Mount Diablo Summit Beacon, “Eye of Diablo” (photo F. McCluhan)

Anthropogenic Climate Change in Mount Diablo State Park, California, USA

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Summary

Greenhouse gas emissions from cars, power plants, deforestation, and other human sources have caused anthropogenic climate change and impacts to ecosystems and human well-being. To assist Mount Diablo State Park to effectively manage natural and cultural resources under climate change, this climate change assessment presents park-specific scientific information on climate trends, historical impacts, future risks, and carbon stocks and emissions, and suggests measures to improve ecosystem resilience.

The annual average minimum temperature in the park increased from 1954 to 2022, and the average maximum temperature has increased in the region. Annual precipitation showed no statistically significant trend. Under the highest greenhouse gas emissions scenario of the Intergovernmental Panel on Climate Change (Representative Concentration Pathway [RCP] 8.5), the average of 32 downscaled models projects an annual temperature increase in the park 4ºC from 2000 to 2100, or a 2.3°C difference with a medium GHG emissions scenario [RCP] 4.5. Published analyses indicate that continued climate change could increase numerous risks to park resources including larger winter storms, increased drought risk, increased wildfire potential, and increase in invasive species. Much of the park's wildlife is vulnerable to climate change, including the park's special status species. The Alameda whipsnake, red-legged frog, California tiger salamander, and the northwestern turtle pond are vulnerable to anthropogenic effects of climate change. A published study identified 6 of the park's 40 special-status plant species as vulnerable to climate change, including the iconic Mt. Diablo globe lily (*Calochortus pulchellus*).

Aboveground vegetation in the park stores the equivalent of 790,000 metric tons of carbon dioxide emissions, which is equivalent to the annual emissions of 52,000 Americans. Conservation of vegetation will prevent the carbon from contributing to climate change. Climate-wise connectivity, specifically through land protection measures connecting the Mount Diablo region to the northern Diablo Range, may increase resilience amid human-caused climate change.

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Introduction

Ecosystems across North America are under increased stress from carbon dioxide concentrations and rising temperatures, increasing vulnerability to climate extremes (IPCC 2022a). Anthropogenic (human-caused) activities have caused the global surface temperature to reach 1.1°C above the 1850–1900 level in 2011–2020, and carbon emissions continue to rise annually at all time highs (IPCC 2021). These climate-related stressors are negatively affecting environments alongside other anthropogenic factors such as land use changes, non-native species invasions, and pollution. Often, these anthropogenic factors exacerbate existing climate change pressures (IPCC 2022a). Climate change has already altered ecosystems across the globe by contributing to wildfire, drought, range shifts, biome changes, among other alterations (IPCC 2022a).

This report is a park-specific climate change science assessment of Mt. Diablo State Park (Figure 1). It presents an assessment of published scientific research on impacts of climate change, future vulnerabilities, and ecosystem carbon. In addition, it presents published results of spatial analyses of historical and projected climate change and ecosystem carbon (Gonzalez et al. 2015).

Location description

Mount Diablo State Park (MDSP) is located on the northern end of the Diablo Range, within the Coastal Range. It is seen as an “island mountain” being a relatively isolated eastern extension of the Coast Range. The park is a significant example of California’s foothill and low coastal mountains ecological region.

MDSP is located in central Contra Costa County in the San Francisco Bay Area. The park is surrounded by a significant amount of urbanization with the cities of Walnut Creek, Clayton, and Danville bordering the state park. Various significant geographic regions are within close proximity to MDSP. The San Francisco Bay and Pacific Ocean are located west of the park; the Sacramento River and Carquinez Straits are north; and the Sacramento Delta is east. There is a complete panoramic of the surrounding region from the 3,849ft summit. On clear days, there is a view range of 200 miles with notable landmarks such as Lassen Peak, Farallon Islands, and Half Dome within sight.

Before colonial occupation, an estimated 2,700 Native Americans occupied the region now known as Contra Costa County (Milliken 1995). A Penutian-speaking group known as “Bay Miwok” is most commonly associated with Mt. Diablo and the Delta region. The Bay Miwok lived in close proximity to other groups including the Northern Valley Yokuts, Plains Miwok, Patwin, and the Costanoan-Ohlone (Moratto 1984).

Mount Diablo was first designated a state park in 1921, making it one of the seven state parks created before the establishment of the California State Park System in 1927. Originally 630 acres, MDSP is now about 20,000 acres with various parks and preserves bordering the park boundary, extending the amount of preserved land in the immediate vicinity.

Mount Diablo State Park, and the Diablo Range, is located within the California Floristic Province, which is listed among the top 25 most diverse and endangered terrestrial biodiversity hotspots in the world (Myers et al. 2000). The state park protects a diverse range of habitats, including grasslands, oak and riparian woodlands, chaparral, creeks, ponds, and seasonal waterfalls (California State Parks 2016). The park’s elevation ranges from 381 feet to 3,849 feet, creating a diverse topography providing suitable habitat for a wide variety of species. The park protects an estimated 250 vertebrate species, and 841 plants have been identified in MDSP (Ertter and Bowerman 2002). California hosts approximately 6,500 plant species (California Department of Fish and Wildlife), meaning MDSP has suitable habitat for more than 10% of all plant species found in the state.

Observed climate trends

Temperature — Temperature in MDSP typically varies depending on elevation and geography. Temperature extremes occur on the peaks, due to exposure, and in the low valleys, where cold heavy air collects. The diverse topographic relief creates a wide range of microclimatic conditions (California State Parks 2016). Sitting as a barrier to the San Francisco bay and the central valley, the mountain gets the cool climate type of the coast and the hot climate of the central valley (Bowerman 1944).

National Oceanic and Atmospheric Administration (NOAA) analyses of data from a weather station in the park show that the average minimum temperature was 1.95°F (0.53 °C) warmer from 2002 to 2022 levels than historic levels from 1952 to 1972 (fig 3). Statistical significance was tested using linear regression.

NOAA analyses show the average temperature in Contra Costa County has increased by 0.2°F per decade since 1895, although the average temperature in MDSP has no significant change (Figure 2). There is no significant change in meteorological season (Figure 4).

Precipitation — Analysis from Stanford et al. (2011) found that the average annual precipitation on Mount Diablo is 24 inches, with a range from 9 (in 1976) to 47 (in 1862) inches. Linear regression of data from the Junction weather station showed no statistically significant trends (fig 5).

Because of the park's diverse topography and proximity to the coast, total annual precipitation varies across the park. Mount Diablo creates a rain shadow effect, resulting in the mountain's summit region receiving approximately 10 inches of more precipitation than the lowlands (Stanford et al. 2011). About 90% of precipitation falls from November to April although rainfall can occur throughout the year. In winter months, precipitation occasionally occurs as snow.

