Climate change poses a threat to California's Tribes through direct impacts on the ecosystems in which they live and are connected. The health of a Tribe is tied to the health of the land and environment.
California Tribes are the original biologists, historians, climatologists, and scientists of the land. Tribal knowledge, acquired from the interaction of Tribes with the Earth over time, is a key component in understanding impact of climate change on human lives and their environment.

This is the first time Tribal Reports have been included as part of an *Indicators of Climate Change in California* report. Over 40 California Tribes contributed to documenting the Tribal impacts of climate change by producing eight Tribe-specific reports and co-hosting and participating in three listening sessions (see list of participating Tribes below). These Tribes reflect a diverse range of landscapes, perspectives, cultures, beliefs, and climate change experiences.

In this report, the term "California Tribes" refers to all Tribal Nations in the state, including those that are non-federally recognized and currently landless. Each holds the right to govern the collection, ownership, and application of its own data. This report upholds indigenous data sovereignty by presenting knowledge and data only with the explicit permission of the respective Tribes.

The Tribes see their lands not as the hard boundaries of a government-imposed reservation or rancheria, but as the ancestral lands they have taken care of since time immemorial. They do not see that contemporary maps, drawn by non-indigenous hands, reflect the extent of Tribal lands. Rather than a boundary map of the location of California Tribal lands, a linguistic map is presented in the Figure 1, showing indigenous languages spoken in California.

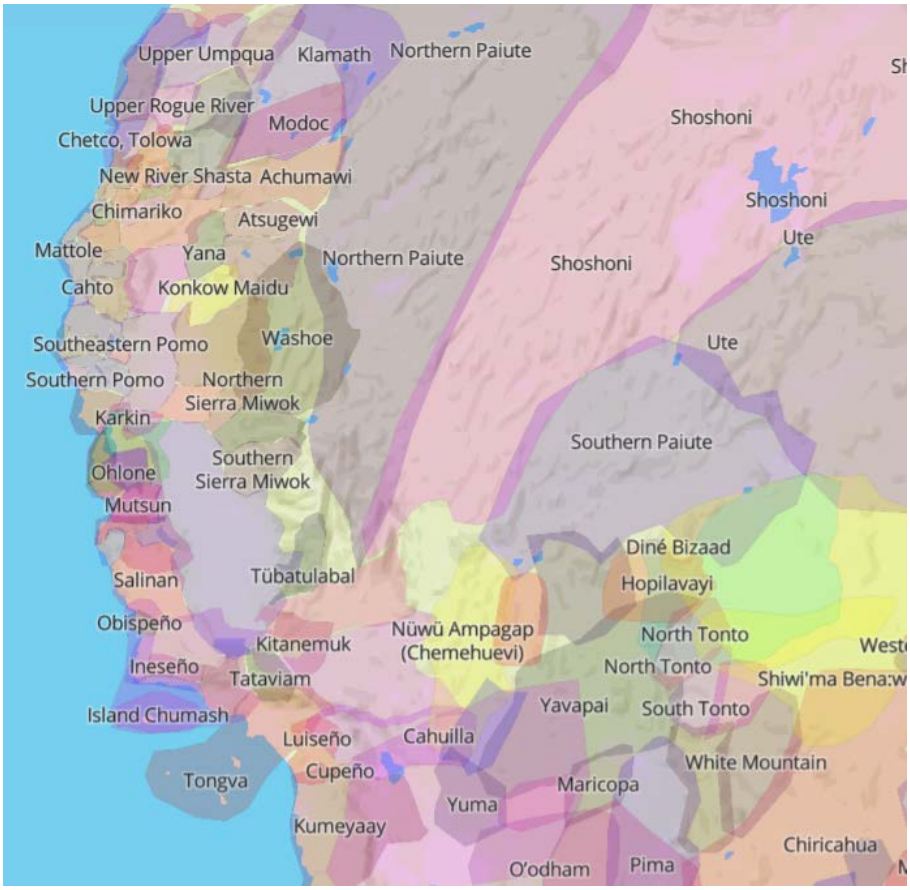

Figure 1. *Hundreds of languages were originally spoken in California before colonization. Many languages are not shown. For example, while this map shows "Island Chumash," every village in Chumash territory had its own language. These were not different dialects, but distinctly different languages. To learn more visit Native Lands or the Native American Heritage Commission Digital Atlas.*

When Tribes speak of nature, they include themselves. Nature and its great variety of plants and animals are on an equal level with people. The Earth provides the food, medicines, and ceremonial materials that are part of the Tribes' daily life. They are embedded within the Tribes' cultural, social, spiritual, economic and political systems. Knowledge of the unique interactions between species and their habitat provides the foundation for Tribal actions to manage the landscape. This is ever more important under the evolving conditions due to climate change.

Warming temperatures, changing precipitation patterns, and intensifying droughts throughout California have significantly impacted the Tribes. These have led to an increased reliance on groundwater, degraded aquatic habitat, stressed vegetation, and less abundant wildlife.

Coastal Tribes have witnessed sea level rise, noting that it has made access to traditional sites along the shoreline difficult, thus hampering the Tribe's ability to pass knowledge down to younger generations. Rising sea levels, along with the loss of kelp forests, have also made parts of the coast more vulnerable to erosion, exposing cultural artifacts. Kelp forests, which provide protective buffer to the coast, are collapsing along parts of the coast due in part to the cascading impacts of warming ocean waters.

Climate change has altered the landscape and has degraded habitat, affecting or displacing the plants and animal species that are important to Tribes.

Reports from the following eight Tribes bear witness to the impacts of climate change on Tribes:

Amah Mutsun Tribal Band
Big Pine Paiute Tribe of the Owens Valley
Big Valley Band of Pomo Indians of the Big Valley Rancheria
Bishop Paiute Tribe
The Karuk Tribe
North Fork Rancheria of Mono Indians of California
Pala Band of Mission Indians
Santa Ynez Band of Chumash Indians

Examples of climate change impacts described in these reports and discussed in listening sessions are highlighted below.

Marine and fresh water habitat

- ***Increasing water toxins:*** Unusually warm ocean temperatures amplify harmful algal blooms (HABs) blooms along the California coast. Marine HABs are especially widespread within Amah Mutsun historic lands, rendering many culturally important resources toxic. In lakes, rivers, and streams, warming temperatures and changing precipitation patterns are associated with increased freshwater HABs, which release harmful cyanotoxins. In Clear Lake, high levels of cyanotoxins are impacting drinking water and food and prevents activities involving contact with lake water. The Karuk Tribe is concerned that tribal members are more likely to be exposed to the toxin as low summer flows in the Salmon and Klamath Rivers create favorable conditions for HABs.

- ***Changes in ocean temperature and ocean acidification:*** have impacted species important to coastal Tribes. They have noted the collapse of kelp forests due to a combination of elevated ocean temperatures and other factors. Populations of abalone, which feed on kelp, have declined. Olivella shells, gathered by the Santa Ynez Tribe and other coastal tribes for use in regalia and as shell money, are becoming scarcer.

- ***Elevated stream and river temperatures and reduced stream flows:*** cause fish mortality, support fish pathogens and diseases, and create more suitable habitat for non-native fishes. The Owens pupfish, a staple food for the Paiute and Shoshone people in the Owens Valley has seen declining numbers along with other native fish species. The Tribes historically caught pupfish by the hundreds. A culturally significant fish for the Pomo Indians, populations of the Clear Lake Hitch have become alarmingly low; in the 1960-70s, hitch were so numerous that they made the water in creeks appear to boil. Rivers and streams where salmon used to run in abundance have reduced numbers or no salmon at all. Salmon hold cultural and spiritual importance to many Tribes. Similarly, steelhead are no longer found in the

Zanja de Cota Creek on Chumash lands, which used to be the site of steelhead fishing derbies.

Chaparral and forests

- ***Fewer culturally important pine nuts and acorns:*** Some Tribes noted that acorns are deteriorating faster with a changing climate. Eastern Sierra Tribes reported a change in the taste of the flour made with local acorns.

- ***Fallen trees in the Sierra Nevada Mountains:*** have reduced the availability of mushrooms, which grow when forest soil is exposed to air. These mushrooms are an important food resource to the North Fork Rancheria of Mono Indians. For the Karuk Tribe, tanoak mushroom (Xáyviish) is both a traditional food source as well as an indication of a balanced ecosystem.

- ***Large scale mortality among pine and oak trees:*** linked to drought, beetle infestations and sudden oak death – has occurred in the Sierra National Forest and its foothills, the Eastern Sierra, Lake, Mendocino and Sonoma Counties, the Klamath Region, and in Southern California along the Palomar Mountain Range.

Figure 2. ***Piñon pine in the Owens Valley killed by drought and beetle infestations***

Photo credit: Carl Smith

- ***A loss of tules in Clear Lake and Owens Valley:*** Tules are used as a food source and as materials for weaving, for traditional ceremonies, for boat-making, and for various household uses.

- ***Elderberry plants are not as fruitful or robust as in the past:*** The Southern Sierra Miwuk Nation uses the elderberry plant for music, fire, food, and medicine. To make clapper sticks for music, the pith needs to be large and the cane sturdy for proper resonance. Without these instruments, the Tribe could lose their ability to pass their music traditions on to future generations.

- ***Climate change has allowed invasive plant species to thrive:*** Examples include water primrose at Clear Lake; pepperweed, cheatgrass, non-native asters and tumbleweed in Owens Valley; and scotch broom, star thistle, Himalayan blackberry, and non-native grasses in Karuk, Pomo, and Paiute lands. These invasive plants are often difficult to eradicate, out-compete native species, and add to the wildfire fuel load.

- ***Dead vegetation:*** Forests made dense by fire exclusion practices, invasive plants, and changing weather conditions have heightened the risk of wildfires. Tribes throughout California are seeing increasing destructive wildfires and their subsequent effects (such as erosion and landslides). They have experienced personal losses, health effects from exposures to wildfire smoke, trauma, degraded watersheds and habitat loss. Cleanup of burned areas has exposed cultural artifacts and destroyed sites important to Tribes.

Wildlife

- Bighorn Sheep, once a staple of Owens Valley Paiute life, can no longer be hunted even for cultural purposes; Jackrabbits and Cottontails are also decreasing due to a lack of vegetation and increased predator populations. The Southwestern willow flycatcher, which has not been seen at Pala since 2013, is assumed to be extirpated due to loss of habitat combined with drought. The Big Valley Band of Pomo Indians has observed fewer flicker and red-wing blackbirds, which provide the feathers used in regalia. Red-legged frogs (Waqaqʾ) that used to thrive on the Santa Ynez reservation, are gone.

