



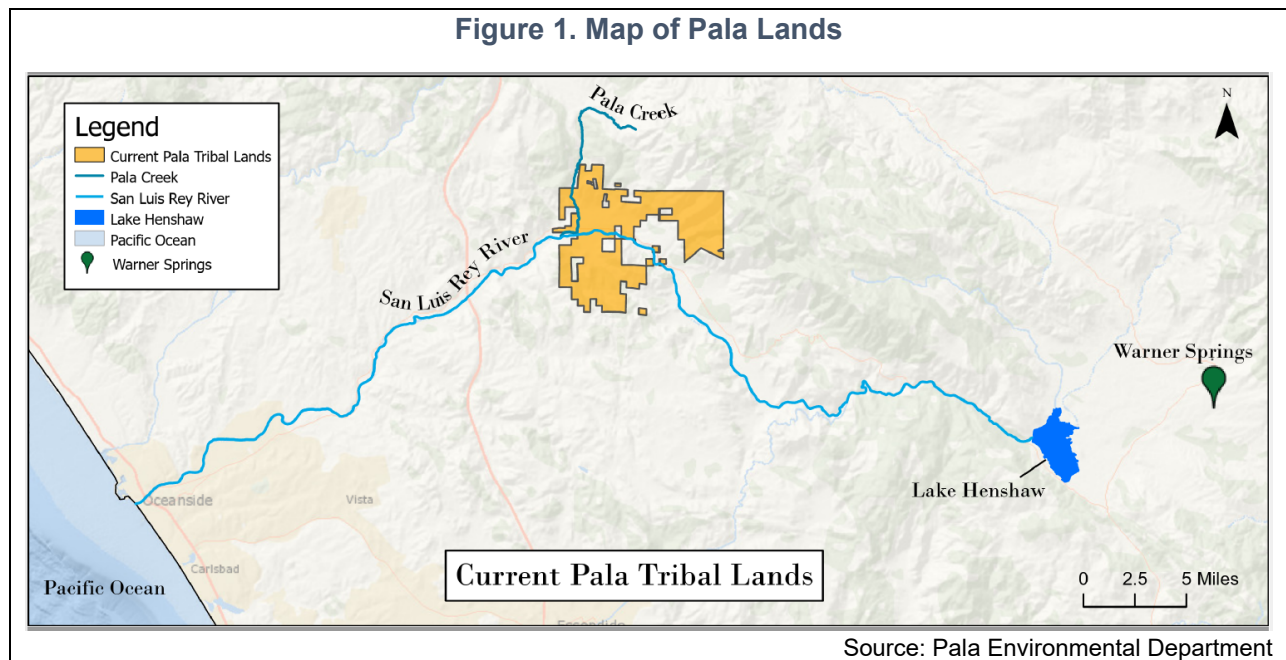
IMPACTS OF CLIMATE CHANGE ON THE PALA BAND OF MISSION INDIANS

Rising temperatures, drought, wildfires, and flooding are threatening the physical, cultural, and spiritual health of the Tribe, its habitats and ecosystems, and its built environment

Background

The Pala Band of Mission Indians is a federally acknowledged Native American Indian Tribe that has a current enrollment of approximately 983 tribal members. The Pala Band has jurisdiction over the Pala Indian Reservation that was established in 1875. The Pala Indian Reservation is located on approximately 13,000 acres in northern San Diego County, roughly 30 miles east of the Pacific Ocean (see Figure 1). The Pala Reservation sits next to the Palomar Mountain range that runs along 5,000 square miles of California desert. Adjacent to the reservation is the Cleveland National Forest to the north and east, and private agricultural lands to the south and west.

Figure 1. Map of Pala Lands



The reservation lies within an alluvial valley surrounded by steep granite mountains and is divided into two areas by the San Luis Rey River; these are referred to as the north side and the south side. The north side contains most of the homes and development; however, there are also approximately 100 homes and structures south of the river. Elevations range from approximately 340 feet above mean sea level (MSL) at the valley floor to approximately 1,250 feet above MSL in the northern and southern mountainous areas, with most residential, agricultural, and industrial activities occurring in the lower elevations of the reservation. Approximately 88 percent of the land is currently



undeveloped. Land uses include agricultural, mining, pastureland, commercial businesses including gaming, and residential uses.

The South Coast of California where Pala is located is home to one of the world's biodiversity hotspots. Rapid development occurring in the areas surrounding the reservation has increased the burden on natural resources and degraded ecosystems and habitats.

Prior to the construction of the Lake Henshaw Reservoir and Dam in 1923, Pala had access to the San Luis Rey River's perennial water supply. A complex history of water diversion by new settlers and legal battles ultimately led to a Congressional settlement that was signed into law. This law quantified the Tribe's prior and paramount water rights and provided for the construction of water projects to facilitate the exercise of Pala's rights. The source of the reservation's domestic water supply, which is drawn from wells scattered throughout the reservation, is the aquifer and underground stream of the Pala Groundwater Basin. The Basin lies directly underneath the San Luis Rey River and the Pala village area. It is replenished by rain events and surface water flows from local creeks and rivers (Pala, 2017).

The people of the Pala Band of Mission Indians have lived from time immemorial in this part of Southern California. Pala's tribal members have a rich and diverse tribal history with members that come from both Cupeño and Luiseño ancestry. They have endured and adapted to many significant impacts on their lands and community which have disrupted culture and traditions, political and social systems, and ecological environments for over hundreds of years beginning with the arrival of Spanish missionaries in 1769 (OPR, 2018). In 1903 the Cupeño Indians were forcibly removed from Warner Springs, shown on the map in Figure 1 (40 miles east) to Pala, joining with the Luiseño Indians already living there, ultimately combining to make the Pala Band. Ongoing development impacts the Pala community's ability to maintain traditional subsistence practices. The Pala people, however, continue to thrive, buoyed by their strong community and culture connectedness, co-existence with nature, and spiritual connections.