Drought — Local historical information, precipitation record, and longer-term climatic analysis shows drought in East Contra Costa County appearing roughly on a decadal scale (Stanford et al. 2011). However, anthropogenic warming increased the probability of co-occurring warm-dry conditions which are associated with drought (Diffenbaugh et al. 2015). Anthropogenic influence accounted for one-tenth to one-fifth of the 2012 to 2014 period of the drought that affected the State of California (Williams et al. 2015).

Observed ecological changes and impacts

Changes detected and attributed to human climate change — Published research that includes data from Mount Diablo State Park has detected changes that are statistically significantly different from natural variation and attributed the cause of those changes to anthropogenic climate change more than other factors.

Increased Wildfire — The annual burned area in California increased ~500% from 1972 to 2018. This is very likely caused by drier fuels due to anthropogenic climate change (Abatzoglou and Williams 2016). The five largest fires in California history occurred since 2018, including the SCU Lightning Complex which burned much of the northern Diablo Range and up to the southern border of MDSP in Morgan Territory Regional Preserve (CalFire 2022).

Bird range shifts — One analysis detected a northward shift of winter ranges of a set of 254 bird species at an average rate of 0.5 ± 0.3 km per year from 1975 to 2004. The study used data from the Audubon Christmas Bird Count, which included count circles in east and west Contra Costa County. They attributed this range shift more to global human climate change than local human factors (La Sorte and Thompson 2007).

Another analysis using data from the CBC also demonstrated northward shifts in winter distribution of six raptor species, five of which are found in Mt. Diablo State Park: American kestrel (*Falco sparverius*), northern harrier (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), and golden eagle (*Aquila chrysaetos*) (Paprocki et al. 2014).

Changes consistent with, but not formally attributed to, human climate change. Other research has found changes consistent with human-caused climate change, but either has not detected changes that are statistically significantly different than historical variability or has not analyzed potential causal factors to formally attribute the cause of the change.

Distribution shift in American Kestrel and Golden Eagle — Data analysis from the Central Contra Costa County Christmas Bird Count shows that since 1952, American kestrel sightings have decreased and golden eagle sightings have increased (Figures 6-7). South of MDSP, the northern Diablo Range supports one of the densest known breeding populations of golden eagles in North America (Hunt et al. 2017). This suggests golden eagles are shifting poleward (north), which is consistent with Paprocki et al. findings.

Vegetation shifts — 15% of all taxa in California have ranges that have shifted upward in elevation over the past century. Non-native species had the most significant change, with 27% of non-native species having shifted upward, and 12% of endemic species shifting (Wolf et al. 2016).

Projected climate trends

Climate projections are dependent on different Representative Concentration Pathways (RCP) scenarios. RCP's are greenhouse gas concentration trajectories used by the IPCC for climate modeling and research describing different climate futures depending on the volume of greenhouse gasses emitted (Moss et al. 2010). RCP 8.5 represents a "business-as-usual" scenario where greenhouse gas emissions continue to rise throughout the century. RCP 4.5 represents an intermediate scenario where global emissions peak around 2040 then decline.

Temperature — Averages from Global Climate Models (GCMs) suggest a RCP 8.5 scenario would raise the average minimum temperature of MDSP by an average of 4.6°F by mid-century, and 8.2°F by the end of the century. By cutting carbon emissions, an RCP 4.5 trajectory suggests the average minimum temperature would increase by an average of 3.7°F by mid-century and 5°F by the end of the century. Similarly, annual average maximum temperature could increase by an average of 4.9°F mid-century and 8.2°F by the end of the century, and a RCP 4.5 scenario could result in a 4°F increase mid-century, and 5.3°F increase by the end of century (CalAdapt 2023). Temperature ranges are available in figure 8.

Precipitation Changes — As temperatures increase, the atmosphere can hold more water which will result in varying rainfall effects across the globe (Allen & Ingram 2002; Collins et al. 2013). Even in an RCP 8.5 scenario, little change would occur for fall and summer precipitation, but there may be significant changes in the winter and spring (USGCRP 2017).

MDSP's annual precipitation could be approximately 22.8 inches mid-century (2035 to 2064) and 22.5 inches end of century (2070 to 2099) under an RCP 4.5 scenario. Under a more extreme RCP 8.5 scenario, annual precipitation would be 22.9 inches mid-century and 25.4 inches end of century (Cal-Adapt 2023). Results were created using climate projections that have been downscaled from global climate models using localized constructed analogs (Pierce et al. 2014).

This projected change in annual precipitation is relatively small compared to the natural range of variability, and precipitation patterns will likely vary across the park due to its proximity to the coast and its diverse topography.

> **Increased storm severity** — Both climate models and atmospheric theory suggest that the largest individual storms could be larger and more intense — possibly resulting in greater damage — in response to climate change (Pall et al. 2017; Prein et al. 2017). Emerging evidence suggests that these larger storms, generally dubbed atmospheric rivers, will increase variability in the Bay Area's precipitation patterns. The region follows a "boom and bust" cycle of precipitation with dry periods followed by wet periods. Increased storms may create more frequent "whiplash" events, where the swing between extremely dry to extremely wet periods will be more dramatic (Swain et al. 2018).

> **Increased drought risk** — Current and future increases in temperature will raise the probability of drought magnitude and duration in California, regardless of precipitation (Wehner et al. 2017).

Future risks to ecosystems

With continued greenhouse gas emissions from human activities, climate change could increase the vulnerability of park resources. Published research identifies multiple vulnerabilities to Mt. Diablo State Park's terrestrial ecosystems.

Increased Wildfire Risks — All of MDSP is in a high or very high fire hazard area. Climate change creates warmer and drier conditions that favors wildfires in North America (IPCC 2022a). Research suggests warming dries fuels and increases the number of days with extreme fire weather (Westerling 2016, Goss et al. 2020). Climate change can extend the wildfire season into fall, and potential decreases in autumn precipitation could exacerbate fire risk (Williams et al. 2019).

Downscaled GCMs suggest the probability of one or more fires happening within state park boundaries can increase 10% by mid century (2035-2064) and 20% by the end of the century (2070-2099) for both an RCP 4.5 and 8.5 scenario (Cal-Adapt 2023).

Plant invasions alter fire regime — Plant invasions can affect a native ecosystem's fire regime by changing fuel properties, thereby affecting frequency, intensity, extent, type, and seasonality (Brooks 2004). One assessment quantifies the effects of 12 invasive grasses on fire occurrence, size, and frequency. Community science has identified five of those as growing within state park boundaries, and two of which having significant alterations on fire regime: cheatgrass *(Bromus tectorum)* and medusahead (*Taeniatherum caput-medusae)* (Calflora 2023). Environments invaded with these grasses have higher fire frequency and fire occurrence but have smaller average fire sizes (Fusco 2019).