- Eastern Sierra Tribes, such as the Tübatulabal and Paiute Tribes, have reported changes in timing of deer migrations and a reduction of deer populations. The Bishop Paiute Tribe reported that in 2017, 120 mule deer migrating late to their winter grounds in Owens Valley ran into persistent snow and ice sheets not normally found in the area at that time of year and slid to their deaths. In Northern California, the Karuk Tribe has observed black-tailed deer migrating later in autumn, which may leave them at greater risk of sudden winter storms and predation.

The health of the environment and the health of a Tribe cannot be separated. As the environment is impacted by climate change, Tribal health suffers. From the Tribal lands in the Owens Valley, which is the largest single source of particulate matter air pollution (PM10) in the United States, to the soaring temperatures in Southern California, and the reduction of native foods throughout California, Tribal physical, cultural, and spiritual health are being impacted. Higher levels of air pollutants, such as elevated ozone concentrations on warmer days, and wildfire smoke from increased uncontrolled fires pose risks to the health of the Tribes. Toxins produced by harmful algal blooms threaten their food and water and impair their ability to use lakes and rivers.

Climate change is deeply affecting the California Tribes as it alters and disrupts ecosystems. Habitable climate is critical to protecting tribal sovereignty, culture, and community cohesion. California Tribes continue to adapt to and protect their communities from the adverse effects of a changing climate. Tribes are managing and protecting their lands to limit the impact climate change is having on their ability to hunt, fish, gather, continue their cultural practices, and maintain activities that are integral to their health, well-being, and livelihood.

Listening session participants

The Office of Environmental Health Hazard Assessment jointly convened listening session with Tribes. The listening sessions had the following objectives:

- Listen to perspectives from Tribal communities on climate change impacts they are experiencing and identify common themes
- Collect Tribal input to help the *Indicators of Climate Change in California* report raise awareness about tribal-specific climate change impacts and increase recognition of the value of tribal knowledge in reporting climate change impacts.

The following Tribes participated in listening sessions.

Antelope Valley Indian Community (Coleville Paiute)
Barona Band of Mission Indians
Big Pine Paiute Tribe of the Owens Valley
Big Valley Band of Pomo Indians of the Big Valley Rancheria*
Bishop Paiute Tribe*
Cabazon Band of Mission Indians
Campo Kumeyaay Nation
Coastal Band of the Chumash Nation
Coyote Valley Band of Pomo Indians
Elem Indian Colony
Federated Indians of the Graton Rancheria
Fernandeño Tataviam Band of Mission Indians
Fort Independence Indian Community of Paiute Indians of the Fort Independence Reservation
Iipay Nation of Santa Ysabel
Jamul Indian Village
Kashia Band of Pomo Indians of the Stewarts Point Rancheria
Los Coyotes Band of Cahuilla and Cupeño Indians of the Los Coyotes Reservation
Manzanita Band of the Kumeyaay Nation
Middletown Rancheria of Pomo Indians of California*
Mono Lake Kutzadika'a
North Fork Rancheria of Mono Indians of California
Paiute-Shoshone Indians of the Lone Pine Community
Pala Band of Mission Indians*
Ramona Band of Cahuilla
Rincon Band of Luiseño Indians
Robinson Rancheria Pomo Indians of California
Round Valley Indian Tribes
San Manuel Band of Mission Indians
Santa Ynez Band of Chumash Indians*
Scotts Valley Band of Pomo Indians of California
Sherwood Valley Band of Pomo Indians
Southern Sierra Miwuk Nation
Tejon Indian Tribe
Tübatulabal Tribe
Twenty-Nine Palms Band of Mission Indians
Washoe Tribe of California and Nevada

* Co-hosted a listening session

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Native Nations Institute (2022). University of Arizona. Retrieved May 11, 2022.

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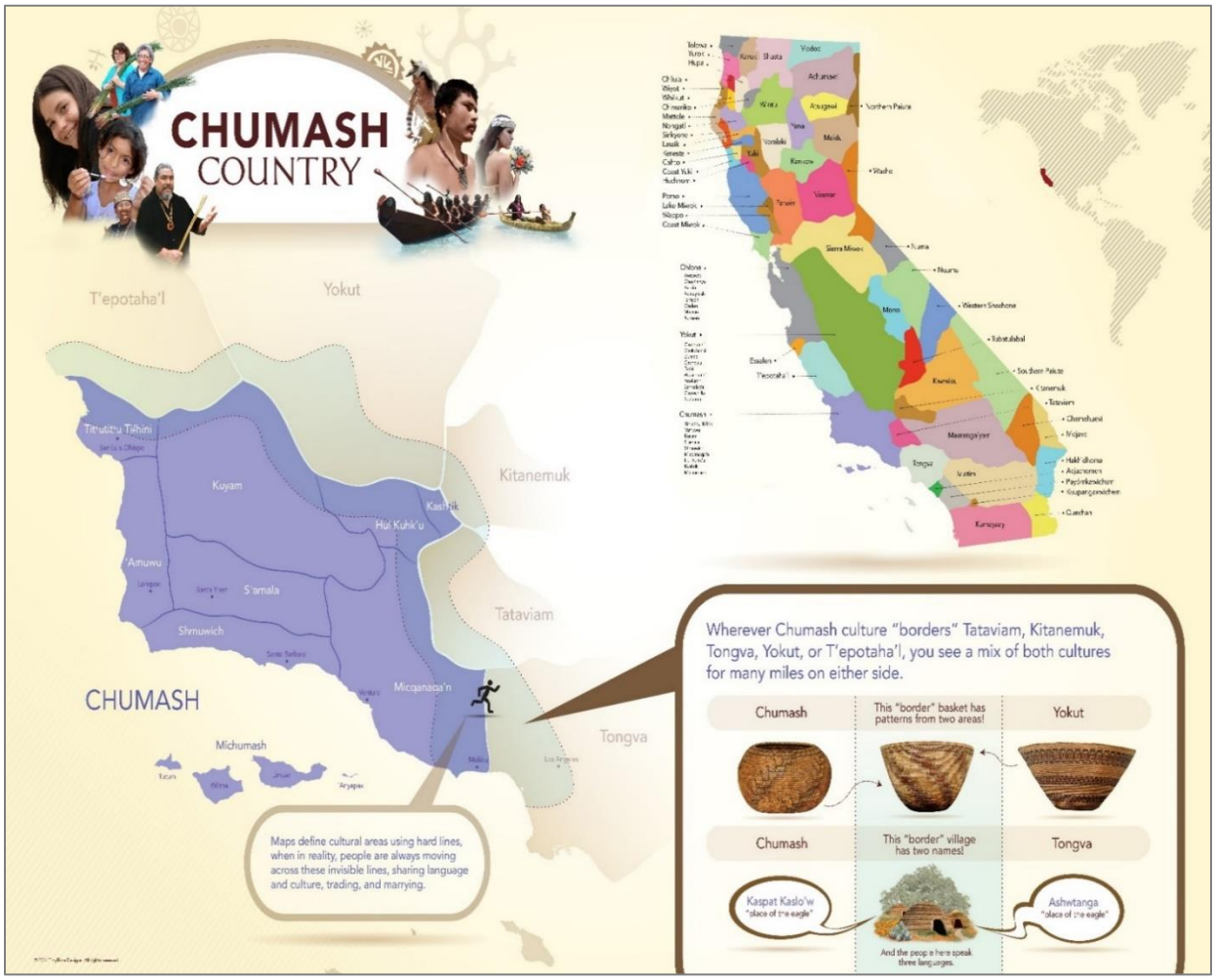
Appendix

While much of traditional tribal territory is now divided and regarded by colonizers as distinct districts, to Tribes, the land is physically and conceptually inseparable in terms of ecology as well as culture, spirituality, and history. Territory maps are often not agreed on, while language maps depict more fluid borders that are respected by Tribes and illustrate where Tribes historically traveled, as illustrated below (Wishtoyo, 2021).

Chumash Country

The maps depict how the hard lines of traditional maps fail to describe the flexible borders that were respected by the Chumash and neighboring Tribes. The map on the left of the figure shows how many languages make up the territories labeled simply Chumash and Island Chumash on other maps, such as in Figure 1.



Map design and content courtesy of Timara Lotah Link, Shmuwich Chumash. Please do not reproduce without express permission.

IMPACTS OF CLIMATE CHANGE ON THE AMAH MUTSUN TRIBAL BAND

Drought, wildfire, and sea level rise, as well as loss of native plants and animals, are threatening the physical, cultural, and spiritual health of the Tribe, its habitats, and ecosystems.

Background

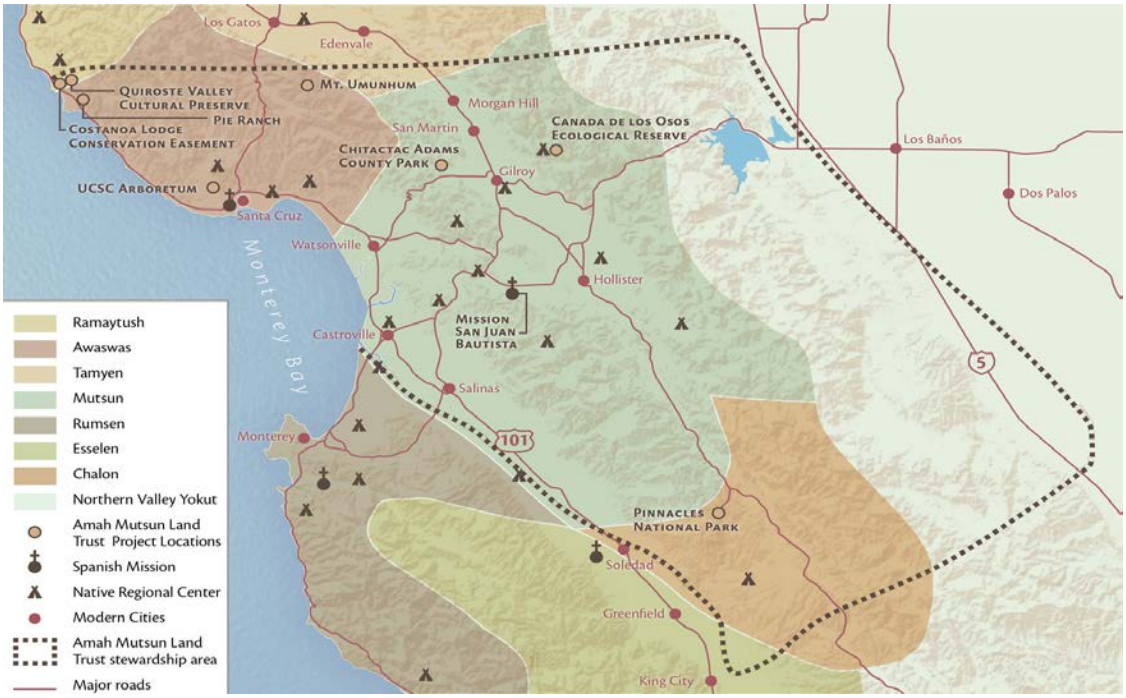
The Amah Mutsun Tribal Band (AMTB) is a continuous and historic Tribe composed of the descendants of the Indigenous peoples whose villages and territories were taken over by Missions San Juan Bautista (Mutsun) and Santa Cruz (Awaswas) during the late 18th, 19th, and early 20th centuries (AMTB, 2021). The Indigenous people were baptized as legal wards of the Franciscans and forced into labor building the missions, farms, and ranches of the colonizers (Madley, 2017). The AMTB represents the surviving descendant families of these groups. The AMTB is recognized by the State of California as a Tribal Government but lacks federal recognition. Consequently, the AMTB holds no tribal lands, nor receives financial assistance from either the Federal or State governments.