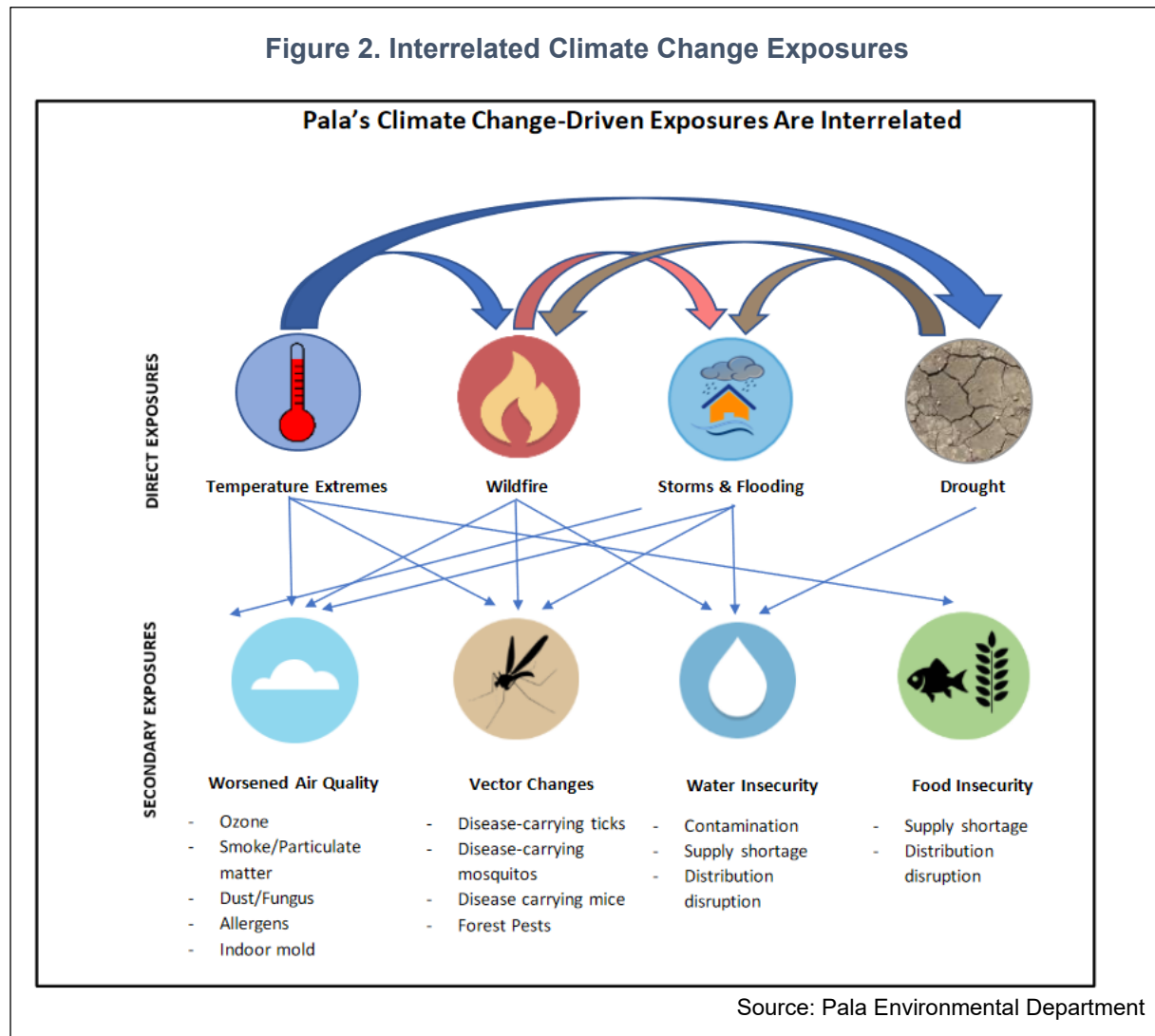
Climate change and the Pala Tribe

Pala's climate has been characterized by moist, mild winters and dry, warm summers, also known as "Mediterranean summers". Temperatures in the Pala Valley are historically relatively moderate, ranging from an average of 60 degrees Fahrenheit during the winter months to an average of 80 degrees Fahrenheit during the summer. Annual precipitation within the Pala Valley averages about 10 to 12 inches a year, and between 25 to 45 inches in the Palomar Mountains, 12 miles east of Pala. Roughly 75 percent of the annual precipitation falls within the basin between December and March (Pala, 2016).

The climate change impacts the Tribe has seen threaten a variety of Pala's community assets and values, ranging from water resources to human health and tribal sovereignty



(Pala, 2019). Pala conducted a vulnerability assessment, based on Tribal science, knowledge and observations shared by Pala’s residents, which matches the more recent scientific evidence and literature. This 2019 Vulnerability assessment is the basis for much of this report. Pala’s location in the southwest region of the United States, within the inland valley and mountainous areas of San Diego County, makes it susceptible to a variety of interrelated climatic exposures as well as secondary exposures. These secondary exposures (e.g., worsened air quality, water insecurity, etc.) occur as a result of direct exposures. The exposures that present the most significant and interrelated risks for Pala are shown in Figure 2 (Pala, 2019).



There are characteristics of the area and of the Tribe that make Pala either more vulnerable to possible impacts of climate change, or more capable of adapting to these impacts. For example, Pala has buildings considered at high risk from flood and critical facilities in a high-risk wildfire area (Pala, 2016). In addition, only 53 percent of residents have air conditioning in their homes to buffer them from heat impacts. However, Pala



also has more tree canopy cover, lower percentages of impervious surfaces, and a lower urban heat island index than most census tracts in California, (Public Health Alliance of Southern California, 2018) which may help buffer residents from expected impacts of extreme heat. Having overcome ecological and human changes on their lands for thousands of years, the people of Pala have also demonstrated exceptional strength, resourcefulness, and resilience, in the face of continued and increasing climate change impacts.