Vegetation Risks

Increased plant invasions — Climate change exacerbates the spread of invasive plant species (Bradley et al. 2010). Increased temperature, CO_2 concentration, and nitrogen deposits favor the performance of invasive plants over native plants; however, decreased precipitation, such as a drought period, may inhibit spread (Liu 2017). An increase in temperature can favor the traits of California's exotic grasses, which tend to be annual, taller, with larger leaves, and larger seeds (Sandel and Dangremond 2012).

Multiple studies suggest climate change can increase the prevalence of yellow starthistle (*Centaurea solstitialis*)—an invasive plant found in MDSP that is considered one of California's most troublesome wildland weeds (Bradley et al. 2009; Dukes 2011).

Rare plant species — One assessment analyzed 156 rare plant species in California, looking at life history attributes and species distribution models, and identified their vulnerability to population reduction as a result of climate change (Anacker et al. 2013). 40 special-status plant species have been known to occur or could potentially occur within MDSP (California State Park 2016), and six of those species were identified by the prior assessment as vulnerable to climate change.

The study found round-leaved filaree (*California macrophylla*) to be moderately vulnerable or presumed stable; fragrant fritillary (*Fritillaria liliacea*), and Mt. Diablo globe lily (*Calochortus pulchellus*) to be moderately vulnerable; dwarf flax

(*Hesperolinon breweri*) and Hall's bush-mallow (*Malacothamnus hallii*) to be highly or moderately vulnerable; and most beautiful jewel-flower (*Streptanthus albidus* ssp. *peramoenus*) to be highly vulnerable (Anacker et al. 2013).

Chaparral Conversion — Unnatural fire return intervals of four to five years (or less) make chaparral environments vulnerable to alteration and type conversion (Lippitt 2013). For example, frequent fires could turn chaparral-dominated landscapes into grasslands. Chaparral is one of the six major terrestrial biomes in the park (California State Park 2016), and the park is at increased risk of type conversion being surrounded by urbanization. Studies have found positive relationships between fire activity and population density in California, especially in wildland-urban interface zones (Westerling et al. 2011).

Sudden Oak Death — Contra Costa County is one of 14 California counties to have confirmed Sudden Oak Death (SOD) findings, which is caused by the invasive species *Phytophthora ramorum* (California State Park 2016). The effects of climate change on SOD is not fully understood, although SOD distribution is influenced in part by climate (Meentemeyer et al. 2004). Western Californian forests could become more susceptible to SOD if spring precipitation is accompanied by warmer temperatures. However, climate shifts may also affect the current synchronicity between host cambium activity and pathogen colonization rate (Pautasso et al. 2015).

Wildlife Vulnerability

Amphibians and Reptiles — Various special status species have known habitats in MDSP including the California tiger salamander (*Ambystoma californiense*), California red-legged frog (*Rana draytonii*), northwestern pond turtle (*Emys marmorata marmorata*), and the Alameda whipsnake (*Masticophis lateralis euryxanthus*). Approximately 70% of the entire whipsnake's species population lives in the park (California State Park 2016).

One assessment found the California tiger salamander, California red-legged frog, and northwestern pond turtle are highly vulnerable to drought. The Alameda striped racer's population can be affected by increased wildfire (California Department of Fish and Wildlife 2016).

Bird species — One assessment analyzed the risk of 544 North American bird species to climate change-related threats under a 1.5°C and 3.0°C future climate scenario (Bateman et al. 2020). In a 3.0°C scenario, there are thirteen highly vulnerable species and twenty-nine moderately vulnerable species in Contra Costa County. Reducing emissions to a 1.5 °C scenario would reduce the risk of the amount of highly vulnerable species by approximately 85%. In the 1.5 °C scenario, two species are highly vulnerable to climate change and twenty-two are moderate. For species found in MDSP, the report finds western forest birds (such as Nutall's woodpecker, spotted owl, and bushtit) to be the most susceptible group, and general birds (such as barn owl, mourning dove, and turkey vulture) to be most resilient (Bateman et al. 2020).

Notable species include the tricolored blackbird (*Agelaius tricolor*), a state-endangered avian species, which is among the two species highly vulnerable to a 1.5 °C shift. California State Park identified MDSP as having suitable habitat for the protected bird across the park (2016), and data from community science has identified the bird within the state park (eBird 2021).

Bateman et al. (2020) assessed climate vulnerability through false springs, heavy rain, fire weather, spring droughts, spring heat, cropland expansion, urbanization, and sea level rise. However, other climate variables could impact local species in ways not explored. One publication suggested that nesting sites for Golden Eagles in the northern Diablo Range could be negatively affected by climate change, as droughts negatively affect oak woodlands and grasslands (Wiens et al. 2018).

Western butterflies — Butterflies in the western United States are susceptible to aridity and warming fall temperatures. There is a 96% probability the total abundance of butterflies in the western United States is decreasing, and an estimated 1.6% fewer individuals per year (Forister et al. 2021). One study analyzing 163 butterfly species throughout Northern California found that many species are on downward population trajectories, even in mountainous regions where human stressors (such as land use change or pesticides) are minimal or non-existent, suggesting anthropogenic climate change could be playing a significant role in population decline (Halsch et al. 2021). These reports suggest climate change could have a negative impact on the San Bruno elfin butterfly

Callophrys mossii bayensis, a federally listed endangered species found in MDSP (California State Park 2016).

Ecosystem Carbon and Conservation Strategies

Carbon — Vegetation naturally removes carbon sequestering it from the atmosphere, thereby reducing the effects of anthropogenic climate change. Deforestation, wildfire, land use development, and other disturbances can emit stored carbon into the atmosphere, thereby exacerbating climate change. It is crucial to monitor how ecosystems are sequestering or emitting carbon to track the role of the ecosystem in relation to climate change (IPCC 2022b).

Using data from Gonzalez et al. (2015), analysis from the Conservation Land Network (2019) shows that Mount Diablo State Park stores about 210,00 metric tons of carbon in above ground vegetation (Figure 9). This is the equivalent of 790,000 metric tons of CO_2). Carbon stocks are particularly dense in the southern end of the park. This is enough to sequester the annual emissions of over 41,000 North Americans (IPCC 2022) or approximately 170,000 passenger cars (EPA 2018).

Conservation of vegetation carbon stocks will prevent carbon from contributing to climate change. Because MDSP's ecosystem is protected by the state from development, the park's carbon stocks are most at risk from wildfire. This is especially crucial as California's carbon loss has exceeded carbon uptake due to wildfires (Gonzalez et al. 2015). In low-frequency, high-severity fire regime environments, where human ignitions unnaturally cause frequent fire, preventing ignitions and removing non-native grasses can reduce fire risk (Keeley and Syphard 2018, 2019; Halofsky et al. 2018). Fire management practices that use frequent prescribed fires in chaparral environments could lead to type conversion and provide opportunities for alien species to become established (Lippitt 2013).

