# Chaparral

***Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project***

*This document represents an initial evaluation of mid-century climate change vulnerability for chaparral in the Santa Cruz Mountains region based on expert input during an October 2019 vulnerability assessment workshop as well as information in the scientific literature.*

## Habitat Description

Chaparral habitats are dominated by sclerophyllous ("hard-leaved") evergreen shrubs and small trees that are well-adapted to fire and drought[1,2]. Dominant chaparral species are typically categorized by mode of post-fire regeneration: *obligate seeders* require fire for germination from stored seedbanks, while *obligate resprouters* have seeds that are easily killed by fire, so they resprout following fire and recruit from seed during fire-free intervals[3]. *Facultative seeders* utilize both vegetative resprouting and seed germination following fire-induced topkill, and can also recruit from seed in the absence of fire[3].

Within the Santa Cruz Mountains region, characteristic chaparral species include chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* spp.), ceanothus (*Ceanothus* spp.), gooseberries/currants (*Ribes* spp.), buckthorn (*Rhamnus* spp.), hollyleaf cherry (*Prunus ilicifolia*), toyon (*Heteromeles arbutifolia*), and knobcone pine (*Pinus attenuata*). Chaparral generally occupies drier sites on south- and west-facing slopes, and can occur on both serpentine and non-serpentine soils[1,2].

## Vulnerability Ranking

**Moderate Vulnerability**


**High Confidence**

Chaparral habitats are sensitive to climate stressors that impact the timing and amount of available water, which affects survival and recruitment of both native and non-native plant species. Climate-driven changes in wildfire regimes may also drive shifts in species composition, reduced biodiversity, and habitat loss of chaparral due to type conversion. Non-climate stressors such as development, roads/highways, invasive species, and fire suppression or fuel reduction activities can further exacerbate habitat sensitivity by increasing habitat loss and fragmentation, invasive species expansion, and human ignitions.

Although chaparral is widespread, habitat continuity and integrity has been significantly impacted by land-use conversion to agriculture and development in many areas. Degraded sites are significantly more vulnerable to invasion by exotic annual grasses and subsequent changes in the fire regime (including possible type conversion). Thus, management activities are likely to focus on facilitating appropriately-timed disturbance intervals and supporting post-fire recovery, as well as maintaining connectivity to allow potential range shifts in response to climate change.

As part of this project, Pepperwood Preserve modeled how major vegetation types in five landscape units of the Santa Cruz Mountains region are projected to shift in response to climate change.[1] For chaparral shrublands, they found that chamise chaparral is expected to increase across all landscape units, while mixed chaparral and mixed montane chaparral are likely to undergo moderate declines in the majority of units.

| Vegetation Type | San Francisco | Santa Clara Valley | Santa Cruz Mtns. North | Santa Cruz | Sierra Azul |
|---|---|---|---|---|---|
| Chamise chaparral | △ | △ | △ | △ | △ |
| Mixed chaparral | ▽ | △ | ▽ | ▽ | ▽ |
| Mixed montane chaparral | — | ▽ | ▽ | ▽ | ▽ |

% Change BY MID-CENTURY
△ Increase
— Relatively stable
▽ Moderate decline
▽▽ Dramatic decline

**Table 1.** Projected trends in vegetation distribution (increase, relatively stable, moderate decline, or dramatic decline) by mid-century within five landscape units of the Santa Cruz Mountains region.

## Sensitivity and Exposure

**Moderate Impact**



**Sensitivity** is a measure of whether and how a habitat is likely to be affected by a given change in climate and climate-driven factors, changes in disturbance regimes, and non-climate stressors. **Exposure** is a measure of how much change in these factors a resource is likely to experience.

### Sensitivity and future exposure to climate and climate-driven factors

Chaparral habitats are sensitive to climate stressors that reduce plant survival and recruitment, increase wildfire frequency, and contribute to invasion by non-native plant species.

| Climate Stressor | Trend Direction | Projected Future Changes |
|---|---|---|
| **Precipitation** | ▲▼ | • Shorter winters and longer, drier summers likely, with higher interannual variability[4,5] |
| **Soil moisture** | ▼ | • Reduced soil moisture likely due to increased evaporative demand[4,6] |
| **Drought** | ▲ | • Increased frequency of drought years, including periods of prolonged and/or severe drought[4,7] |

- **Changes in patterns of precipitation (e.g., amount and timing)** and **soil moisture** may affect chaparral recruitment and community composition[1,8,9], with greater impacts likely in obligate-