Prior to European contact, the Amah Mutsun community was made up of approximately 20 to 30 contiguous villages stretched across the Pajaro River Basin and surrounding region. These villages were united by shared cultural practices and traditions. Most significantly, Amah villages were distinct from tribes outside their valley because of their unique language. While the Costanoan/Ohlone language family was made up of eight separate languages, including Mutsun, each language was different. Mutsun was one of the first American Indian languages extensively studied in North America (AMTB, 2021).

The Amah Mutsun Tribe was drawn to the abundant resources in the triangle of land formed by the Monterey Bay and the Pajaro and San Benito Rivers by the abundant resources. These lands later attracted other settlers who drastically changed the lives of the Amah Mutsun. While the traditional territory of the Amah Mutsun encompasses all or portions of the current Counties of San Benito, Monterey, Santa Cruz, Santa Clara, and San Mateo, the high cost of living in the San Francisco and Monterey Bay areas, combined with a lack of treaty or tribal trust land, has resulted in over 80 percent of Tribal members living outside of their ancestral territory. Many members live in Fresno, Madera, Hanford, Las Vegas, and Lake County, and other areas outside of California (AMTB, 2021).

Through three periods of brutal European colonization (Spanish, Mexican Republic, and United States) (Madley, 2017), the Tribe's traditional ecological knowledge and physical connection to their ancestral lands were disrupted.

Figure 1. Amah Mutsun (Awaswas and Mutsun) historic lands and neighboring Tribes



Source: AMTB, 2021

The AMTB continue to maintain a sacred obligation to continue in the footsteps of their ancestors, stewarding the lands and waters of their traditional homeland. In 2013, the AMTB created the Amah Mutsun Land Trust (AMLT) to help achieve this vision.

AMLT is a Native-led, non-profit organization. Through the AMLT, the AMTB is restoring Indigenous stewardship to the Mutsun and Awaswas-speaking peoples' ancestral lands and waters, which stretch from Año Nuevo Point to the Monterey Bay, and inland to include the Pajaro and San Benito watersheds (see Figure 1 above). AMLT focuses on education, stewardship, research, and cultural revitalization, in addition to land acquisition. AMLT brings an Indigenous perspective to resource management that models constructive relationships between people and place, where active engagement with the land contributes to more diverse, resilient, and meaningful landscapes. AMLT engages a Native Stewardship Corps (NSC), made up of AMTB members plus an array of state, county, University and Tribal partners, to bring Indigenous stewardship to lands that are already in conservation. Because the Tribe is currently unrecognized by the federal government, the NSC functions much as an environmental department would.

Cultural and spiritual health

Historically, the Amah Mutsun ensured a sustained yield of plant and animal foods by careful management of the lands. Controlled burning of extensive areas of land was carried out each fall to promote the growth of seed-bearing annuals.

When the Tribe speaks of “cultural resources,” they look all around at the mountains, the meadows, the waterways and wetlands, the air, and scenic vistas – as well as those buried beneath them, and those who inhabit them. Those are the Amah Mutsun cultural resources – all holds value to the Amah Mutsun Tribe (AMTB, 2021).

When non-indigenous people think of California Indian culture and cultural resources, they often look at tangible objects such as basketry, housing, clothing, food, and dance regalia such as feathers, whistles, skins, clapper sticks, etc. These are all important manifestations of Amah Mutsun culture, but to understand the culture of the Amah Mutsun Tribe, one must also understand two important axioms.

Axiom I: There is no natural hierarchy in the Amah Mutsun culture that categorizes plants, animals, minerals, or humans as being above any of the others. It is the Tribe’s belief that the Creator made all beings – therefore we are all equal. Men, women, and children were all created equally and are respected equally. The Amah Mutsun are a matriarchal society. Women can bring life – possessing the strength to bear the burden of two souls within them. Men possess physical strength to provide and protect – creating balance in the family and community. The Amah Mutsun believe human beings were gifted with a higher level of intelligence and reasoning for the express purpose of protecting and caring for all other life.

Axiom II: The Creator, using infinite wisdom, placed the Amah Mutsun in the lands of “*Popeloutchum*”, the homeland, as the protectors and stewards of the lands, waters, plants, and other creatures of this place. The Creator blessed the Amah Mutsun with these magnificent lands with a mild climate, bountiful foods from the land and sea, and a landscape that is considered among the most beautiful in the world.

As Amah Mutsun ancestors worked to fulfill their obligation to protect the plants and animals of the land, they also studied their non-human relatives for thousands of years. The Bear Clans, Bird Clans, etc. were given the responsibility to learn all they could about those creatures. The knowledge they collected was shared with their Tribe and their descendants.

The Amah Mutsun, never felt that they owned the land – rather that they belong *to it.* When the Amah Mutsun talk about “our land” – or “*makke pire*”, they are referring to the land to which *they belong*…rather than the land which they “own.”

Because the Amah Mutsun have a responsibility to care for our finned and winged brothers, they must protect and conserve the rivers (water quality) and the sky (air quality). The Tribe must help ensure that their populations can move and interact (habitat corridors) to maintain healthy and resilient populations (AMTB, 2021).

Impacts

The impacts and future threats resulting from climate change in Amah Mutsun Territory are drastic and rapidly compounding, both on land and in the sea. On land, the

increasing destructive wildfires are followed by higher rates of erosion and landslides. Culturally important plant and bird species are being impacted by drought, wildfire, and increasingly variable rainfall. Tribal members living in the inland areas report drier, hotter summers, less annual rainfall, low water tables, lakes and creeks drying up, poor air quality, and more intense, more frequent wildfires. These changes, along with development and urban sprawl, impact housing and intensify destructive land-use practices. In the sea, the coast has become more vulnerable to coastal erosion resulting from high energy storms and swell events with the collapse of kelp forests that had acted as buffers. This erosion, along with sea level rise, are threatening cultural sites along the shoreline. Loss of ocean biodiversity, drastic reductions of certain species and overpopulation of others, and marine harmful algal blooms (HABS) also threaten Tribal resources.

Land

The most recent and high-profile impacts of climate change are evidenced by the August 2020 CZU Complex fires, started by lightning in an area that historically had a very low number of lightning strikes. The CZU Complex burned for over a month, torching 86,509 acres in Santa Cruz and Santa Clara counties, destroying 1,490 structures, and damaging 140 (CALFIRE, 2020). These fires led to the evacuation and displacement of the NSC, loss of a month's work, loss of necessary field equipment, and an overall unstable, uncertain, disrupted work and life flow. Heavy rain four months after the fires led to another evacuation because of potential landslides, putting the NSC in yet another high-risk situation.

Droughts brought about by climate change are making oak woodlands more susceptible to death from pathogens and pests. Wildfire in areas with these dead and dying trees will tend to form crown fires that spread from treetop to treetop. Once removed by wildfire the woodlands may be replaced by shrubland and other vegetation types that are unable to support native plant, animal, and bird species.

Catastrophic fires impact watersheds, water and air quality, rangelands, wildlife, culturally significant sites, infrastructure, croplands, and of course, the Amah Mutsun's way of life. These fires are intense due in part to unmanaged fuel loads. The CZU Complex is also a prime example of how the compounding impacts of fire suppression, poor land management, and climate change can result in widespread, destructive wildfires. The Tribe believes that fire can be managed more effectively if Indigenous stewardship and cultural knowledge around Indigenous peoples' use of fire are more widely accepted and implemented by land managers.

Recent eco-archaeological research in the area provides evidence that Amah Mutsun people had regularly practiced cultural burning as a landscape management strategy prior to European colonization. Informed by traditional ecological knowledge, cultural burning by Indigenous people protects ecological and cultural resources and builds wildfire resilience. Cultural burns are properly timed, low-intensity fires that move slowly

through a segmented management unit of land and promote the abundance and health of many culturally significant native plants.

Figure 2. Amah Mutsun controlled burn

Source: AMTB, 2021

The Amah Mutsun have great respect for fire as a land stewardship tool. As Chairman Valentin Lopez explains:

> "*We see fire as a gift from Creator. Like all gifts, it is important to respect and recognize it in that way. Fire is sacred and used as a prayer. A spiritual fire is placed in the middle during ceremonial dances and carries our prayers up to Creator. Fire is used as a light, and as a land management tool. Our ancestors divided the land into management units, they then burned segments when needed, on a rotating cycle, until the cycle was complete. This allowed for consumption and reduction of fuel loads and control of encroaching brush, aiding the ecosystem. Coastal prairie grasslands have diminished due to outlawing the practice of Indigenous burns. Fire has a critical role in maintaining the coastal grassland prairie. The coastal prairie*

grassland was one of the most viable landscapes and rich in biodiversity in North America before Europeans arrived."

"Cultural burns help control pests, reduce buildup of heavy fuels, and aid native plants that require fire to germinate. We have a responsibility of taking care of plants, birds, and feeding the animals by taking care of native seeds. The first year of the burn cycle aids in seed and seed bed preparation. The second year after the burn, plants strengthen reproduction, and shoots are soft and nutritional for grazing wildlife. The third year, there is increased fruit productivity. The fourth year yields strong plant fibers which are utilized for crafts and housing materials. A special ceremony is held when cultural burning in oak woodlands. Smoke helps purify the trees. Smoke chokes out pests in trees, and therefore aids in the production of acorns. Insects are choked out and fall down, and then are consumed in fire. Therefore, fire and smoke aid with insect infestation in trees and killing of pests such as ticks in grasses."

Wildland fire knows no boundary and taking care of Mother Earth requires a coordinated effort, and as Honorable Chairman Valentin Lopez says, *"Indigenous stewardship must lead the way."* Indigenous stewardship practices like cultural burning are gaining traction among land managers as effective methods of building resilience in natural systems.