Climate-wise Connectivity — Species habitat range has already shifted due to anthropogenic climate change, and species will continue to undergo significant range shifts in response to climate change. Land connectivity, specifically through the use of wildlife corridors, have shown to facilitate species movement in fragmented landscapes, and is thought to increase landscape resilience to climate change (Ackerly et al. 2019).

Climate-wise connectivity, an emerging area of conservation science, builds upon historic knowledge of habitat connectivity but focuses on connectivity that facilitates species movement in response to climate change (Ackerly et al. 2019). This mode of connectivity emphasizes the need to connect current habitat to habitat that will be suitable in the future, which will be crucial for species that will need to shift their range in response to climate change. (Heller & Zavaleta 2009; Mawdsley et al. 2009; Hannah 2011, Hodgson et al. 2011).

Increasing landscape protection that connects Mount Diablo to its host range, the Diablo Range (Figure 10), may increase resilience to climate change. Given the rugged geographic features on the large scale of the range, there may be a diversity of microclimate that can buffer the effects of climate change, which will allow species to travel shorter distances, giving them more time to track the changing climate (Hannah et al. 2014). Obtaining more scientific knowledge on climate change velocity, refugia sites, and animal movement paths within the range may be important to justify connectivity projects with climate resilience objectives (Ackerly et al. 2019). Information search from the Clarivate Web of Science shows little published research about the ecological value of the Diablo Range. However, one publication already lists the range as a priority conservation site for California based on ecological value, especially for its phylodiversity significance (Kling et al. 2019). This conservation strategy also advances California Executive Order N-82-20, the conservation initiative that pledges to conserve 30% of the state's land and waters by the year 2030.

Acknowledgments

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Tables, Figures, Legends

Figure 1

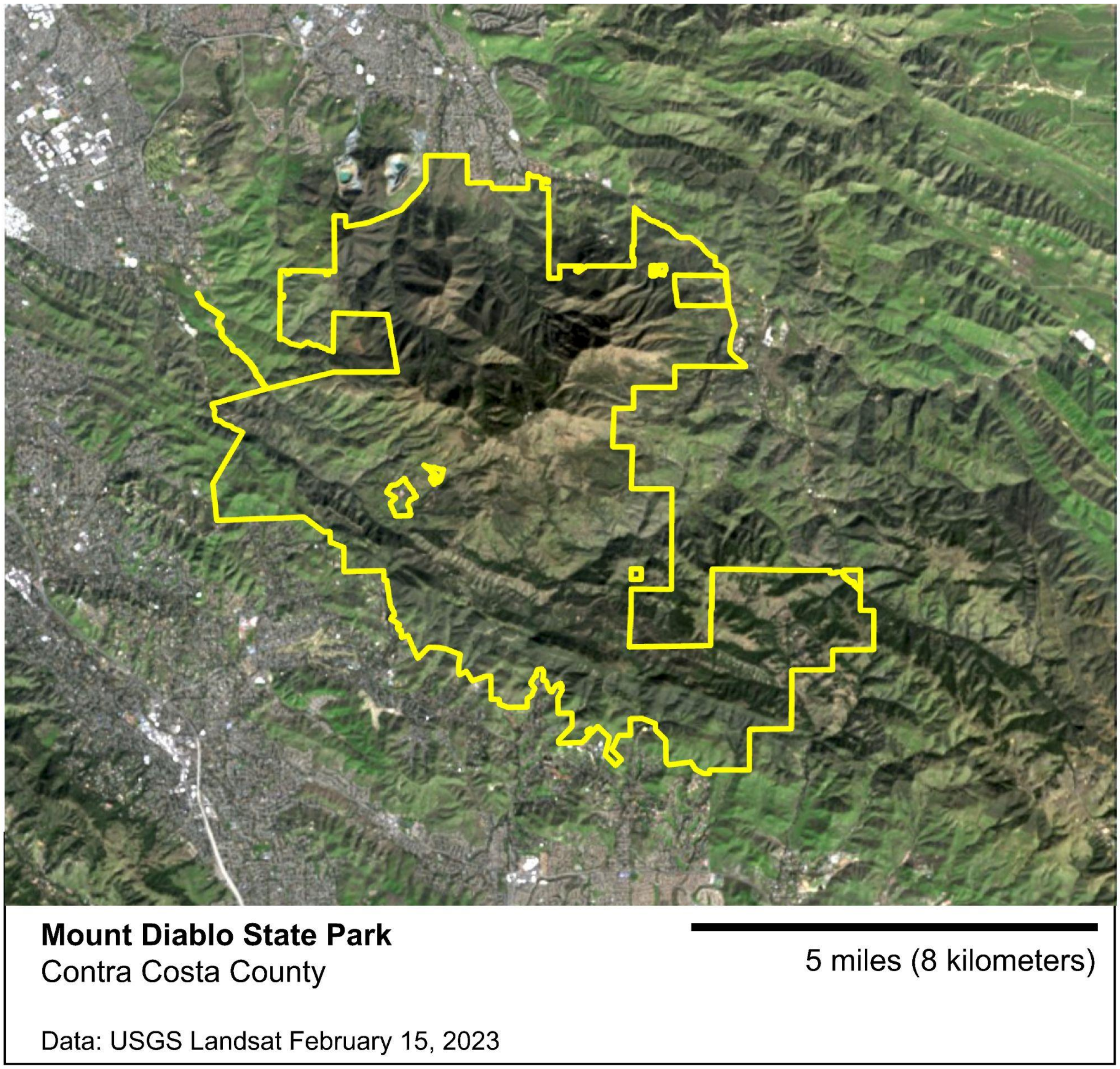
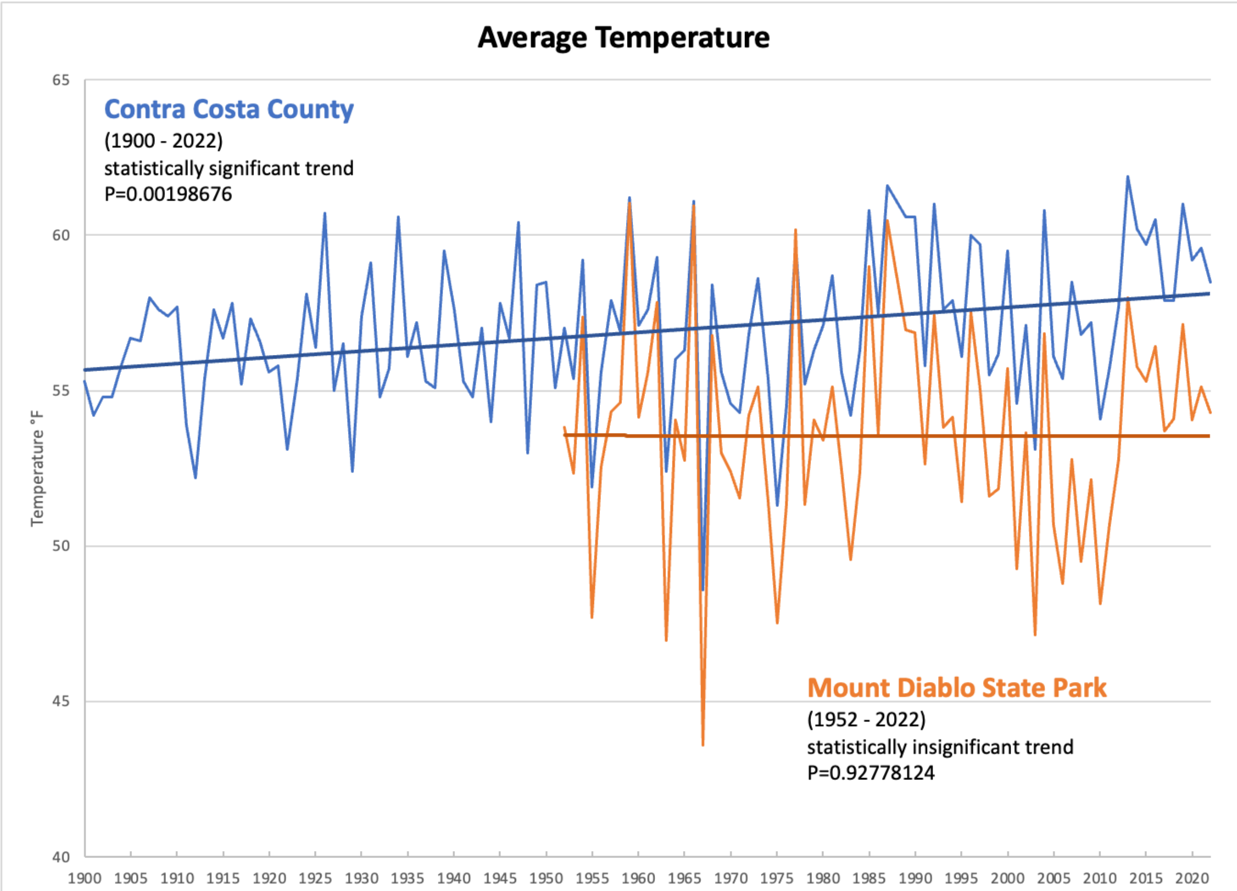