[1] Information about the methods used to generate these projections can be found on the project page (http://ecoadapt.org/programs/awareness-to-action/santa-cruz-mountains).

seeding and obligate-resprouting species compared to facultative seeders[8]. In general, increased precipitation contributes to higher chaparral species richness and facilitates shrub growth and regeneration, particularly for obligate-seeding species[3,10]. However, increased precipitation and associated increases in non-native annual grasses may also enhance fire risk in subsequent years, exacerbating climate-driven changes in wildfire regimes[11–13]. Drier conditions are likely to limit seedling recruitment and can reduce plant survival[1,9,14]. Reduced fuel moisture also increases wildfire risk and rate of spread[13,15]. Finally, shifts in the timing of precipitation may affect chaparral phenology[16] and/or the distribution of sensitive species[17].

- **Increases in the severity and length of future droughts** can lead to significant shrub dieback and mortality, with higher observed mortality among obligate-seeding species due to their shallower root systems[10,18–20]. Seedlings are also significantly more sensitive to drought because they have not yet developed root systems; the presence of exotic grasses further increases drought-related mortality in seedlings due to increased competition for near-surface soil moisture[21]. Within burned landscapes, persistent drought can significantly impair post-fire recovery, particularly among resprouting shrubs[22,23]. Over time, drought-related mortality and reduced post-fire recruitment may affect community composition and structure[19,20,23].

### Sensitivity and future exposure to climate-driven changes in disturbance regimes

Wildfire is the key disturbance regime in chaparral habitats within the Santa Cruz Mountains region due to its strong influence on vegetation dynamics. Climate-driven changes in wildfire regimes may cause shifts in species composition, reduced biodiversity, and habitat loss due to type conversion.

| Disturbance Regimes | Trend Direction | Projected Future Changes |
|---|---|---|
| **Wildfire** | ▲ | • Slight to moderate increase in wildfire risk, particularly in areas of higher rainfall[24,25] |

- While chaparral is generally well-adapted to the severe crown fires that characterize the fire regime[1,15], climate-driven **increases in wildfire frequency** can inhibit regeneration by killing sprouts and seedlings before they mature and reproduce, decreasing biodiversity and shifting relative dominance towards facultative-seeding species[8,14,26,27]. This can result in local extirpation of species with limited distributions, particularly obligate-seeding shrubs whose soil seedbanks may become depleted[1,8,14,26]. Reduced regeneration of native shrubs as fires become more frequent is likely to facilitate the establishment and eventual dominance of invasive species[1,14,26–28]. Multiple fires in quick succession (i.e., within five years of one another) have also been known to facilitate vegetative type conversions from chaparral to non-native annual grasslands[26–30].

### Sensitivity and current exposure to non-climate stressors

Non-climate stressors can exacerbate habitat sensitivity to changes in climate factors and disturbance regimes by increasing habitat loss and fragmentation, invasive species expansion, and human ignitions.

- **Residential and commercial development** in the region has resulted in significant habitat loss and fragmentation[1,2], which may limit species migration and dispersal in response to climate change[17]. Continued expansion of the wildland-urban interface (WUI) is also associated with increased anthropogenic fire ignitions[12,31–33], enhancing the risk of shifts in species composition and/or type conversion following frequent fires[28,30,32].

- **Roads, highways, and trails** fragment existing habitat areas[34] and act as a barrier to the movement of small mammals and other wildlife[35,36], including those that act as seed dispersers for chaparral vegetation. Transportation corridors also facilitate the spread of invasive species[34] and are associated with increased fire ignitions[33]. Finally, vehicular travel promotes nitrogen deposition that facilitates invasive species establishment following canopy-opening disturbances[27,28], especially in serpentine habitats[37].
- **Invasive species** can become established in chaparral ecosystems following canopy disturbances such as fire, displacing understory vegetation and increasing competition for soil moisture and other resources[1,27,28]. Because they increase the availability and continuity of fine fuels, invaded habitats experience more frequent fire and increased likelihood of type conversion[27,28].
- **Fire suppression and fuel reduction activities** (e.g., fuelbreak construction, mastication) physically alter stand structure and can contribute to the expansion of invasive species[2,38–40]. These activities may also have negative impacts on species that are rare and/or have very narrow ranges[41].