“The summers are extremely hot, which is a concern for our elders, even our natural flowers are blooming late in the year. We need change!”
~Pala Tribal Member Survey Respondent

Cultural and Spiritual Health

At Pala, the people, the culture, and the environment are connected. Thus, it is impossible to tease out climate change impacts that affect cultural and spiritual health from those that do not. For example, the plants and animals that are being impacted by climate change are often used in traditional practices and ceremonies. When medicinal plants are impacted by climate change, the Tribe’s traditional healing practices are affected. The absence of culturally important foods, such as acorns, limits their use in celebrations.

Habitable climate is critical to protecting tribal sovereignty, culture, and community cohesion for the people of Pala. Extreme heat days can threaten cultural expressions and traditional ways of life at Pala, including disruptions to culturally and/or spiritually important activities such as traditional gatherings, annual ceremonies, traditional food foraging, performances by traditional bird singers, and basket weaving. As temperatures continue to rise, residents may opt out of these traditions, modify how they are conducted, or relocate their household out of the area; this affects community cohesion and cultural identity and sovereignty (Pala, 2019).

Increased temperatures also result in a variety of ecosystem disruptions. For Pala, that can mean declines or disappearance of culturally important plants and animals. At Pala, survey respondents were concerned about culturally important plants including those required for baskets, ceremonial structures, or foods, such as rushes (*Juncus*), sourberry (*Rhus trilobata*), acorns, sage (*Artemisia californica*), willow, and tobacco. Community members report that culturally important plants like basket rush (*Juncus textilis*) and ferns have also become harder to find (Pala, 2018).

Declining trees and plants impact resources that support the Tribe’s cultural traditions. The coast live oak (*Quercus agrifolia*) was known as wi’awlet to the Cupeño people. For many Tribes, oak trees were a key source of nutrition (acorn mush or wi’wish) and are a symbol of life, growth, and the cycle of the seasons.



As climate change puts Pala at increased risk, impacts to the psychosocial health of the community are inevitable. Psychosocial health refers to the mental, social, spiritual, and emotional health of a community. While Pala has been committed to addressing these impacts, the stress on the community from heat, drought, severe weather, loss of species and cultural sites, and wildfires cannot be ignored.

Elevated Temperatures

Temperatures have been increasing at Pala. Elevated temperatures affect human health, mental health, cultural and spiritual health, and socio-economic health, as well as the plants and animals that are part of Pala. Elders, children, outdoor workers, and those with existing medical conditions are particularly susceptible to these impacts (Pala, 2019).

What does this indicator show?

At Pala, both the nighttime temperatures (Tmin) and daytime temperatures (Tmax) are rising, with the nighttime temperatures rising more quickly. As shown in Figure 3, before 1950 the annual average minimum temperature varied between 44.7 degrees Fahrenheit (°F) and 51.3°F and the average maximum annual temperatures varied between 74.5°F -and 78.6°F. Since 1950 the annual average minimum temperature has been between 47.7°F and 54.4°F and the annual average maximum temperature has ranged from 74.3°F -79.2°F (PRISM, 2022).

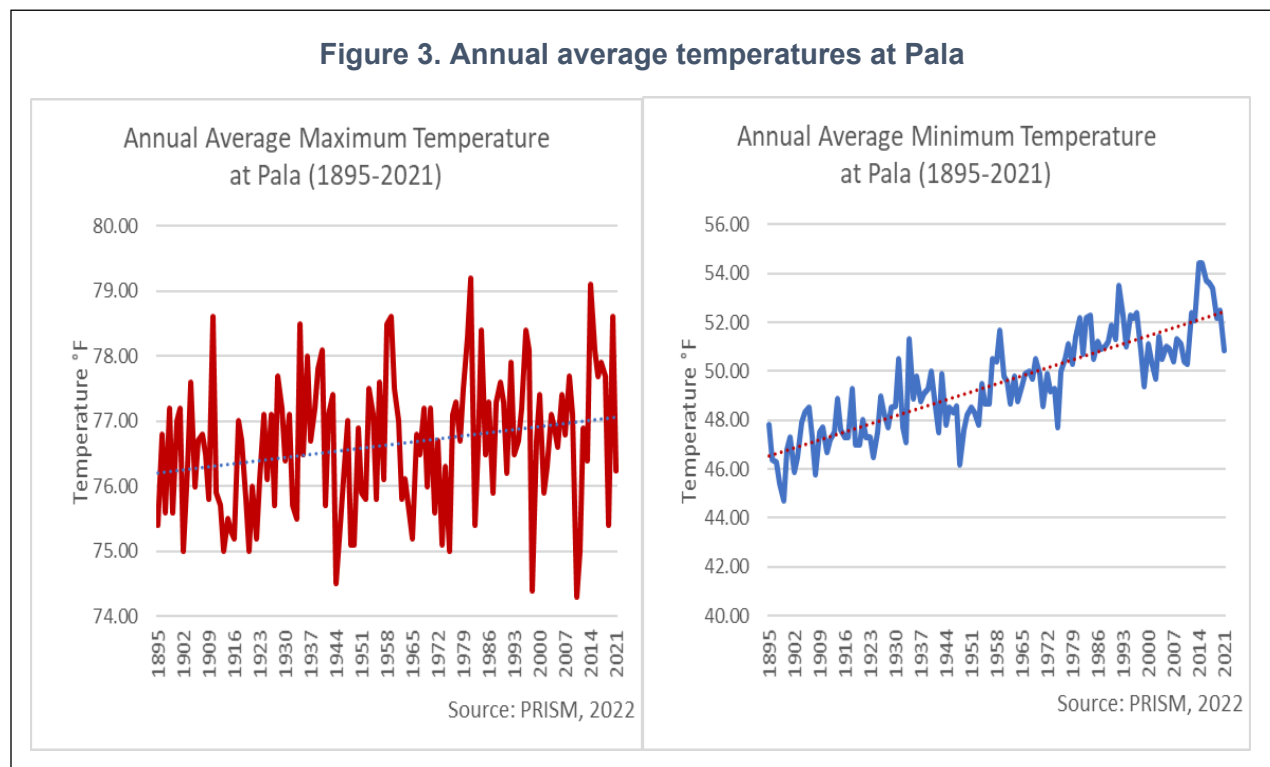


Table 1. Change in Day and Nighttime Average Annual Temperatures Over Time at Pala