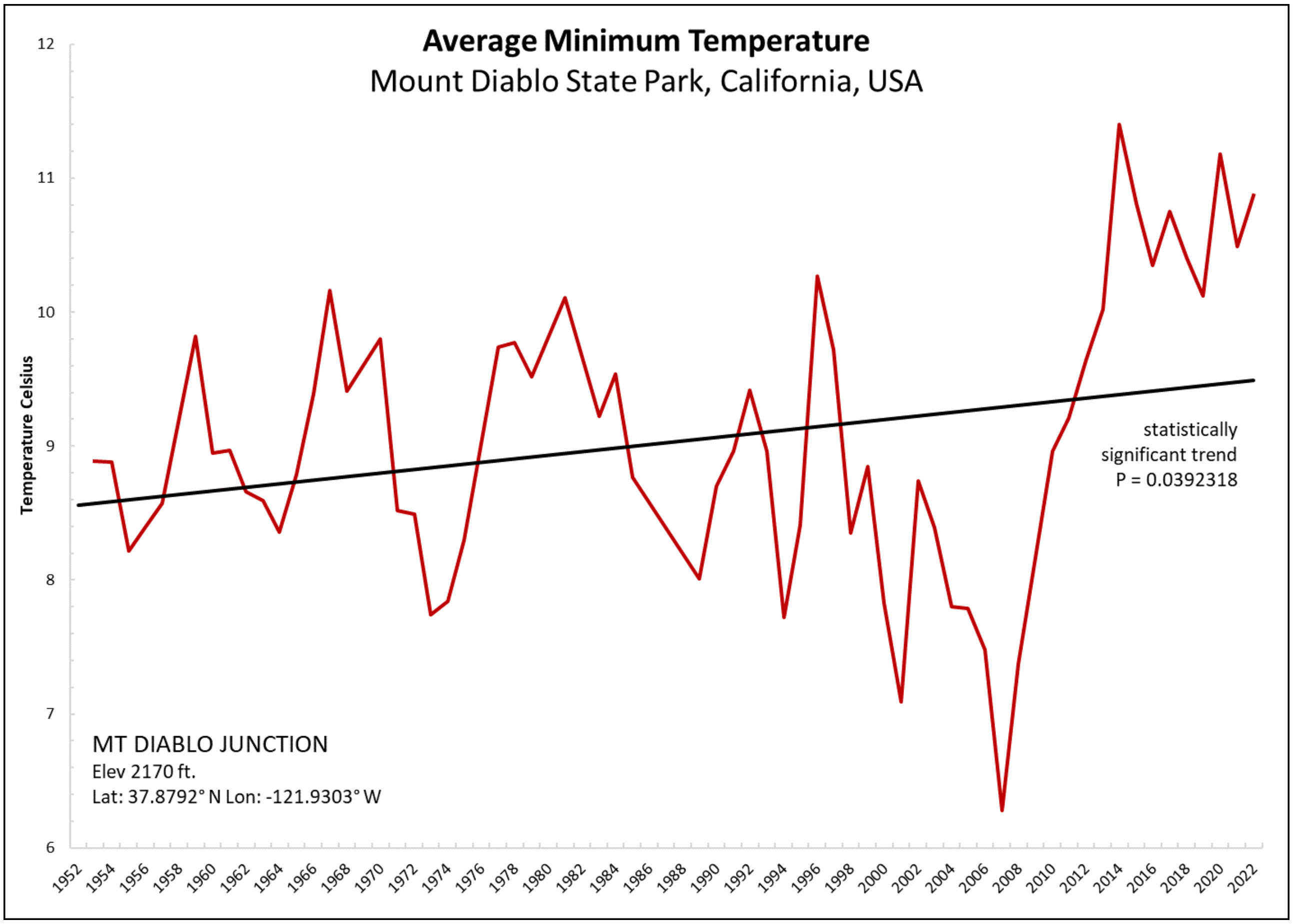
Figure 2



Main conclusion: While average temperature has no significant change in Mount Diablo State Park, the larger time series for Contra Costa County shows an increase of about 0.2 °F per decade.