To restore ecological health and resilience to the Amah Mutsun by bringing back small-scale fire as a tool to mitigate the impacts and threats of destructive wildfires, the AMLT works with:

- California State Parks and University of California (UC) campuses at Berkeley and Santa Cruz to understand the historic extent of fire as a Native landscape management tool.
- California State Parks and CALFIRE to remove thick stands of Douglas fir to create fuel breaks and restore grasslands.
- California State Parks and UC researchers in Quiroste Valley, an area east of Año Nuevo State Park to research and re-introduce traditional resource and environmental management, including cultural burning, as practiced in the valley before the arrival of Europeans. The uplands above the meadow and riparian valley contain dense Douglas fir, and coyote brush stands with little to no understory. These stands have encroached upon the open coastal prairie grassland. Due to the dense canopy cover, little sunlight reaches the forest floor, allowing little to no grasses and forbs. This reduces biodiversity and threatens the coastal prairie, which was once much more widespread.
- Inter-Tribal Fire Network to better relationships with federal and state land management agencies and with other tribes throughout California.
- A grant from the California State Coastal Conservancy, which has provided funding (cap-and-trade funds from California Climate Investments) to aid in the

development of a Cultural Burns program, where the Tribe can strive to best steward ancestral lands.

- A cooperative Habitat Restoration Project with Pinnacles National Park using an integrated approach to habitat restoration and research by incorporating traditional Native American land management practices with contemporary techniques to restore and protect the natural and cultural processes.
- The Karuk and Yurok Tribes, which host Prescribed Fire Training Exchanges (TREXs). These trainings emphasize the stewardship of cultural resources and build key working relationships and coordination with many land management organizations. Tribal members are currently becoming National Wildfire Coordinating Group Firefighters, Type 2 certified, and are gaining experience with prescribed fire.

Bird species important to the Tribe have also been impacted by climate change. The condor is a culturally important species to the Amah Mutsun and the Tribe has worked with Pinnacles National Park reintroducing the birds and providing an understanding of the cultural meanings of the California condor (AMTB, 2021). These newly released birds were again threatened when the CZU Complex burned in nesting areas with fledgling birds, unready to fly to escape (NPR, 2020).

Along with exacerbating wildfire risks, climate change has also impacted the availability of certain native plant species of ethnobotanical importance to the tribe. These are species traditionally used for building, basketry, and food. Members of the NSC have reported that many culturally important coastal prairie and woodland plants are becoming rarer and more difficult to restore, while invasive plants like Jubata grass, poison hemlock, and thistles are incredibly difficult to eradicate in grasslands.

Figure 3. Amah Mutsun Tribal members and Land Trust propagate plants

Source: AMTB, 2021

Part of AMLT's land restoration work includes:

- Working with UC Santa Cruz arboretum to propagate ethnobotanically important plants.
- A coastal grasslands propagation project at Quiroste Valley. This California Proposition 68 funded project intends to directly plant 30,000 native plants at Quiroste Valley.
- An additional 90,000 native plants at a neighboring location, which will provide additional seed to be sown directly into the Valley in subsequent seasons. Despite ongoing impacts of COVID-19 and the August 2020 CZU fire complex in the Santa Cruz Mountains impacting water supplies, the program has remained on track to meet the ambitious goal of returning culturally important grassland plants.
- Tending a permanent source of grassland seed for gathering and restoration. This is even becoming more important since AMLT can propagate and plant drought-tolerant native grasses, like Purple Needlegrass, the state grass of California.

Sea

The Amah Mutsun have lived and interacted closely with the coast since time immemorial. Their ancestors stewarded the sea through resource management practices that maintained abundant, healthy coastal waters. The rich and biodiverse kelp forests provide habitat for fish, marine mammals, and invertebrates. The sandy and rocky shorelines are filled with a myriad of seaweeds and animals. This depth of knowledge lives with the Amah Mutsun Tribal Band elders. It is further documented in ethnographic records and evidenced in archaeological sites along the coast.

Today, the Amah Mutsun witness a wide range of impacts on local coastal waters. Sea level rise is eroding ancient cultural sites from the shoreline. The loss of kelp forests due to the rapid spread of purple sea urchins because of the mass wasting of sea stars, their main predator, is leading to significant losses in biodiversity. Ocean temperatures affect the availability of food for sea lion pups and pregnant sea lion mothers. Warmer waters can reduce the abundance of phytoplankton and other organisms that make up the base of the marine food chain along the California coast. Changes to the availability of these organisms affect higher levels of the food chain, including sea lions (OEHHA, 2018). Unusually warm ocean temperatures can also amplify harmful algal blooms that periodically occur along the California coast. Certain algae species produce toxins such as domoic acid that enter the marine food web and ultimately harm sea lions (OEHHA, 2018). Harmful algal blooms are especially abundant and widespread within Amah Mutsun territory and can render many culturally important resources toxic and inedible. Rising ocean temperatures and increased carbon levels make it difficult for many native species to survive, especially considering the competition of encroaching invasive species that crowd them out. By monitoring these resources throughout the year, the Tribe can better understand the issues affecting them and contribute to protecting and managing them.

Figure 4. Amah Mutsun youth and UC Berkeley researchers getting ready for a day at the beach.

Photo courtesy of Rob Brodman

At the direction of Tribal leadership, the Amah Mutsun are now looking to build the capacity of AMTB members as ocean stewards by developing and implementing a new AMLT marine stewardship program. Work includes:

- Participating in the Tribal Marine Stewards Network (TMSN) pilot project, along with four other Tribes/Tribal organizations, who received funding from the Ocean Protection Council in 2020.
- Developing a coastal monitoring program that will return traditional resource stewardship to the coast within Mutsun and Awaswas territories. This program builds upon previous work that combined archaeological and ethnographic information to restore and revitalize resource stewardship on the land, such as fire to manage coastal grasslands.
- Partnership with the California Indian Environmental Alliance, Tolowa Dee-ni' Nation, Resighini Rancheria, Kashia Band of Pomo Indians, and Ecotrust to form a Tribal Marine Stewards Network. The Tribal Marine Stewards Network pilot project received generous funding from the Ocean Protection Council in 2021. The Amah Mutsun Tribal Band's participation is further supported by a grant made through the Sustaining California's Ocean Program of the Resources Legacy Fund.

- Monitoring other significant natural and cultural resources, especially kelp forests, rocky intertidal zones, and seagrass beds, which provide habitat for a diverse range of species and are essential for maintaining productive marine ecosystems.

Each of these projects will build the capacity of AMLT Native Stewards as stewards of the marine environment by creating opportunities for Tribal members to learn and practice new skills. These projects will also contribute new data that will be shared with the State and aid in the management of California's Marine Protected Areas. The community outreach project will be focused on revitalizing and building upon the AMTB tribal communities' traditional ecological knowledge about coastal and marine resources and how to steward them.

Other impacts

The creeks, streams, and rivers within AMTB historic lands have also been impacted by climate change in a myriad of ways. Rising temperatures and drought have decreased water flows and led to warmer waters in culturally important fish habitat and unfavorable spawning conditions.

Salmon populations are impacted by nutrient availability, drought, temperature, and freshwater/saltwater interfaces, all of which are affected by climate change. To gain more insight into managing habitat conditions to favor salmon populations, AMLT collaborates with:

- Researchers at Michigan State University to study ancient and modern salmon and steelhead genetics within their traditional territories.
- Researchers at UCLA to develop an environmental DNA monitoring program for species of ecological and cultural importance, many of which are influenced by climate change. As part of this research AMLT is actively working on a dam removal project in their territory geared towards salmon restoration.

Summary

Climate change is causing a loss of native plants and animals, causing droughts, wildfires, landslides, sea level rise, and increasing marine harmful algal blooms. These impacts are threatening the physical, cultural, and spiritual health of the Amah Mutsun Tribe.

Neither the lack of a permanent land base, nor the lack of federal recognition has prevented the Amah Mutsun Tribal Band from fulfilling their continuing obligation to protect the plants and animals on their Tribal homelands. The AMTB are reaffirming their role as environmental stewards of Mutsun and Awaswas territories by using innovative research, partnerships, and Tribal community education to relearn traditional ecological knowledge and apply it to the most pressing issues in natural resource management and conservation. AMLT continues to successfully apply this approach to terrestrial ecosystems, using archaeology and modern ecological science to affirm the

utility of ancient traditional resource management practices to restore balance and resilience to the diverse ecosystems in AMTB territory.

The Tribe relies on historical ecological data preserved in coastal archaeological sites. These sites contain information regarding past stewardship practices and traditional ecological knowledge of coastal resources. The archaeological record is a non-renewable resource with specific windows of opportunity for the Tribe to engage. Unfortunately, due to climate change-related sea-level rise, these windows are rapidly closing as artifacts are exposed and destroyed, as they are washed out to sea or collected by treasure hunters for sale. Many of these sites are being impacted by rising seas and high energy storms, both directly linked to climate change. Without adequate monitoring and protection of these sites, this vital historical dataset for the Amah Mutsun Tribal Band could be lost forever, impacting the conservation science. Indigenous knowledge and evidence from the archaeological record hold information regarding human relationships with marine ecosystems over thousands of years.

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IMPACTS OF CLIMATE CHANGE ON THE BIG PINE PAIUTE TRIBE OF THE OWENS VALLEY

Depleted groundwater, drought, air quality and decreased traditional foods are threatening the physical, cultural, and spiritual health of the Tribe, its habitats and ecosystems, and its built environment.

This document is written by L'eaux Stewart, a member of the Big Pine Tribe, and is based on her observations of climate change in the Owens Valley.