Time Period	30-year Annual Average Minimum Temperature (Tmin)	30-year Annual Average Maximum Temperature (Tmax)
1895-1924	47.17°F	76.19
1925-1954	48.59°F	76.60
1955-1984	50.05	76.76
1985-2014	51.31	76.83
2015-2019*	52.95	77.38
*7 years		

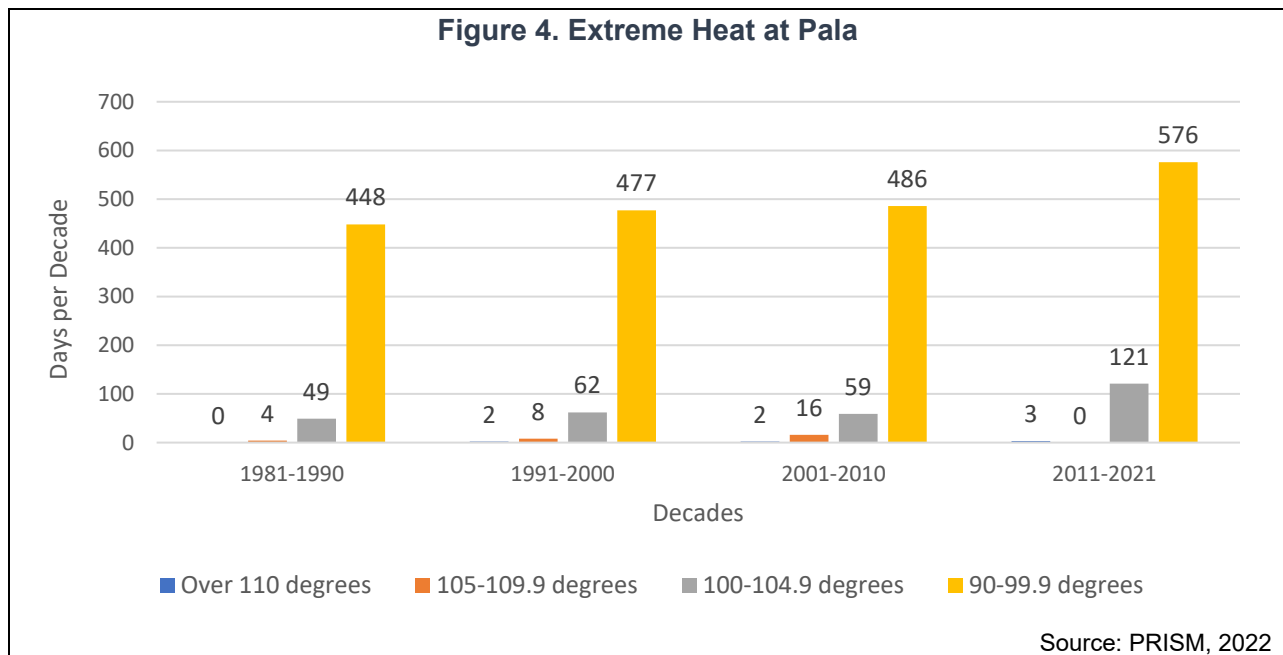
Source: PRISM, 2022

Table 1 shows the averages of the annual minimum (nighttime) temperatures (Tmin) and the annual maximum (daytime) temperatures (Tmax) during 30-year periods from 1895-2021. The Tmin has risen 5.8°F and the Tmax 1.2°F over the last 125 years.

Why is this indicator important?

Warming temperatures are considered a high-risk exposure for the Pala Tribe. Heat waves consisting of multiple consecutive days of triple-digit heat have increased and are expected to become more common. As is evident from the increasing minimum temperatures, the cooling nights that Pala is accustomed to are warming over time. The combination of warmer daytime and nighttime temperatures are impacting both the human and the plant communities (Pala, 2016).

As shown in Figure 4, in the 30 years from 1981 – 2010 there were an average of 67.3 days per decade with temperatures over 100 degrees. The 11 years after that (2011-2021) had 124 days with temperatures over 100 degrees.



As temperatures have increased, Pala's Environmental Department staff have observed declining areas of important habitats including chaparral, native grasslands, wetlands, riparian, and upland habitats and increasing areas of non-native grasslands. Pala has observed impacts to production of some crops cultivated on the Reservation, including avocado and citrus fruit. These trees need a certain number of chilling hours in the winter when temperatures are between 32 and 50°F; as temperatures increase and chilling hours are reduced, crop yield decreases (Pala, 2019).

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~Pala Tribal Member Survey Respondent

Climate changes are also causing certain native animal populations to decline in Pala's region. Temperature increases are altering habitat suitability for endemic species like the federally endangered Quino checkerspot butterfly and California gnatcatcher, for which range shifts have been observed (Parmesan, 2015).

Increasing temperatures and earlier spring warming can also trigger extensive and prolonged algal blooms. These temperature shifts can also impact the breeding cycles of aquatic species that are triggered by warming temperatures, like the federally endangered arroyo toad (*Anaxyrus californicus*). Algal blooms can also negatively impact overall productivity of instream communities (CEC, 2018).