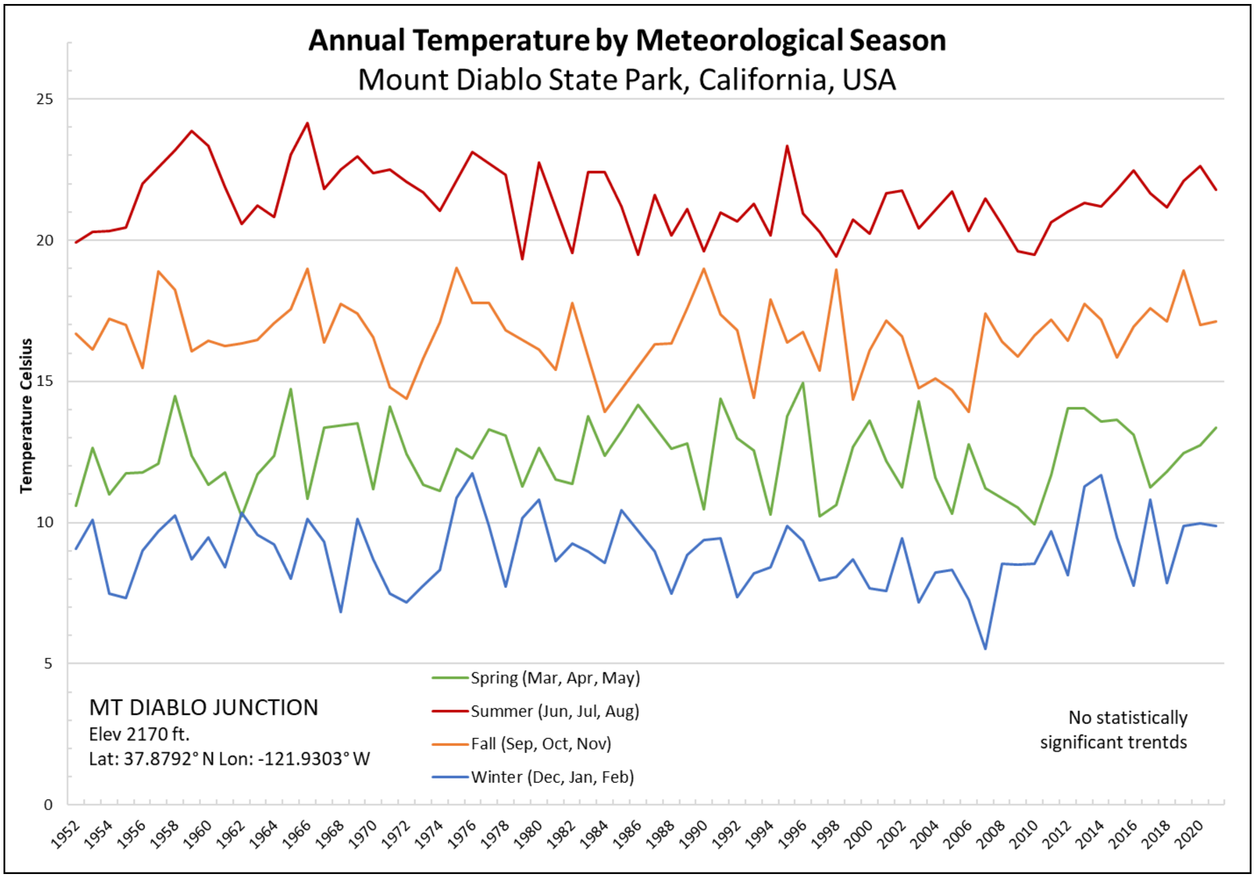
Source:
Data series for MDSP comes from a NOAA station, Mt Diablo Junction (Lat: 37.8792°N Long: -121.9303°W, Elevation 2170 ft.). Data series for Contra Costa County comes from NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published May 2023, retrieved on May 10, 2023 from https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series

Figure 3



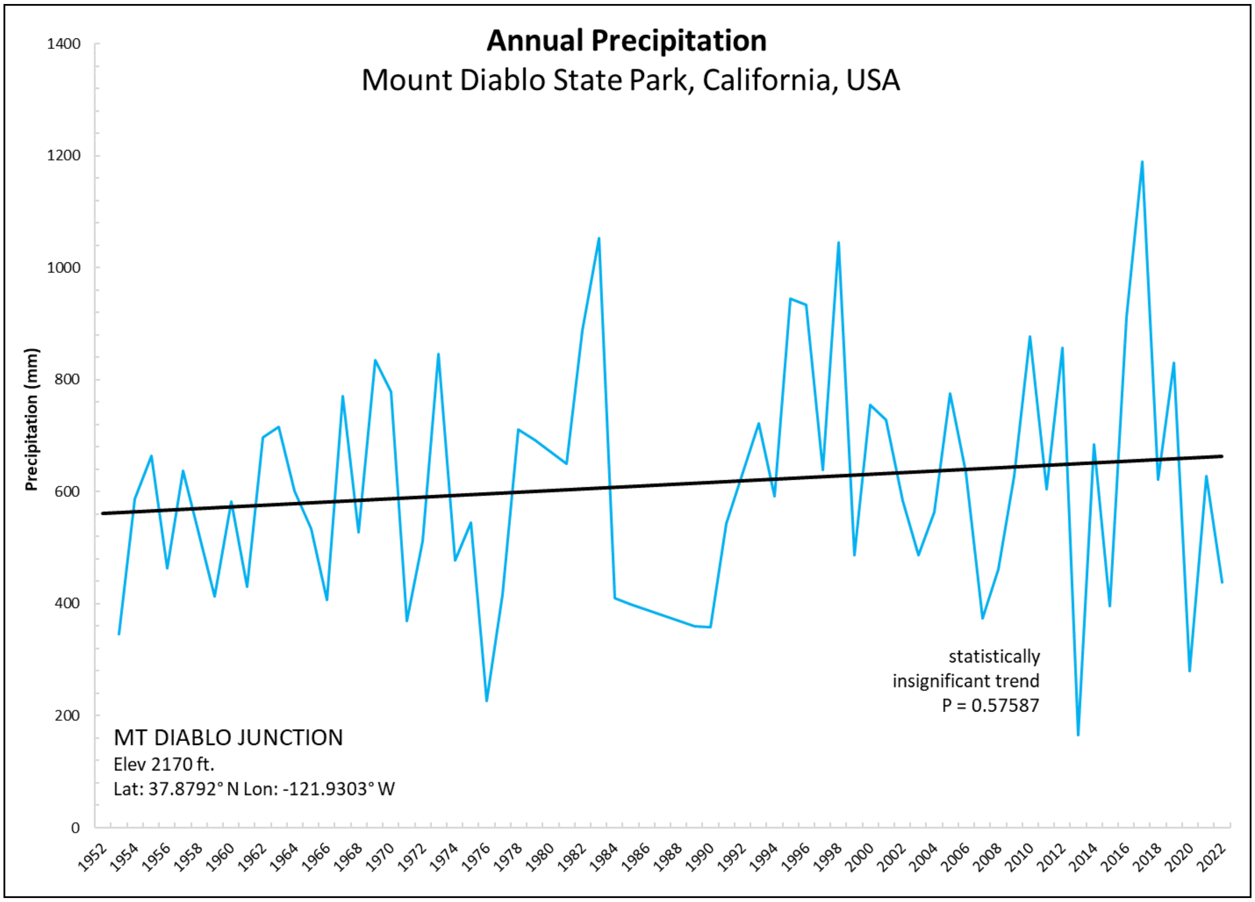
Main conclusion: Average minimum temperature shows statistically significant change.