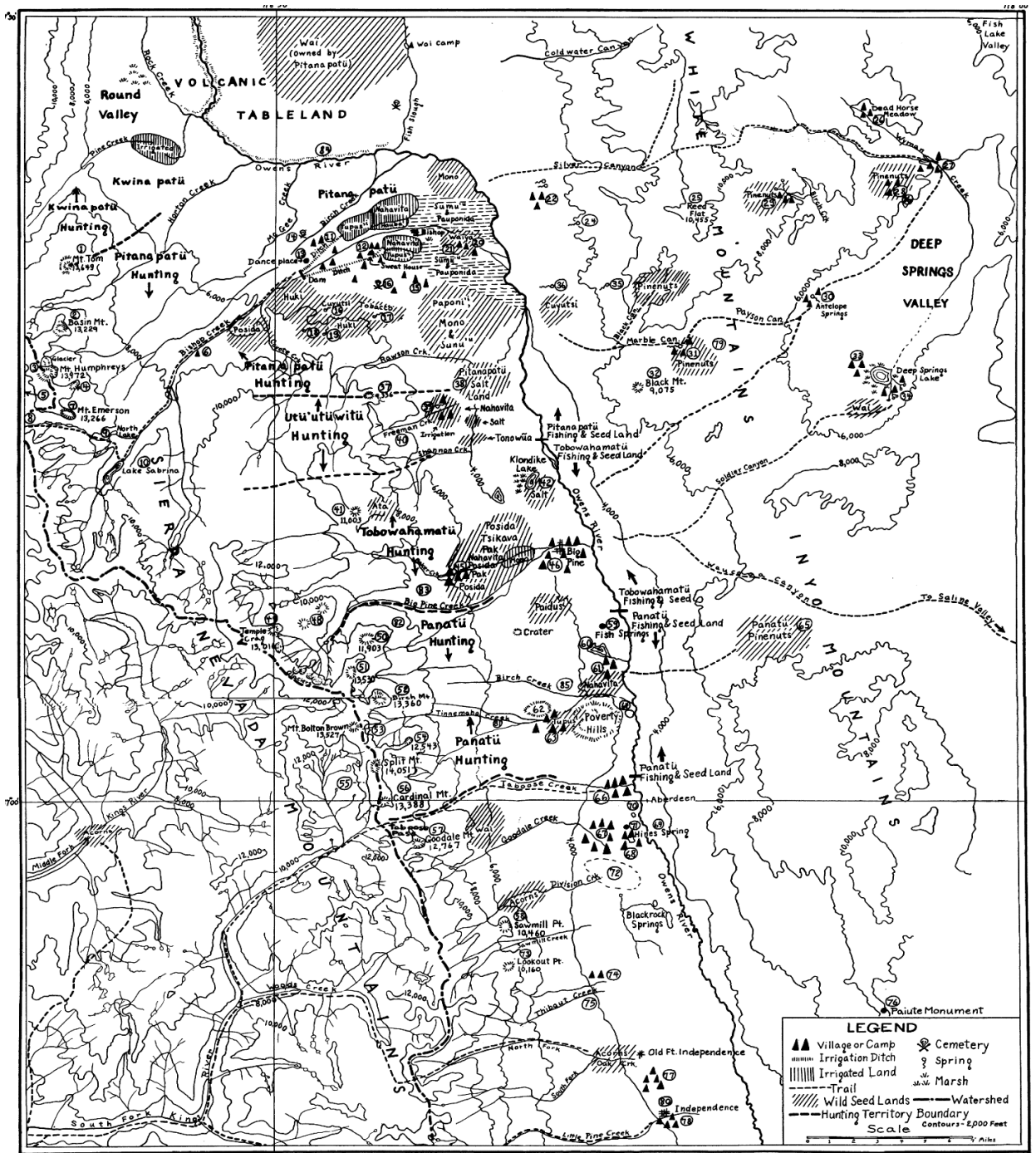
Background:

The Big Pine Paiute Peoples are comprised of three different groups from the Big Pine region: Tovowahazi, the people of Tovowahamatü (the land now currently containing the Big Pine Paiute Reservation); Panapitahahnwitü, the people of Panapita (the land on the west side of Big Pine currently known as The Indian Camp); and Tunigahahnwitü, the people of Tunigawitü (the land to the south of Big Pine known as Fish Springs). The overlapping areas inhabited by these groups and other Paiute neighbors are shown in Figure 1. The Big Pine Paiute People referred to themselves as Nümü, "The People", as did other tribes in the area, so for this document, we will refer to them as the Big Pine Nümü to differentiate them from other Paiute People in the community.

The boundaries of the traditional lands used by the Big Pine Nümü begin at Keogh's Hot Springs (seven miles north of Big Pine) and extend south to Fish Springs (two miles south of Big Pine). The two mountain ranges, the Whites and the Sierras, formed the east and west boundaries respectively. The entire area was considered territory of the Big Pine Nümü and was regarded as important to them for purposes of food and material collection, spiritual and ceremonial practices, and living space. Certain families and groups had unique sites that were important to them and those locations are passed on through lineal dependency via oral storytelling.

The traditional lands of the Big Pine Nümü have since been developed for wildland grazing, for grass grazing, for residential properties, for commercial properties, and for pumping by the Los Angeles Department of Water and Power (LADWP). The majority landowner is LADWP. Figure 2 shows the current lands of the Big Pine Nümü and the surrounding area.

Figure 1 Hand drawn map showing Paiute areas and boundaries



Source: Steward, 1933

Figure 2. Map Showing the Owens Valley and Big Pine (below the word "Owens")

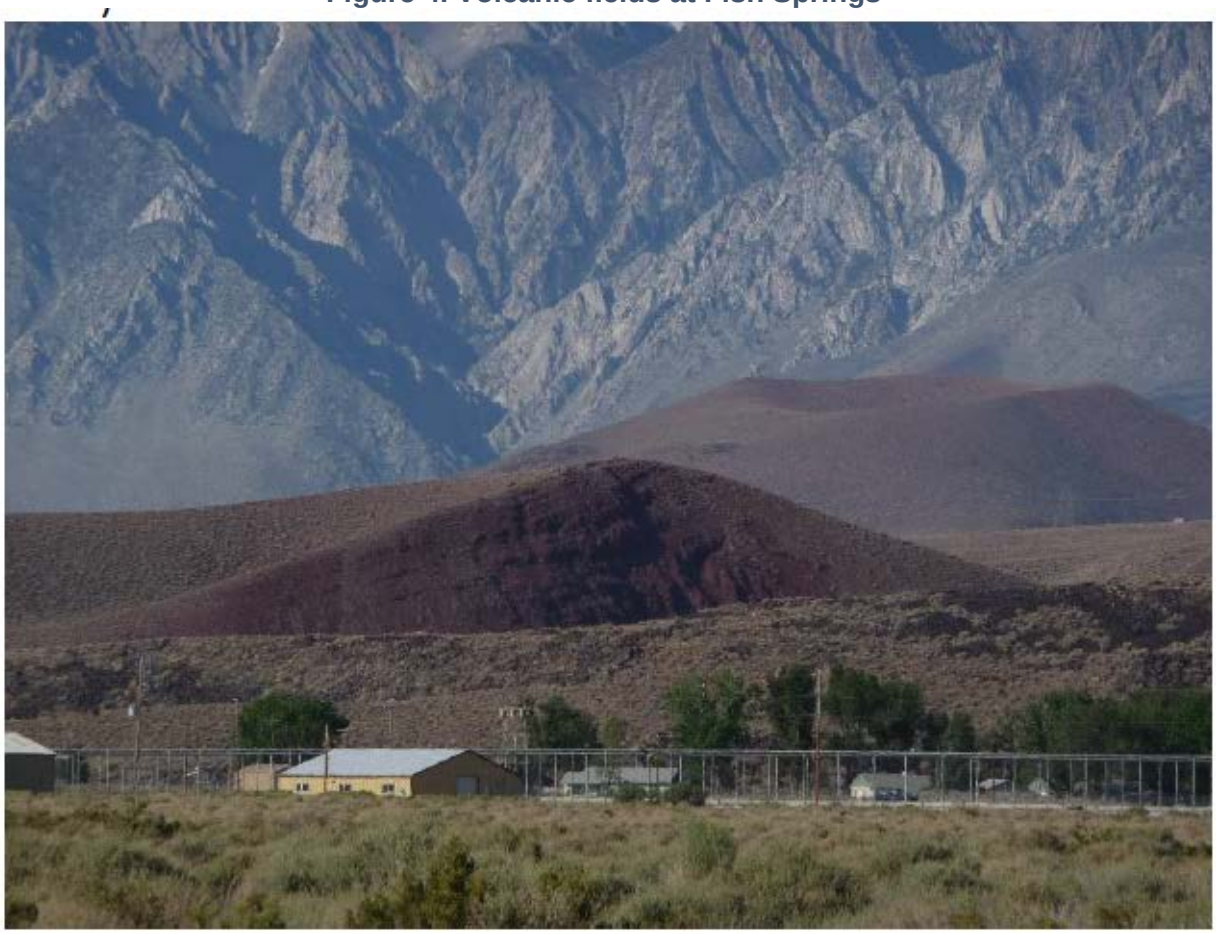
When the land that is now known as the Big Pine Reservation was originally set aside for Native Americans in the 1930s, it was originally designated as a Rancheria, which designated the land to be used as small homesteads for the people who were admitted to live upon it. In the 1970s, the Rancheria was converted into a reservation, which permitted more home building upon the land and agricultural practices became reduced.

Figure 3. The Eastern Sierras route to the Palisades, part of the Big Pine traditional territory.

Source: L'eaux Stewart

In the Big Pine (Tunigawitü or Fish Springs Band) *Creation Story of the World*, Coyote and Wolf created the Owens Valley region and by proxy the surrounding lands that other tribes live on; it is originally described as a great flood that covered the world, higher than the mountain tops and by having Mud Hen retrieve soil from the bottom of the flood, Coyote was able to rebuild mountains and cover up the water. In the *Creation of the Big Pine Peoples*, actual landmarks within the Big Pine Region are mentioned: a sub-alpine lake above Big Pine in the Eastern Sierras was the location of The Most Beautiful Woman's Mother's house; a fresh spring about a mile north of Big Pine at the base of the Eastern Sierras was The Most Beautiful Woman's home; and there are big boulders on the north end of Big Pine where Coyote hunted game for The Most Beautiful Woman.

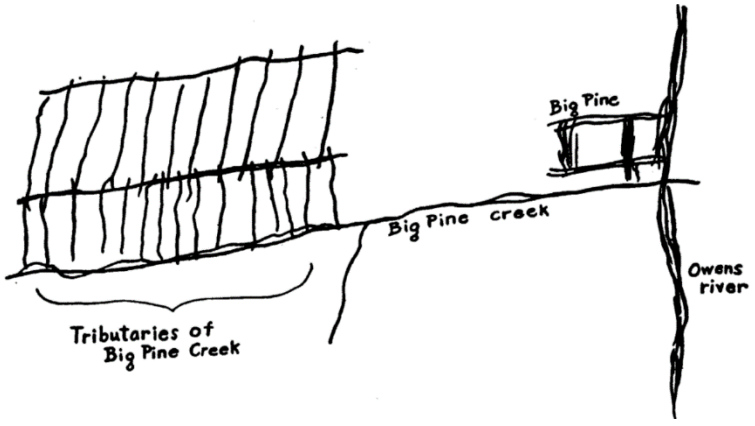
Figure 4. Volcanic fields at Fish Springs



Source: L'eaux Stewart

Hunting was performed with bows and arrows, snares, rabbit drives, sheep drives, deer drives, atlatls and points, and clubs. (Drives are a hunting activity.) Rabbits, chuckwallas, birds, deer, elk, big horn sheep, and pack rats were hunted for meat. Fishing was performed with special baskets and woven traps to catch fish that lived in creeks and streams. Pole fishing, spears, and nets were also used to catch fish. In addition, fish were collected from the streams and rivers of the area by diverting water out of the body of water into shallow ditches so that the fish might be stranded on the ground to be picked up. As shown in Figure 5, the Big Pine Paiute Nümü would create a

Figure 5. Drawing of Paiute irrigation



Source: Drawing by Big Pine Paiute member Jack Stewart in Lawton, 1976

drain off the side of the small creek or stream with fish; the drain would lead down rows scraped out of the ground by sticks. The water would flow down the rows and the fish would be left behind. These ditches would also irrigate the surrounding areas, bringing water to wild seeds and plants that would nourish the people. There were also stories about golden trout in lakes at the top of the mountains that were fished; settlers believed these stories to be myths until the forties when aerial photography showed alpine lakes that later were found to have the golden trout.

