK WOODLANDS

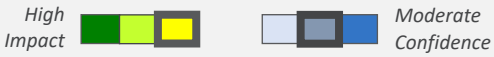
Climate Change Vulnerability and Adaptation Strategies for the Santa Cruz Mountain Region

Habitat Description

Oak woodlands in the Santa Cruz Mountains region are a diverse habitat group that can have a variety of dominant or co-occurring oak species, including coast live oak (*Quercus agrifolia*), valley oak (*Q. lobata*), blue oak (*Q. douglasii*), interior live oak (*Q. wislizeni*), canyon live oak (*Q. chrysolepis*), black oak (*Q. douglasii*), scrub oak (*Q. berberidifolia*), and leather oak (*Q. durata*; on serpentine soils). Oak distribution and woodland species composition are strongly influenced by slope, elevation, drainage, soils, and other site-specific characteristics. Habitat structure is relatively open (30–60% canopy cover) with an understory comprised of native and non-native grasses and forbs, as well as a limited variety of shrubs.

Habitat Vulnerability

Sensitivity & Exposure



Projected Changes	Trend
Precipitation	▲▼
Soil moisture	▼
Drought	▲
Soil temperature	▲
Wildfire	▲
Disease	▲
Insects	▲

Potential impacts:

- Increased water stress, affecting acorn germination and seedling/sapling growth and survival to adulthood
- Shifts in habitat distribution and/or range contractions likely where conditions are too dry to support oak recruitment
- Increased drought-related mortality in stressed trees
- Increased fire-related injury and mortality, and possible type conversion following repeated severe wildfires
- Extensive mortality in black oak and coast live oak due to sudden oak death, particularly if wetter conditions allow greater pathogen production and transmission
- Shifts in habitat composition and ecosystem functioning likely following loss of keystone species to disease

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

- *Residential/commercial development* increases loss and fragmentation of habitat (including potential refugia), and increases the likelihood of human ignitions
- *Fire exclusion/suppression* alters habitat structure/composition and increases risk of severe fires
- *Invasive grasses* alter understory composition, displacing native species and increasing fire risk
- *Inappropriately-managed grazing* can decrease seedling/sapling growth and survival to adulthood, and is associated with adverse effects on understory shrubs and introduction of invasive plants

Oaks are most sensitive to factors that increase water stress, which impacts acorn germination, seedling/sapling growth and survival, and, ultimately, future habitat distribution. Increases in wildfire and disease significantly increase oak mortality, impacting habitat structure/composition and ecosystem functioning. However, tolerance of these factors varies widely by species.

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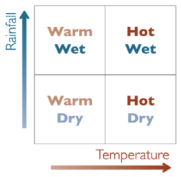
Modeled Changes in Vegetation Distribution

	San Francisco	Santa Clara Valley	Santa Cruz Mtns. North	Santa Cruz	Sierra Azul
Blue oak forest/woodland					
Valley oak forest/woodland					
Interior live oak forest/woodland					
Canyon live oak forest					
Black oak forest/woodland					
Coast live oak forest/woodland					
Oregon oak woodland					
Blue oak/foothill pine woodland					

Black oak and canyon live oak are expected to undergo dramatic declines, while blue oak, valley oak, and interior live oak are expected to remain relatively stable or increase. Other species show mixed results, underscoring the variable environmental tolerances of component oaks in the region.

Climate Future



Adaptive Capacity

Moderate Adaptive Capacity *High Confidence*

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

- ▲ Widely-distributed within the region
- ▲ Provide critical wildlife habitat
- ▲ Well-adapted to drought and wildfire
- ▼ Significant habitat loss and fragmentation
- ▼ Decreased plant and animal diversity
- ▼ Reduced resistance/recovery in stressed forests

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

- ▲ High public and cultural value
- ▲ Increasing societal support (e.g., funding) as a result of sudden oak death
- ▼ Many constraints (e.g., staff training, air quality regulations, burn windows) limit more extensive use of prescribed fire

Historical habitat loss and fragmentation are important drivers of vulnerability in oak woodlands across the region, and the innate ability of oaks to tolerate a wide variety of environmental conditions and disturbances is significantly reduced in degraded habitats.

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Adaptation Strategies for Oak Woodlands

Both the scientific literature and traditional knowledge document successful restoration efforts in oak woodlands through management strategies that create favorable conditions for oak germination, growth, and reproduction, while also increasing resilience to climate impacts such as drought and wildfire. These include increased use of prescribed fire, restoration of native perennial grasses and forbs, climate-informed management of livestock grazing, and protection of oak woodlands within climatically-suitable areas and/or potential refugia.

ADAPTATION APPROACH	ADAPTATION STRATEGIES
Resistance strategies: Maintain current conditions by limiting change *Near-term approach*	• Remove invasive species, especially those that create ladder fuels and/or are likely to carry fire • Remove encroaching Douglas-fir in coast live oak, black oak, and interior live oak ecosystems • Fence oak seedlings to limit browsing and allow survival
Resilience strategies: Accommodate some change while enabling a return to prior conditions *Near- to mid-term approach*	• Identify individual trees that are thriving and collect seed for use in restoration plantings • Plant shrubs that can serve as nurse plants for oak seedlings • Collect and store acorns during "boom events" to use during periods when dry conditions decrease acorn production* • Restore the use of frequent prescribed fire to reduce fuel loads, moisture stress, and insect/disease outbreaks* • Identify and propagate disease-resistant genotypes in species impacted by introduced diseases (e.g., sudden oak death)*
Response strategies: Intentionally facilitate or direct change to adaptively respond to new conditions *Long-term approach*	• Protect and maintain soil moisture refugia and areas that are projected to remain climatically suitable for dominant oak species* • Experiment with using seeds from climate analog zones (e.g., assisted gene flow) in restoration projects*
Knowledge strategies: Gather information about climate changes, impacts, and/or management effectiveness *Near- to long-term approach*	• Research black oak acorn storage and germination to improve silviculture techniques* • Monitor oak woodlands to identify type conversion in early stages and identify triggers that would require intervention* • Set up monitoring networks focused on early detection of sudden oak death in order to support proactive site management* • Survey areas impacted by sudden oak death to identify naturally-occurring resistance*
Collaboration strategies: Coordinate management efforts and/or capacity across boundaries *Near- to long-term approach*	• Work with private landowners to support protection of black oak, coast live oak, and canyon live oak on neighboring lands • Partner with tribes to promote cultural burning and stewardship of ancestral lands* • Increase public education and outreach to raise awareness of prescribed fire as a critical management tool in the context of climate change*

** 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.