Figure 4



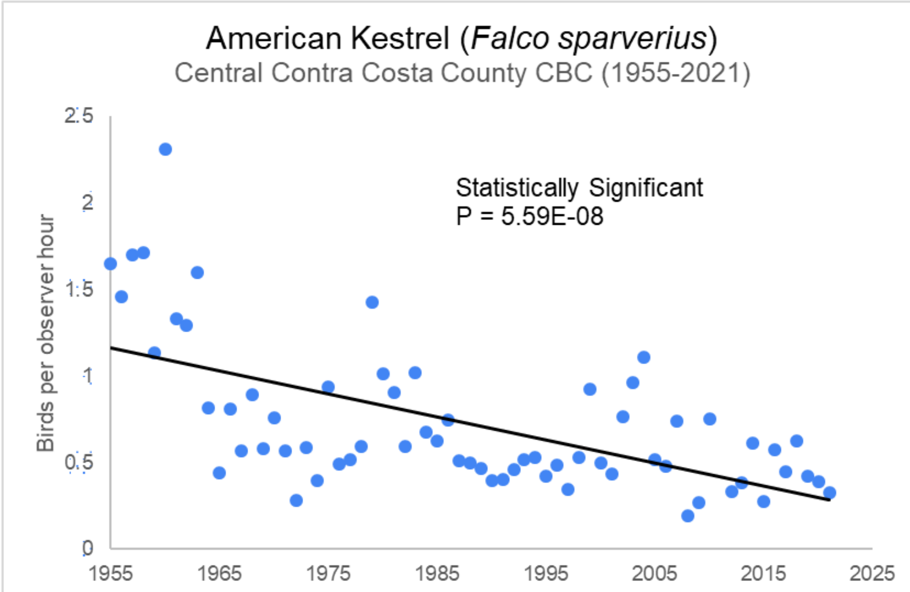
Main conclusion: There is no statistically significant change in the meteorological seasons.

Figure 5



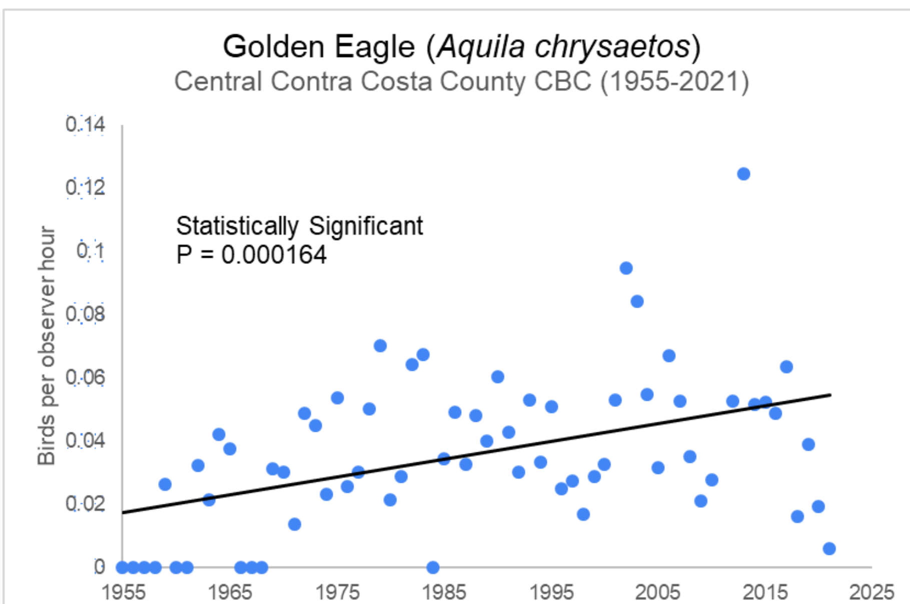
Main conclusion: Precipitation has shown no statistically significant change.

Figure 6



Main conclusion: American Kestrel sightings in the Mount Diablo region are decreasing.

Figure 7



Main conclusion: Golden Eagle sightings in the Mount Diablo region are increasing.

Figure 8

Future Climate Projects for Mount Diablo State Park

Temperature	IPCC Pathway	Modeled historical temperature (1961–1990)	Modeled range projections for mid-century (2035-2064)	Modeled range projections for end of century (2070-2099)
Average Minimum	RCP 4.5	46.2 – 51.3°F	49.7 – 54.8°F	50.5 – 56.4°F
	RCP 8.5	46.2 – 51.3°F	49.8 – 57.2°F	52.5 – 62.2°F
Average Maximum	RCP 4.5	68.0 – 74.6°F	71.6 – 78.8°F	73.7 – 80.9°F
	RCP 8.5	68.0 – 74.6°F	72.0 – 80.9°F	74.4 – 84.9°F

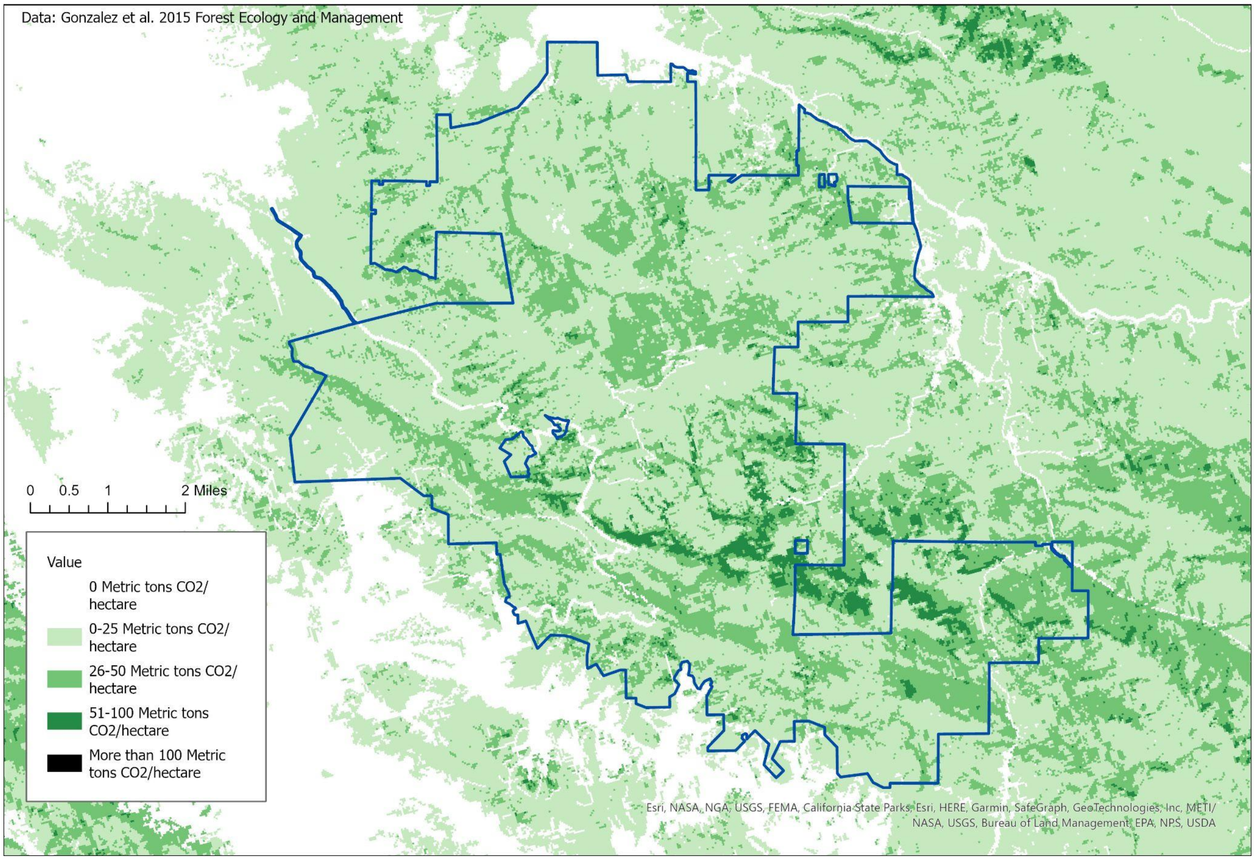
Main conclusion: Both an RCP 4.5 and 8.5 scenario will result in a sharp temperature increase mid-century, but a 4.5 scenario will plateau by the end of the century whereas the 8.5 scenario will continue to increase. This highlights the importance of cutting carbon emissions as fast as possible to prevent a hotter end of century outcome.