The food of the Big Pine Nümü was bland for the most part, as only limited salts and sugars were available, but they were high in protein and nutrients. Rabbits were the most constant source of protein; both Jackrabbits and Cottontails were eaten. Rabbit meat would be added to acorn mush to create a protein and vitamin-rich meal that was very filling. Due to diseases, any rabbit that had been hunted would be checked fastidiously for signs of lumps on the body and discarded if found with any irregularities. Deer were hunted and often divided up amongst two or three family groups. Big horn sheep were a prized catch and hunted in drives in the mountains. Smaller game such as ground squirrels, porcupines, and wildcats were caught in snares. Birds were often hunted; quail, doves, and waterfowl were shot with arrows or snared. Swans and birds of prey were not eaten. There were taboos on eating bear meat as a skinned bear's body resembles a human's body.

Chia seeds were also a regular staple in the diet; they were often ground and kept in small buckskin pouches, where the ground chia could be snacked on while walking. Other seeds from plants in the valley were eaten frequently and provided both fiber and folic acids.

The Big Pine Nümü ate cicadas as they emerged from the ground and beetle larvae; these insects would have their heads pinched off and would be toasted in a basket and salted. Acorns and pine nuts were vital to year-round survival. Both were harvested in the fall in large quantities by entire communities. The acorns were buried next to the riverbed so that the water could leach the tannins out of the nuts and pine nuts were cooked in baskets. The buried acorns were removed from the ground up to a year later to be shelled and ground into a fine flour. Both the pine nuts and acorns were made into mushes which were seasoned with chunks of meat and fat, or bitter salt. Sweetened acorn mush was created by adding a large amount of harvested sugar to a bowl of acorn mush, which was then placed outside in the snow, where it would freeze. The mix was then scraped to create a pseudo-ice cream style treat.

Cattail and tule shoots were eaten, especially when they were young and tender. Clovers, cresses, and small greens were harvested and eaten fresh. Berries that grew in the hills were harvested and eaten fresh.

There was a “coyote potato,” an unknown fungus (likely the *Calvatia booniana*, “Western Giant Puffball”), which grew in the sand around the roots of plants, particularly sagebrush. It could be dug up and cooked.

Teas were made from many of the leaves and barks of the plants; ephedra was the most common tea consumed, though pine needles and sagebrush bark were brewed and seeped as well. Wild rosehips were a quite common ingredient in teas due to the vitamin C they provided and the abundance in which they could be gathered.

In modern times, when money was scarce, a family member would go out to hunt rabbits or deer (sometimes out of season), or wild plants would be harvested. Grinding stones, metates, baskets, and pottery bowls were used in food preparation and storage.

Gatherings

Fandango, the fall gathering, was a practice shared by many of the tribes in the Owens Valley as a gathering of all peoples. It was hosted by a different group each year and provided an opportunity for everyone to see each other. Traditional activities included dancing, gambling, and a communal rabbit drive. Big Pine is the only community in the Owens Valley who has continued this gathering annually. The modern version of the Fandango involves a parade on the Reservation roads to the “Fandango Grounds” and tribal members participate in the parade with floats, horses, cars, and by foot. There have also been games such as bed races, early morning walks, and volleyball tournaments. There are also competitions for traditional and non-traditional food cooking. It is held in October each year, usually during the first weekend.

Figure 6. Photograph of a Paiute gathering circa 1906-1913, taken by Forbes

Source: Paiute Shoshone Cultural Center

Places

The burial sites of the Big Pine Nümü located throughout the territory have often been desecrated and their locations are no longer shared with outsiders. Burial was not done by water and usually in locations that were not common to visit, so as not to disrupt them.

Figure 7. Paiute men dressed and performing war dance

Source: Paiute Shoshone Cultural Center

Agriculture

While the Big Pine Paiute Nümü did not have developed agricultural processes such as row crops, they developed the practices of plant grooming, which creates ideal materials and seed collections for later usage. The creeks and streams were expanded to improve irrigation of plants and to strand fish to make them easier to catch. Basket makers would often tend to willows and maintain spacing so that in two to three seasons the willows growing would be ideal for basket making. Those who produced bows and arrows did the same with saplings, grooming them to grow the best materials for later harvest. Oak trees and pine trees had their habitats tended to so that harvests the following year were bountiful.

Climate Change Impacts:

Changes in climate

The spring and early summer seasons have become more temperate; during the 1990s, it was common for the month of May to be extraordinarily hot, with temperatures reaching the 110s+ degrees Fahrenheit. The Memorial Day Weekend has been an especially good marker for this as now it is common to bring a jacket along while watching the parade in the neighboring town of Bishop due to the slight chill in shade. It still reaches the 90s during the day, but we do not experience the heatwaves that were once so common in May. In the past, it wasn't unusual to have at least a dozen cases involving tourists being treated for heat exhaustion or heat stroke. Heatwaves still exist in Big Pine but now occur later in the summer.

Drought conditions have become commonplace over the past twenty years; the region is a Great Basin High Desert climate, so there is not an abundance of water during the year, but over the past ten years it has become more noticeable that the amount of rainfall and snowfall has significantly decreased.

Figure 8. "Dust Devil" as seen from Route 168, heading east towards the White Mountains and Westgaard (east of Big Pine)

Source: L'eaux Stewart

High winds have always been a part of the weather in the Owens Valley, but the frequency at which these winds occur is increasing; this has led to soil erosion around the community, the uprooting of rabbitbrush and sage brush, and complications in native plants establishing root systems when the seeds try to grow. Paired with the drought conditions, this has led to areas that once had established root systems becoming barren spaces.

Winters often lack snow on the valley floor, though it will snow in the mountains. "White Christmas" was fairly common until the early 2000s. Now winters are typically milder in temperatures and drier. Any rain begins in January and then there is typically no rain again until the start of Spring. The milder temperatures have resulted in certain insects

such as mosquitos and wasps coming out of hibernation earlier in the year. These insects would normally die off during the cold winter but now they persist.

Figure 9. Alpine Lake within the Eastern Sierras, at the Palisades (west of Big Pine and part of the Big Pine watershed)

Source: L'eaux Stewart

Impacts on physical systems

Petroglyphs and pictoglyphs in the area have been affected by climate change due to erosion of the rock faces due to the increased frequencies of dust storms, and moisture from rain and dew accumulating under the surface of rock panels which causes them to fall and damage other panels below them. The pigments in the pictoglyphs are becoming lost due to the wind erosion.

Areas north of the town of Big Pine and to the east accumulate water during the wet seasons, forming temporary lakes; the water leaches alkaline soil to the surface which causes a thin crust to form when the water eventually evaporates. The alkaline dust then gets caught in wind and blows south into the town, affecting everyone's breathing. Due to less and less precipitation each year, the alkaline dust caught in the air becomes greater overtime. Currently the tribe tracks air particulate matter through their Air Quality program to document the increase in particles trapped in the air that is causing breathing issues. The Tribe has seen an increase in dust and is working with outside officials to mitigate the problem.

Wetland areas have nearly disappeared due to the water table dropping and the lack of sustained rainy seasons. The Big Pine People's ancestral territories included many freshwater springs that have now disappeared or remain mostly dormant; these areas

were the sites of traditional stories and often were markers of certain family boundaries. The loss of these areas is due to a drop in the water table, likely a combination of LADWP pumping activities and the lack of rainfall to replenish the aquifers.

Snowpack has been reduced for years and has impacted the amount of water runoff into the valley, which leads to further issues such as reduction of native plants in the spring and summer, causing animals to have to move to different areas in order to find resources.

Access to traditional pine nut harvesting areas has been greatly impacted by soil erosion; root networks in the soil have disappeared in many areas due to a lack of water and as a result, many roads and paths have been washed out due to rainstorms that cannot be absorbed into the soil and create mini mud/rock slides. This requires hiking into areas, which can be perilous as the disturbed roads and trails might not be stable and the hiker risks the possibility that the rocks they're walking on might slide out from under them.

Impacts on vegetation

The abundance of plant species has reduced by a significant amount in the Big Pine area: plants typically associated with basket making such as willow and devil's claw are often so difficult to source that they must be found outside of the traditional land boundaries (often by Bishop or Mono Lake). Food such as Taboose (*Cyperus esculentus*), a plant that grows a small nut-like tuber, was once so prevalent that a person could walk through miles of plants within arms distance; Taboose is now only found in spaces in the backcountry around Big Pine and can no longer serve as a supplementary food to an adult's diet without depleting the plant population severely. Acorns were another primary source of protein for the Big Pine peoples. Now to harvest acorns, one would have to travel south to Fort Independence, which does not produce acorns regularly enough to support an adult through the winter season. Previously, acorns could be gathered in such large quantities that it was common to bury a large cache in a riverbank over the year so that the running water could leach the tannins out of the nut meat. The taste of the local acorns has purportedly changed so that the tannins are stronger and require more time being leached.

Pine nut harvests are commonly less successful. This is not due to an overharvest or loss of land, but due to climate change. Pine nuts grow on a seven-year cycle and it is common to rotate traditional pine nut harvesting sites every year. Families select their own harvesting site and often keep the information private; it is not an easy task, and most people aren't knowledgeable about pine nuts. There is little evidence that the lack of pine nuts from year to year has to do with interference by anything but the climate changes our area experiences. Pine nuts are no longer the primary source of winter foods due to convenience of modern foods, but they are still a very welcomed food in the Paiute and non-Native community of the Owens Valley. We have also noticed that the size of the pine nuts has gotten smaller.

Tule and cattail are no longer harvested in abundance for food or housing material due to the development of the lands that they grew on. Wetlands have dried up and houses or other development have replaced the tule beds. There is also high concern about the quality and safety of eating them due to chemicals that are sprayed on them for mosquito control and in the water that they grow around.

Wildfires in the area have become increasingly dangerous due to the drier plants in the wildland areas around Big Pine; certain plants have a difficult time regrowing after the area has been burned such as blackbrush, while others invade the area, such as foxtails and cheatgrass.