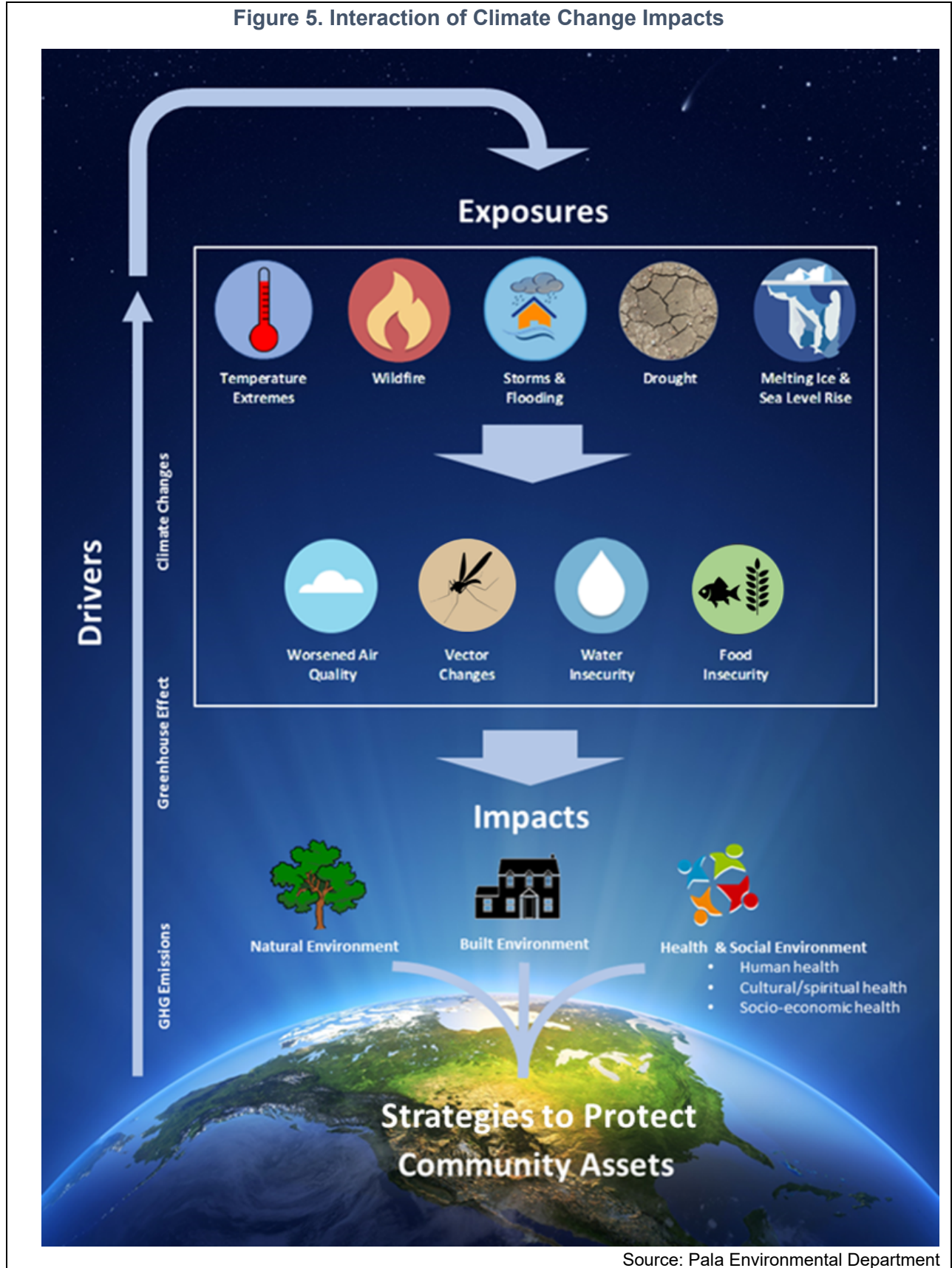
A Tribe's social and economic institutions are an important factor in its overall community health. Extreme heat and its effects on human health can result in a variety of negative socio-economic impacts. Health impacts and power disruptions triggered by extreme heat can result in lost work days and revenues for tribal businesses. For Pala, critical economic drivers include gaming, entertainment, hospitality, and other business ventures. Health impacts and power outages can also result in lost school days and closures of school and afterschool activities that impact Pala's youth.

Figure 5 shows how changing exposures impact health, social, natural, and built environments (Pala, 2019).

Elevated temperatures at Pala increase water evaporation and lower water levels in rivers, streams, and aquifers. This presents a challenging scenario as Pala already relies on groundwater for domestic water and irrigation. Increased water demand from development in the region, coupled with declining water supply from the California snowpack and the Colorado River, will place additional burdens on local water resources.



