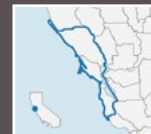


Open Oak Woodlands & Savannas

Climate Change Vulnerability
and Adaptation Strategies for the
Golden Gate Biosphere Region



Ecosystem Description

Open oak woodland and savanna ecosystems in the Golden Gate Biosphere (GGB) region are dominated by evergreen and deciduous oaks, including coast live oak (*Quercus agrifolia*), blue oak (*Q. douglasii*), Oregon white oak (*Q. garryana*), and valley oak (*Q. lobata*). California black oak (*Q. kelloggii*) can also occur at woodland edges, although it is relatively uncommon. Oak ecosystem distribution and species composition are strongly influenced by site-specific factors, including slope, elevation, drainage, and soil type.

Ecosystem Vulnerability - Moderate

Sensitivity & Exposure - Moderate

Projected Changes	Trend
Precipitation	▲▼ Varies
Drought	▲ Increase
Soil moisture	▼ Decrease
Air temperature	▲ Increase
Wildfire	▲ Increase
Disease	▲ Increase
Insects	▲ Increase

Potential Impacts:

- Reduced acorn production, seedling establishment, and tree growth due to changes in precipitation and soil moisture
- Likely range contractions in species adapted to wetter conditions as drought frequency increases
- Reduced recruitment of species requiring cold temperatures to initiate germination as winter soil temperatures rise
- Increased fire-related injury and mortality, with possible type conversion following repeated high-severity fires
- Mortality in oak species susceptible to sudden oak death, particularly if wet conditions increase disease transmission
- Decreased oak health attributed to insects, exacerbated by warmer temperatures driving range expansions

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

- *Residential and commercial development* increases loss and fragmentation of oak ecosystems and increases the likelihood of accidental ignitions
- *Livestock grazing and agriculture* lead to soil compaction, acorn/seedling destruction, and shifts in plant composition
- *Invasive species* alter understory composition, displacing native species and increasing fire risk
- *Fire exclusion*, including the interruption of cultural burning and modern fire suppression, alters structure/composition and can lead to ecosystem loss and type conversion



Oak woodlands are sensitive to factors that increase water stress, which impacts seedling establishment, growth, and survival. Climate-driven increases in wildfire and disease increase oak mortality, impacting ecosystem structure, composition, and function. Non-climate stressors contribute to habitat fragmentation, reduced species diversity, and changes in fire regimes.

Ecosystem Vulnerability - Moderate

Adaptive Capacity - High

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

Enhance:

- Broadly distributed throughout the region
- Well-adapted to drought and wildfire
- Multiple dispersal mechanisms, including acorn masting and resprouting
- Provides habitat for wildlife

Undermine:

- Decreased plant and animal diversity due to fire exclusion and invasive species
- Limited genetic and pollen exchange in oaks due to short acorn/pollen dispersal distances

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

Enhance:

- Highly valued by the public for recreation, wildlife habitat, and cultural significance
- Management strategies, including the reintroduction of Tribal stewardship practices, can increase climate resilience

Undermine:

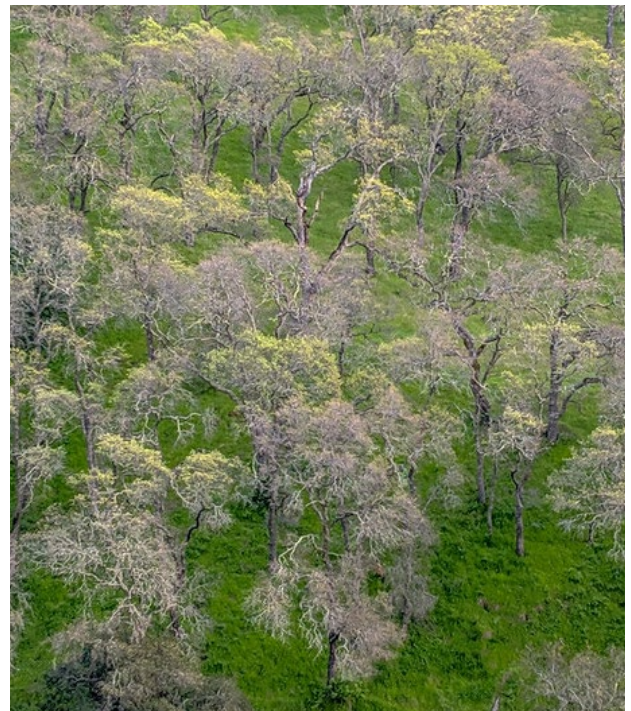
- Risk of conversion and degradation as a result of high development pressure



Forests with high structural and species diversity have high potential for coping with climate changes; however, degraded stands are less able to resist stressors and disturbances. Ensuring Tribal access and integration into climate-informed management activities can improve climate resilience of this ecosystem.



Valley oak, David Abercrombie, Flickr (CC BY-SA 2.0)



Mt. Diablo, David Abercrombie, Flickr (CC BY-SA 2.0)

Adaptation Strategies & Actions

Adaptation strategies can reduce climate change vulnerability of a given ecosystem or species by addressing any or all of the three components of vulnerability (i.e., by reducing sensitivity, reducing exposure, and/or increasing adaptive capacity). The table below presents examples of adaptation strategies and actions, which fall within five categories, or approaches: Resistance/Resilience **(R)**, Acceptance **(A)**, Direct/Response **(D)**, Knowledge **(K)**, and Collaboration **(C)**. *Please note that the strategies and actions provided here should not be considered a checklist or plan, but rather as a set of examples for land managers to consider for further study when developing site- or species-specific actions.*

Adaptation Strategies	Adaptation Actions
Identify high-quality oak woodlands on public and private land and prioritize for management, protection, and restoration efforts	<ul style="list-style-type: none"> • Develop a Floristic Quality Index for oak woodlands and prioritize sites with the richest groundcover composition, especially those with endemics (K) • Identify priority corridors and areas for future buyouts (K)
Manage and restore oak woodlands and savannas	<ul style="list-style-type: none"> • Monitor herbaceous groundcover composition and remove invasive weeds that compete with oaks for limited resources (R/K) • Remove encroaching Douglas-fir and California bay to reduce competition for resources and the spread of sudden oak death (R) • Restore the use of frequent prescribed and managed fire to reduce fuel loads, moisture stress, and insect/disease outbreaks (R) • Partner with tribes to promote cultural burning and tribal stewardship (C)
Enhance the ability of woodlands to resist and/or recover from introduced pests and pathogens	<ul style="list-style-type: none"> • Create an early monitoring/warning system to track pathogens and pests (e.g., Mediterranean oak borer, shot hole borer) (R/K) • Set up monitoring networks focused on early detection of sudden oak death, and manage key sites that are still uninfected (R/K)
Incentivize protection of oak woodlands on private lands	<ul style="list-style-type: none"> • Develop conservation easements and management agreements to protect and manage (e.g., through prescribed fire) oak woodlands on private lands (R)

Adaptation strategies and actions generated through breakout group exercises during the adaptation workshop in December 2023.



Blue oak twig, Joe Decruyenaere, Flickr (CC BY-SA 2.0)