The coyote potato has been difficult to find, and it is unknown if this is due to the destruction of the land by development that would have typically served as its habitat or due to loss of water in the area overall.

Wild tobacco grows in recently burned areas, so there has been an increase in wild tobacco growth around the town of Big Pine in areas where wildfires burned; however, there is a lack of native plant growth in those same areas afterwards. Instead, those places have become covered by cheatgrass and tumbleweeds, which do nothing to save the soil during windstorms, or create a root network to help establish soil stability. This also means that looking for traditional plants that might grow after the tobacco has repaired the soil is becoming difficult.

Impacts on wildlife

There has been a noticeable decrease of Jackrabbits and Cottontail Rabbits in the valley due to a combination of predators moving down into the areas where we would hunt for rabbits and due to a lack of vegetation for the rabbits to eat. Our area was known for the rabbit drives (a hunting activity) that occurred the fall, where it was common to kill between 70 and 100 rabbits in a day. That is no longer a sustainable activity and tribal members no longer rely on rabbits as a main source of food.

The insects that were once harvested for food are now no longer easily found; the landscapes where insects such as cicadas once lived have changed so drastically due to lack of water and vegetation in the past thirty years that the insects have either migrated or died out.

Larger predatory animals such as mountain lions and bears, as well as smaller predatory animals such as coyotes and bobcats have begun to appear more frequently on the reservation lands; there have been numerous incidents of pets and livestock being killed or maimed, trashcans being disturbed, or prowling on Tribal Member assignments (plots of land held by the Tribe but assigned to Tribal members) in the past fifteen years. Some of the animals have been captured and relocated by California Fish and Wildlife, while other animals have been killed by cars or shot by townsfolk within Big Pine for the danger

they pose. This is likely because their typical hunting areas have been deeply affected by their prey migrating to different areas closer to town to access water and vegetation.

Birds of prey are slowly returning to the area due to conservation efforts, however many lack the areas they would typically use for nesting and hunting. The food upon which these avian predators rely, such as rabbits and mice, are impacted by a lack of vegetation. The trees in which the birds of prey would typically live are dying due to lack of water. Owls have been able to adapt by living in abandoned or isolated human-built structures such as silos. They are now seen often in residential areas; owls are considered an omen of bad luck, so many Tribal Members are uncomfortable with their frequent presence.

Native fish species are on the endangered species list due to introduction of other fish species, destruction of habitat, and lack of water, the impacts of which are exacerbated by climate change. Fish can be very delicate to care for, as even small fluctuations in temperature and sunlight can negatively affect their health. Reestablishing the native fish populations has been a struggle due to the change in the landscape and the lowering of the water table throughout the valley. If more is not done to protect them, there is a likelihood that species such as the Tui Chub and Owens Valley Pupfish will go extinct in the next decade. The Big Pine Peoples have focused all their attention to preserving the native fish and no longer fish for them.

Figure 10. Bighorn Sheep

Source CDFW, 2021

Bighorn Sheep have been impacted by drought and are no longer in the area, though are slowly returning with the assistance of the California Fish and Wildlife Bighorn Sheep Reintroduction Program. They were once a staple of the Owens Valley Paiute life, but can no longer be hunted even for cultural purposes; to hunt Bighorn Sheep in the White Mountains, one must acquire one of the six hunt tags through a lottery offered by the state. The Big Pine Peoples have been incredibly supportive of areawide conservation efforts to restore the original herd sizes to the valley.

Impacts on human health and well-being

While the spring is becoming milder. Summers are hotter. As our people no longer travel to the mountains to live during the hotter summer months, they are routinely exposed to higher temperatures in the summer; summer is typically dry and windy, with exposure to smog from tourist vehicles and smoke from California wildfires. During the 2020 fire

season, residents of the Owens Valley were forced to remain indoors for many months straight. It should be noted that during this time there was little wind, which allowed the smoke to settle over the town of Big Pine; many people commented about how unusual it was. Not all households own air conditioners or swamp coolers, so many people are left in houses that are too hot to safely occupy.

Droughts have become commonplace in the area. The dry soil leads to dust, which often affects the breathing of all community members; there are a number of elders with lung issues and a growing number of cases of children with asthma and other breathing issues. The soil is alkaline and causes dust clouds that are very irritating to the eyes and throat/lungs.

Hunting isn't as readily accessible due to game having left the immediate area. Smaller game such as doves and quail are easy to find around the south and eastern border of the reservation, but rabbits and deer must be sought out. The death and/or lack of plants has also led to a huge change in diet for the people and has spanned over multiple generations.

Summary

Overall, climate change and the lack of water within the Big Pine area have become of great concern. Climate change has led to soil erosion, loss of wetlands and springs, loss of plants, animal migration, changes in traditional trail systems, and changes in diets and cultural practices; these impacts are tied to water, heat, wind, and fire hazards. Without a return of water to the area, the Tribe is looking at scenarios where the land will not recover and thusly lose out on many of the practices that make up our culture. As a result, the Big Pine Paiute Tribe has become involved in water rights, and activism surrounding the politics and usage of water in our community. It has led to the Tribe working hard to manage water and educate our Tribal Members how to best use the water we are able to obtain.

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IMPACTS OF CLIMATE CHANGE ON THE BIG VALLEY BAND OF POMO INDIANS

Warming air temperatures, variable precipitation, drought, wildfire, warming lake temperatures, harmful algal blooms, reduction of fish, bird and animals, as well as other stressors are impacting Tribal livelihood, culture, and traditions.

Background

The Big Valley Band of Pomo Indians of the Big Valley Rancheria of California is a self-governing, federally recognized Tribe of Pomo Indians residing on the shores of Clear Lake in Lake County, California (Figures 1 and 2). Their ancestors, the Xa-Ben-Na-Po Band of Pomo Indians, inhabited the Clear Lake area for over 11,800 years (BVR, 2022). In 1851, a treaty was agreed upon with the office of the U.S. President which established a reservation of approximately 72 square miles with extensive lake front property, including much of the Clear Lake basin including Mt. Konocti. However, the U.S. Senate refused to ratify this treaty, along with 17 others. Largely because of the opposition of the Legislature and the Senators from California, the United States Senate refused to ratify the treaties, on July 8, 1852. The United States Senate placed the treaties under an injunction of secrecy which was not removed for over 50 years (Flushman and Barbier 1986). Instead, Congress passed the Land Claims Act of 1851 requiring claims to California lands be presented within two years (Patrick, 2008). Tribes were intentionally never told of this new requirement. Like all Tribes, the Big Valley Band of Pomo leaders failed to meet the statutory deadline, and their Tribe and others became landless. After the US Government took Indian homelands, they gave loans to settlers to buy Indian land (Montez, 2022).

Figure 1. Clear Lake basin looking from what is now called Soda Bay

Photo: L Monserrat, OEHHA

Big Valley, along with other bands of Pomo, were granted small rancherias years later. In 1914, the U.S. Department of the Interior purchased land for the Big Valley Rancheria. In 1936, under the Indian Reorganization Act of 1935, the Tribe became federally recognized, formed its government, and ratified its constitution. Then in 1963 the Tribe was illegally terminated under the California Rancheria Act of 1959. The Tribe was subsequently re-established by court order as a federally recognized Tribal entity in 1983. During that 20-year period approximately half of the original Rancheria land, including Mt. Konocti, had been seized and sold to non-Indians. In 1986 the Big Valley Tribe began the process of reconstituting their rights of self-determination by re-forming their government through the guidance of their 1936 Constitution. The Tribe is also in the process of buying back their homelands (BVR, 2022a).

Figure 2. Map showing location of Big Valley Rancheria (red and green area), the City of Lakeport (green-striped area), and the general area in which the Tribe engages in natural resource protection (tan area). The tan area is also closely tied to the Tribe's ancestral boundaries.

General area of Big Valley involvement regarding natural resource protection. Connected with ancestral boundaries of the Tribe

City of Lakeport

Big Valley Rancheria

Source: BV EPA, 2014

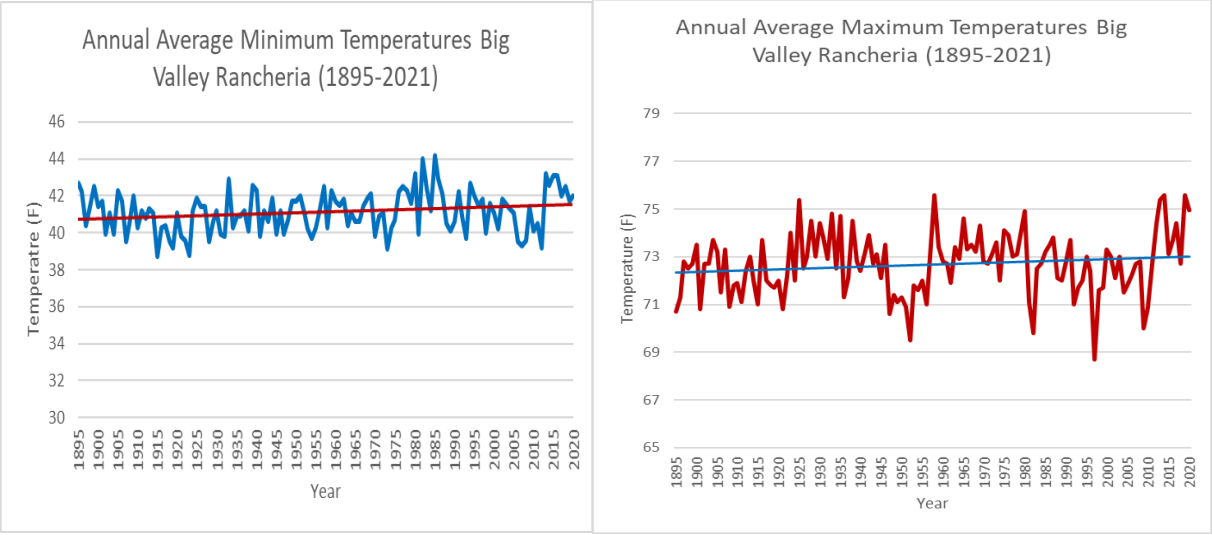
Current Big Valley Tribal membership is approximately 1,300 people. Though the Rancheria sits on 350 acres today, traditional Tribal lands extend much farther. Additionally, Tribal members live all around the lake, and throughout California. Figure 2 shows the Rancheria territory, the City of Lakeport, and the much larger general area in which Big Valley is involved in natural resource protection. This map helps illustrate that the lands the Tribe uses and cares for extend beyond Rancheria borders. Big Valley Pomo rely heavily on Clear Lake and the resources surrounding it for subsistence and livelihood, as well as for important cultural and spiritual practices.