Figure 5. Interaction of Climate Change Impacts



Source: Pala Environmental Department

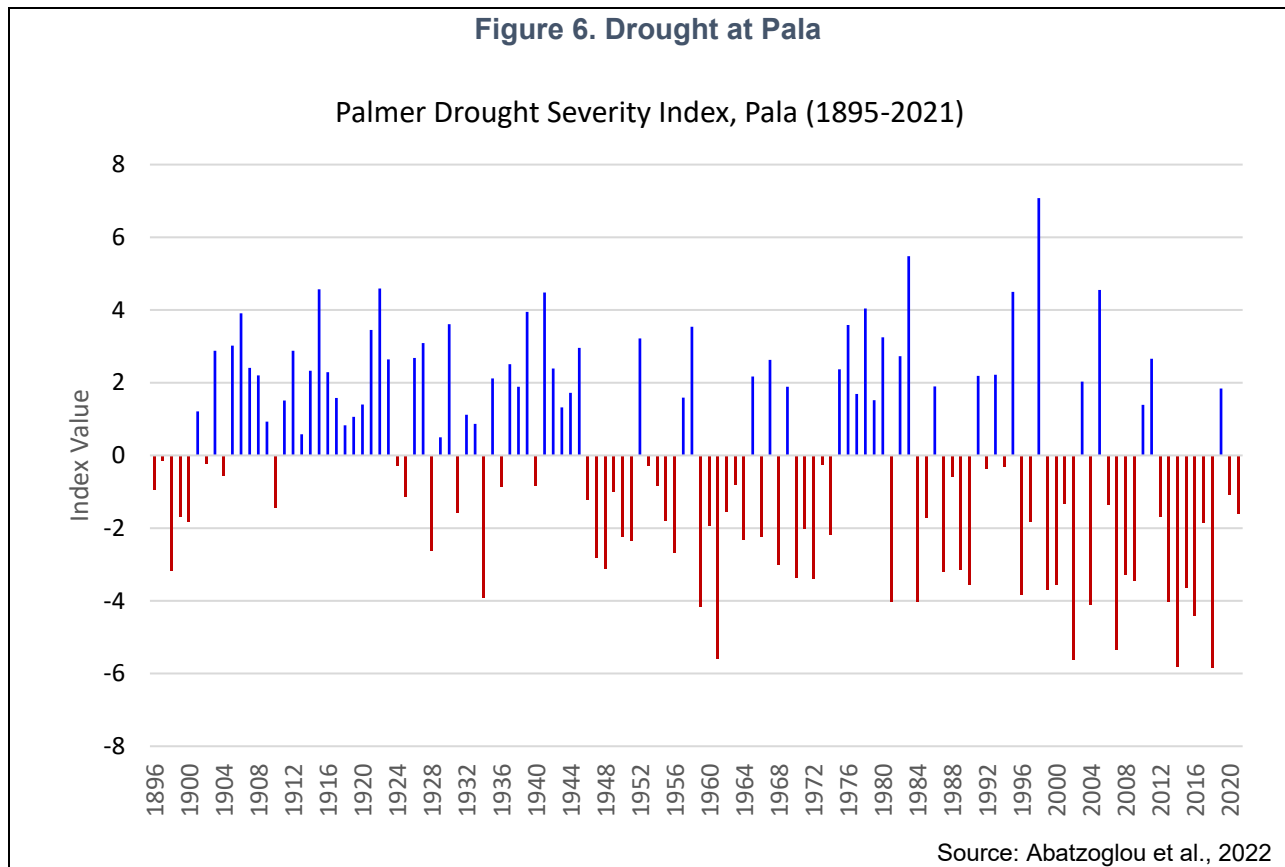


Increased heat intensifies photochemical reactions that produce ground level ozone, a key component of smog associated with motor vehicles, wildfires, and power generation. Levels of ozone at Pala are higher than in 71 percent of the census tracts in California (OEHHA, 2021).

Ozone and smog irritate the human respiratory system and can contribute to and exacerbate respiratory diseases. As a result, Pala residents may experience more cases of decreased lung function, respiratory symptoms, hospitalizations for cardiopulmonary causes, emergency room visits for asthma, and premature death. Anecdotal reports by Pala tribal members indicate an increase in the severity and frequency of asthma symptoms in recent years (Pala, 2019).

Drought

The Palmer Drought Severity Index (PDSI) combines both temperature and precipitation data to provide data on relative dryness (drought) on a scale from +10 (wet) to -10 (dry). The lower the number the drier the conditions. As is shown below in Figure 6, Pala is having more frequent, and more intense, dry years. Prior to 1950, dry years (with PDSI values below zero) occurred 20 times, none of which were classified as extreme drought (PDSI at or below -4). From 1951 to 2021 Pala experienced 48 dry years, including 11 years of extreme drought (Abatzoglou et al., 2022).



What does this indicator show?

Drought, combined with climate change driven extreme heat, season shifts, and insect and pest outbreaks can weaken plants, trees, and forests or shift growth patterns. There is ample evidence of such drought impacts in Southern California. Some vegetation types in Southern California (e.g., chaparral and coastal sage scrub) have experienced declines in vegetation greenness over the last 17 years (Pala, 2019).

Why is this indicator important?

Pala Environmental Department staff note that manzanita and other upland plants are moving into the riverbed as riparian vegetation and wetlands dry up. Reduced riparian vegetation lowers the area's natural capacity to absorb storm water, which exacerbates flooding threats on the Reservation. Gold spotted oak borer beetle is a concern for the oak groves on the reservation, particularly in light of the increased drought, which has taken a toll on native oak species. Pala Environmental Department staff note declining numbers of Englemann (*Quercus engelmanni*) and coast live oak (*Quercus agrifolia*) trees, which are considered culturally important (Pala, 2019).

Pala Creek used to flow for many days after a substantial precipitation event, but that is no longer the case since repeated droughts have reduced the groundwater basin. Pala staff report that the San Luis Rey River and Pala Creek no longer have regular flow.

Because water levels have been so low in the river and streams, Pala Environmental Department notes that aquatic species such as the arroyo toad and anadromous fish such as Steelhead and Pacific Lamprey are no longer present in significant numbers.

According to Pala Environmental Department's Wildlife Biologist, Pala's reservation is

Figure 7. Southwestern willow flycatcher



Source: USFWS

home to endangered or threatened plant species including Parry's tetracoccus (*Tetracoccus dioicus*) and Rainbow manzanita (*Arctostaphylos rainbowensis*). Drought, along with increased temperature, stresses these plants and creates conditions for certain non-native, invasive species to thrive. Examples of invasive species present on the Pala Reservation are eucalyptus, *Arundo*, and tamarisk. These species can degrade habitat quality for native wildlife and contribute to increased wildfire frequencies.

The loss of habitat combined with drought is assumed to be the cause of the disappearance of the southwestern willow flycatcher (*Empidonax trailii extimus*).