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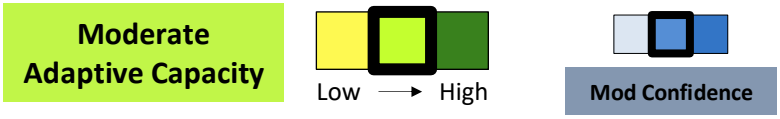
## Adaptive Capacity




**Adaptive capacity** is the ability of a habitat to accommodate or cope with climate change impacts with minimal disruption.

### Habitat extent, integrity, continuity, and barriers to dispersal

Chaparral is the most abundant vegetation type in California[2]. It is extensive from Baja California north into south-central Oregon, and occurs in disjunct patches as far north as Washington and as far east as Arizona[1]. Within the study area, chaparral is patchier than in areas further south, and primarily occurs along the coast and on the eastern slopes of the Santa Cruz Mountains[42]. Serpentine chaparral is much less widespread because it occurs in small and spatially isolated areas of suitable substrate, which is likely to limit serpentine species' ability to track climate changes[43].

Habitat continuity and integrity has been significantly impacted by land-use conversion to agriculture and development, particularly at the wildland-urban interface[1,2]. These factors have resulted in habitat degradation (i.e., through increased wildfire ignitions and spread of invasive species), fragmentation, and loss[30]. Because chaparral species tend to exhibit slow growth rates and limited seed dispersal distances[3], continued expansion of development and associated infrastructure (e.g., roads) are likely to further reduce post-disturbance recovery and constrain opportunities for range shifts in response to climate change[30,41].

### Habitat diversity

Chaparral habitats have high species diversity as a result of variable topographies, disturbance histories, and soil types[1,44]. Additionally, both *Ceanothus* and *Arctostaphylos* exhibit high rates of speciation, contributing to the development of endemics such as Santa Cruz manzanita (*Arctostaphylos andersonii*)[14,44]. Serpentine sites are also important contributors to overall species diversity within this

habitat type, as these sites are generally dominated by specialized plants with stress-tolerant functional traits that allow them to successfully compete in unproductive soils[43,45]. Chaparral habitats also support a variety of wildlife, including many rare or specialized migratory birds and pollinators as well as diverse mammal, reptile, and invertebrate communities[14,36].

### Resistance and recovery

Chaparral habitats are well-adapted to many stressors and disturbances, including drought, wildfire, and non-native species invasion[1,10]. For example, component shrub species feature adaptations that allow them to resist seasonal drought stress (e.g., waxed leaf coatings, recessed stomata)[1,9,18], and recent studies have found that shrub growth rebounded rapidly following the conclusion of a severe, multi-year drought[10]. Chaparral species have a variety of regeneration strategies that allow them to survive and/or rapidly recover from fire[1,3,46], and shrublands with intact canopies are also relatively resistant to invasion by annual grasses[27]. In serpentine shrublands, lower productivity is associated with greater resistance to invasive species[27] and an open habitat structure that decreases fuel availability and connectivity[1,45,47]. However, post-fire recovery is also slower on serpentine sites, likely due to low nutrient availability for regenerating vegetation[47]. Across all sites, both resistance and recovery are lower where invasive species have become established, driving more frequent fires and increasing risk of post-fire type conversion to non-native annual grassland[1,27,30].

### Management potential

Chaparral habitats provide many critical ecosystem services, including flood and erosion control, water filtration for plant communities within the lower watershed, carbon sequestration, wildlife habitat, and recreation[2,14,48–50]. However, chaparral has low public value compared to most other vegetation types, largely because it is perceived as a fire risk for adjacent human communities and cannot be utilized for grazing or timber production[2].

Management activities focused on reducing vulnerability to climate change are likely to emphasize minimizing the impacts of altered fire regimes and associated risk of type conversion. For example, planting in recently burned areas may hasten recovery following severe and/or short-interval fires[41], and limiting development adjacent to chaparral could reduce the risk of anthropogenic ignitions and limit the need to manage chaparral for fuel reduction objectives[30]. Prescribed fire may be used to restore natural fire regimes and maintain ecosystem benefits for wildlife, though site-specific factors must be considered to prevent detrimental impacts on chaparral recruitment, recovery, and vulnerability to invasive species as climate stressors continue to increase[39,40]. Managers could also consider identifying and protecting potential migration routes to allow range shifts in response to climate change[41].

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## Recommended Citation

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Further information on the Santa Cruz Mountains Climate Adaptation Project is available on the project page (http://ecoadapt.org/programs/awareness-to-action/santa-cruz-mountains).

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