Method: Temperatures were obtained by importing MDSP's boundaries as a shapefile into Cal-Adapt's climate tools. Temperature averages are obtained using Global Climate Models (GCMs) from the CMIP5 archive. Models are downscaled using Localized Constructed Analogs to get fine-scale detail on GCMs -- a technique developed by the Scripps Institution of Oceanography.

Source: Cal-Adapt. Data: LOCA Downscaled CMIP5 Climate Projections (Scripps Institution of Oceanography), Gridded Observed Meteorological Data (University of Colorado Boulder), LOCA Derived Products (Geospatial Innovation Facility).

Figure 9

Carbon in Aboveground Vegetation at Mount Diablo State Park

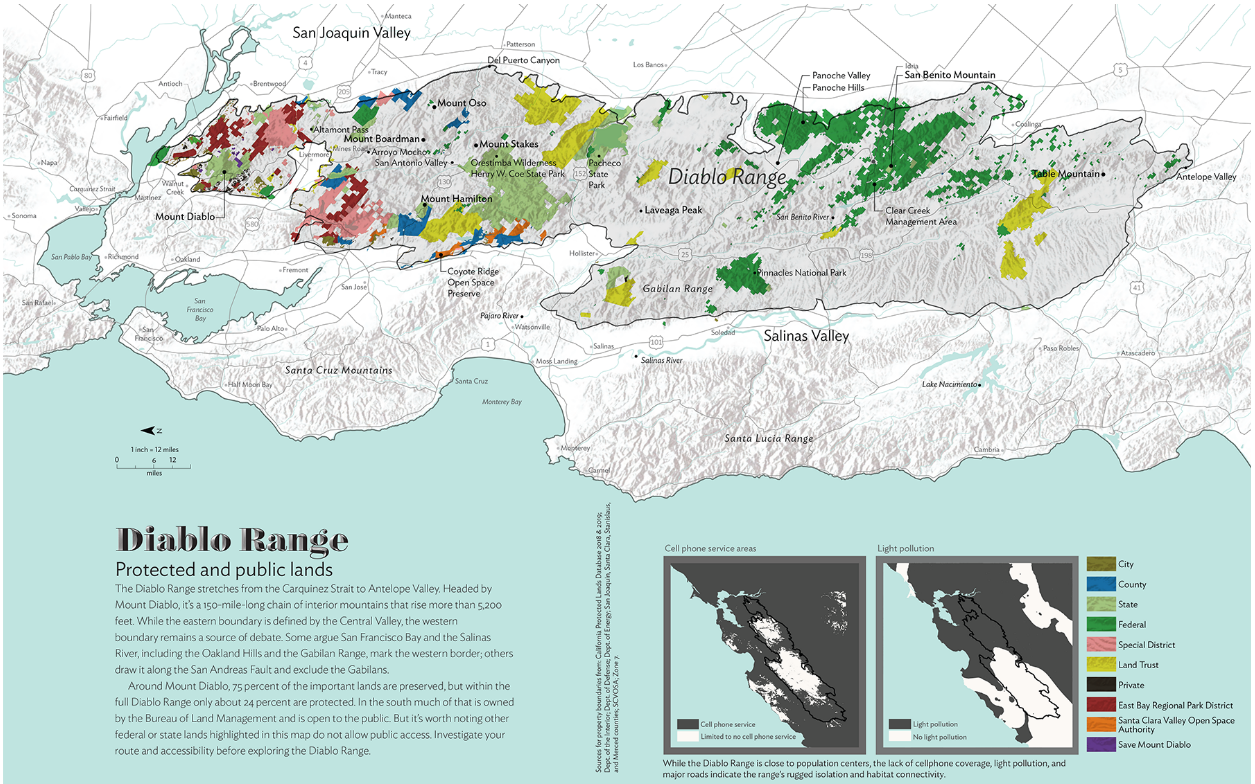


Main conclusion: There is approximately 210,000 metric tons of carbon stored in the aboveground vegetation in Mount Diablo State Park. This is approximately 790,000 metric tons of CO_2.

Method: Carbon information was obtained by creating a "Conservation Portfolio Report" of MDSP's boundaries through the Conservation Land Network. The program uses data from Gonzalez et al. 2015 (methodology for quantifying aboveground carbon is outlined in the publication). GIS data sets used to create the map were accessed from "The Conservation Lands Network 2.0 Report."

Cartography: Floyd McCluhan

Figure 10



Main conclusion: While much of the immediate Mount Diablo region has varying forms of land protection, most of the Diablo Range is unprotected.

Source: Simmons, Erik. "The Spine of California." Bay Nature Magazine. (March 2020). https://baynature.org/article/the-spine-of-california/

"Cartography by Sahoko Yui and range boundary by Heath Bartosh. Sources for property boundaries from: California Protected Lands Database 2018 & 2019; Dept. of the Interior; Dept. of Defense; Dept. of Energy; San Joaquin, Santa Clara, Stanislaus, and Merced counties; SCVOSA; Zone 7."

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