Southwestern willow flycatchers live in moist microclimatic and vegetative conditions and breed only in dense riparian vegetation near surface water or saturated soil. Southwestern willow flycatchers have not been seen at Pala since 2013 and are assumed to be extirpated (Pala, 2019).

Drought and changes in precipitation contribute to species migration and range shifts. Native bird species at Pala are dependent on native vegetation for habitat, which has declined during severe drought (Assoc FWS, 2012). At Pala, tree and habitat losses have affected several bird species. In addition to the southwestern willow flycatcher, Pala biologists have also observed a reduction of acorn woodpeckers (*Melanerpes formicivorus*), a species tied to oak trees.

Storms and Flooding

As precipitation becomes less predictable and more intense, flooding is a high concern for Pala and has impacted the Tribe (Prosper Sustainably, 2018). Drought conditions and lower soil moisture lead to flash floods in inland areas, as well as mudslides and landslides, especially in areas recently affected by wildfire.

What does this Indicator show?

Since 1895 Pala has received less annual rainfall over time. When the rains come, these rain events are becoming more intense, causing flooding that rises and falls quickly. (Prosper Sustainably, 2018) The Pala Environmental Department tracks rainfall, water flows, stream levels, storm damage, and flooding at multiple locations on the Reservation. Flooding has become a regular occurrence at Pala. Between 1917 and 1997 there were two major flood events. Since 1997 there have been 22 major floods impacting which flooded roads, damaged property, and trapped residents (Pala ED, 2019).

Figure 8. Flooding across Lilac Extension Road at Pala, February 2019



Source: Pala Environmental Department

Why is this indicator important?

Flooding can weaken and remove vegetation and soil leading to downed trees, erosion, and mudslides. Pala staff have observed that floods have shifted riparian habitats. For example, shifting river sediments and braided water flows during heavy storms have



created new San Luis Rey River channels in some areas, while silting and blocking previous flow channels. This leads to a shifting riparian regime that can change between major flood events.

Loss of riparian vegetation reduces the ability of the floodplain to naturally absorb and manage high levels of stormwater. Certain invasive species on Pala lands, such as *Arundo donax* and tamarisk easily spread in flood conditions.

Animals that depend on the riparian habitat and may be temporarily or permanently displaced by storms and flooding including endangered species at Pala such as the southwestern willow flycatcher, yellow-billed cuckoo, coastal California gnatcatcher, and the arroyo toad. The yellow-billed cuckoos (*Coccyzus americanus*) historically nested on or near the San Luis Rey River (USFWS, 2019). According to a recent study (HT Harvey and Associates, 2015), habitat at Bubble Up Creek and Pala Creek (south of the San Luis Rey River), was of poor quality and unsuitable for breeding, due in part to the minimal width of the riparian habitat.

Figure 9. Flooding at a Pala home, February 2019



Source: Pala Environmental Department

Severe storms, flooding, and runoff can contaminate water supplies with bacteria, viruses, and other pathogens and toxins, limiting the availability of safe drinking water. For example, the 2017 flood event at Pala exposed drinking water pipelines and caused a substantial rise in influent into the wastewater treatment plant (Pala, 2017).

The changing and intensifying storm and flooding patterns Pala has seen have harmful effects on the natural environment.

The effects of changing precipitation over time and the difficulty in predicting future rainfall are compounded by uncertainty in how much the inherent resiliency of plants and animals adapted for dry, variable climates can accommodate changing conditions (CEC, 2018).

Wildfire

What does this Indicator show?

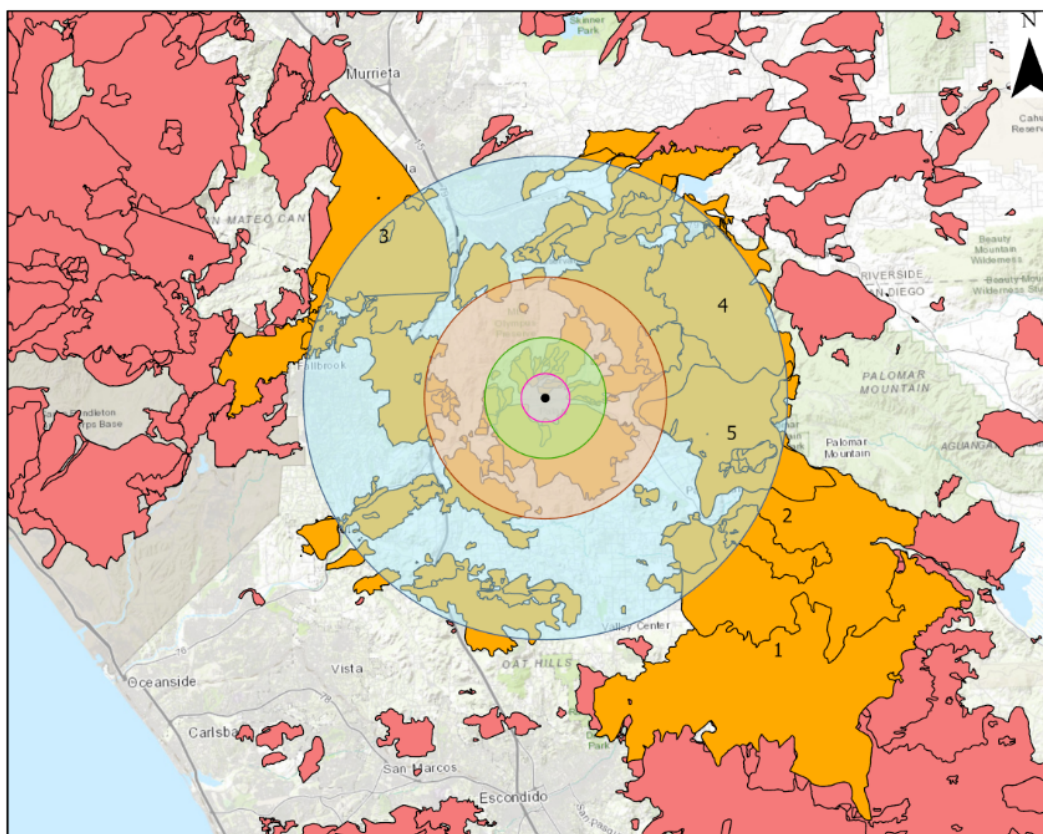
The incidence of large forest fires in the western United States has increased since the early 1980s (Wehner et al., 2018). Fire season in California is starting earlier and



ending later each year (CAL FIRE, 2020a). There were 40 fires from 1920 to 2021 that affected Pala directly. Recent fires have burned significant portions of Pala’s lands (Gaughen, 2020). Three of California’s largest wildfires, occurred in San Diego County (CAL FIRE, 2021): The Cedar Fire in 2003, the Poomcha Complex/Witch Fire in 2007 and the Laguna Fire in 2007. These fires burned 273,246 acres, 240,207 acres, and 175,425 acres respectively (CAL FIRE, 2020b). Figure 10 shows fires in the area of the Pala lands that occurred between 1950 and 2021 (CAL FIRE, 2021). In 2021 two fires directly impacted the Pala Reservation.

Figure 10.

Fires Impacting Pala Band of Mission Indians (1950-2021)



Legend

- Pala Band of Mission Indians
- Fires within 10 miles
- California Fires (post 1950)

Fire Buffer Distance (miles)

- 1
- 2.5
- 5
- 10

0 2.5 5 10 Miles

Basemap: SanGIS, Bureau of Land Management, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Source CAL FIRE, 2021

Why is this indicator important?

Wildfire is considered a high-risk exposure for the Pala Tribe. Nearly a third of Pala’s population lives in a high-risk wildfire area. Historically, large, high intensity fires occurred regularly but infrequently in the region. Climate factors including Southern



California's uniquely intense Santa Ana winds, increasing temperatures, and severe drought conditions are increasing the wildfire risk at Pala (OPR, 2018).

Burned areas that then experience heavy rain will be subject to flooding, landslides and rockfalls. Large rain events after wildfires have caused extensive flooding and mudslides at Pala.

Exposure to smoke-related air pollutants, including particulate matter (PM) from wildfires has been associated with a wide range of human health effects, including cardiovascular consequences, early deaths and low infant birth weight, and acute respiratory illness (CARB, 2019).

At Pala, water security, compounded by drought, is an ongoing concern. Wildfire can further stress water supplies if watersheds or water treatment infrastructure are damaged during a wildfire, or when domestic water supplies are used to combat the fire.

Figure 11. Retardant drop on fire near Pala



Source: Pala Environmental Department

Wildfire can destroy culturally important ecosystems, sacred sites, and points of access to culturally important places to Pala. Numerous cultural sites, functions or traditions are



in danger of wildfire encroachment and damage. This can threaten Pala's traditional practices, sovereignty, and community cohesion, which are considered highly important community assets (Prosper Sustainably, 2018).

Wildfires have caused evacuations and disruptions at Pala. The Poomacha Fire in 2007 resulted in evacuation of 400 tribal members and closure of the Pala Casino, causing temporary but significant impacts to educational and economic opportunities. Fires at Pala have also disrupted telecommunication lines, hampering the Tribe's ability to do business (Pala, 2016).

Wildfire can initially increase the abundance of ticks and increase the risk of Lyme disease (MacDonald, et al. 2018). There have been cases of Lyme disease in the Pala region in recent years.

Wildfire risk can also increase due to pest infestations and disease vectors affecting forest health (e.g., bark beetles, fungus, shothole borer). Invasive forest pests and tree diseases increase wildfire risk by stressing and killing trees, which increases the mass of dead and dying vegetation that can fuel wildfire outbreaks. Pala environmental staff have observed an increase in diseased trees and an overall decline in oak trees as a result of invasive forest pests.

Pala's wildlife depends on healthy, large, and connected habitats to roam, breed, and hunt. Impacts of wildfire include habitat loss, degradation, and fragmentation that result in genetic isolation. Burned areas are subject to increased erosion resulting in the siltation of creeks, streams, and rivers. This can result in channel aggradation (wider, slower channels) and steep slopes destabilized due to the lack of vegetation (Pala, 2019).

Repeated wildfires at intervals too short to allow recovery of natural vegetation facilitate the conversion of natural woody shrublands (e.g., coastal sage scrub) to weedy, flammable annual grasses. For example, the large fire events of 2007 in San Diego resulted in nearly 74,000 acres of overlap with the four-year-old recovering vegetation that burned in the 2003 Cedar Fire. At Pala, the Poomacha fire burned most of the vegetation in the eastern mountainous region, and the area is now dominated by scrub and non-native grasses (Pala, 2016). The US Forest Service documented that shrublands have converted to non-native annual grasslands on a widespread scale across the Cleveland National Forest, which borders the Pala Reservation (OPR, 2018).

Wildfire and its impact on vegetation conversion, habitat connectivity, food, and freshwater supplies can force animal species to migrate from the area. In San Diego County, repeated fires reduce habitat for shrubland threatened species like the California gnatcatcher (CEC, 2018).

Summary

The people of the Pala Band of Mission Indians continue to work to protect and enhance the natural resources and habitat of their lands. Climate change continues to



deeply affect the environment and alter and disrupt the ecosystems within and around Pala. The Pala community is actively working to understand, adapt to, and mitigate the effects of climate change. Their goal is to continue to manage and protect their lands and limit the impact climate change is having on Pala's right to hunt, fish, gather, and continue their cultural practices; activities that are integral to their cultural and psychosocial health, well-being, and livelihood.

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Suggested citation:

Pala Band of Mission Indians (2022). Impacts of Climate Change on the Pala Band of Mission Indians. In: OEHHA 2022 Indicators of Climate Change in California

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