The waters of Clear Lake itself are of cultural importance to the Big Valley Tribe. The Tribe conducts their Tule Boat Festival and other important cultural and spiritual events on Clear Lake. The Tule Boat Festival is a three-day festival showcasing traditional Pomo boat-making skills. The boats, constructed primarily using materials gathered from shoreline tule plants, are raced by Tribal members. The festival draws Tribes from around the North Coast region and beyond and provides an opportunity for sharing traditional foods. (BVBPI and MRPI, 2021).

Air Temperatures

Figure 3 shows that over the past century, maximum temperatures (daytime) and minimum temperatures have increased at the Big Valley Rancheria. However, minimum temperatures, which reflect temperatures at night, are increasing at about 1.2 times the rate of maximum temperatures (0.06°F/decade and 0.05°F/decade, respectively).

Figure 3. Annual average daily maximum temperatures (left) and annual average daily minimum temperatures (right) at Big Valley Rancheria.



Source: PRISM, 2022

Warming air temperatures are linked to numerous impacts on human health and livelihood, as well as ecosystem health and function. Warmer air temperatures change precipitation and runoff patterns, which impact the availability of freshwater. Warming air temperatures lead to changes in species distribution and abundance and the timing of life-cycle events, all of which alter the ecosystem as a whole. Rising temperatures also strain energy demand and infrastructure, increasing the number and length of the Public Safety Power Shutoffs (PSPS) the Tribe has seen. To protect Elders during these PSPS events the Tribe has purchased generators. Increasing air temperatures promote ozone formation leading to adverse health effects such as lung irritation, inflammation, worsening of asthma, and increasing mortality (USEPA, 2021a).

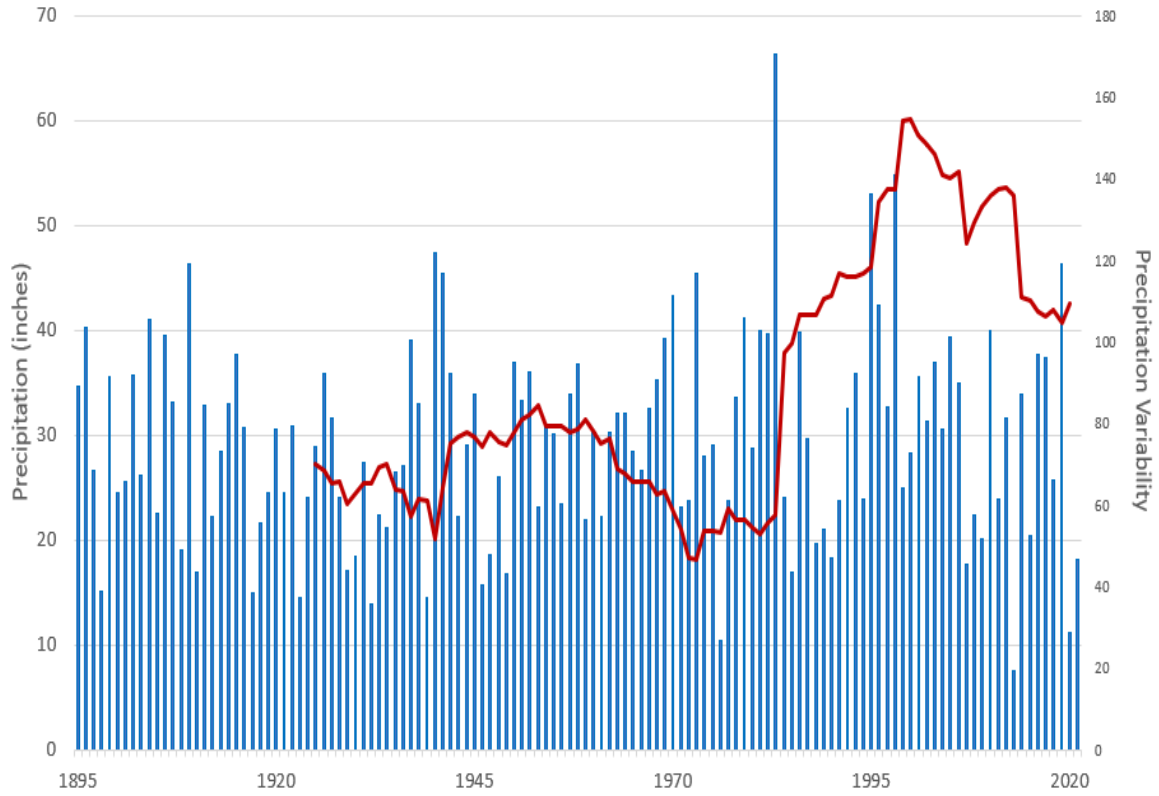
Warmer air temperatures along with a lack of rainfall over time stresses vegetation, creating susceptibility to pests, disease, and death. The increase in dead vegetation then increases wildfire risk for the Tribe. The effects on vegetation also reduce the availability of materials and resources important to the Tribe for various cultural and spiritual uses, such as tules.

Warming temperatures and changing precipitation patterns are associated with increased harmful algal blooms (HABs) in Clear Lake. Additionally, warmer winter temperatures have allowed the invasive water primrose to flourish year-round, leading to further tule loss along the shoreline due to competition (BV EPA, 2014).

Precipitation

As shown in Figure 4, there is considerable year-to-year variability in the amount of rain at the Big Valley Rancheria, particularly in the last thirty years. Average annual precipitation dropped to its lowest around 2013/2014 and during a period when Lake County experienced extreme drought (Lake County, 2021). The Rancheria has experienced years of extremely high and extremely low rainfall, as well as increasingly unpredictable precipitation patterns throughout the year. High rainfall events cause a sharp increase of surface water flow into Clear Lake, leading to sedimentation and erosion, particularly in shoreline areas where vegetation has been lost. Sediment deposition into the lake impacts water quality (USDA, 1995). Sediments carry contaminants such as trace metals and organic and inorganic compounds which are toxic to plants and animals (BV EPA, 2017a). Sediments are often nutrient-rich, and these excess nutrients cause HABs.

Figure 4. Total yearly precipitation at Big Valley Rancheria, 1895-2021



Source: PRISM, 2022

Heavy rains affect infrastructure at Big Valley. The Rancheria needs a better drainage system to prevent flooding which also damages homes. Many Tribal members live in mobile homes, which are particularly susceptible to flooding and seepage. Several members have had to build their own weirs to access their homes during high rainfall. The Tribe has identified increased mold growth after heavy rain events as an impact of climate change (BVBPI and MRPI, 2021). The marina at the Rancheria has been replanted with vegetation previously lost along the shoreline to combat erosion, but during periods of heavy rain, large sections of shorelines wash away.

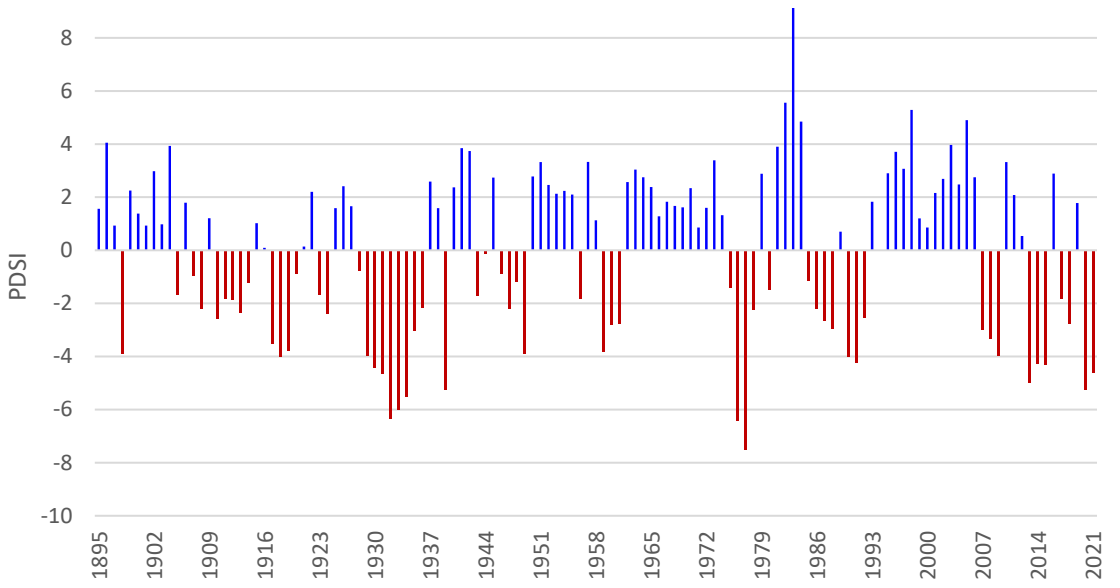
Big Valley's Integrated Solid Waste Management Plan addresses climate change impacts such as flooding and resulting landslides the Tribe is seeing as a result of extreme rain events. The Tribe has experienced landslides that blocked roads and damaged Tribal buildings and lands following heavy rainfalls in recent past and the Tribe is working to protect its facilities from future impacts (BV ISWMP, 2015).

Drought

Figure 5 shows a commonly used measure of drought, the Palmer Drought Severity Index (PDSI), which combines both temperature and precipitation data to provide a measure of relative dryness (drought) on a scale from +10 (wet) to -10 (dry). The lower the number the drier the conditions. In the 80 years between 1895 and 1975 the Big

Valley Tribe experienced extreme drought (-4 or below) 7 times, including the state-wide drought that impacted California from 1928-1934 (USGS, 2022). During the 47 years since then Big Valley has experienced extreme drought 9 times. The most recent two years 2020 and 2021 were -5.25 and -4.62 respectively (Abatzoglou et al., 2022).

Figure 5. Palmer Drought Severity Index, Big Valley Rancheria (1895-2021)



Source: Abatzoglou et al., 2022

Drought has impacted Clear Lake resources, lake water quality, and consequently, the people and other species that rely on the lake. Additionally, drought has caused stress to vegetation throughout the Lake County area, notably to native pine trees, making them more susceptible to pests such as the Pine Bark beetle. Dead trees and other vegetation increase fuel for wildfires. Water scarcity impacts local agriculture, stressing crops such as pears, walnuts, and grapes. Increased reliance on groundwater to support agriculture in areas near the Rancheria reduces the volume of surface water entering streams where Clear Lake Hitch, an endemic and culturally significant fish, spawn (see Lake water temperature section). Many streams and creeks surrounding Clear Lake have dried up during periods of drought (BVBPI and MRPI, 2021).

The Pine bark beetle has killed large areas of Pinon pine trees which are a food source for the Tribe. Government policies have prevented traditional cultural burning, leading to an increase in large-scale wildfires as well as an increase in invasive species and pests. For example, invasive star thistle and other non-native plants have taken hold, increasing the use of herbicides which also poison native species, further exacerbating the issue. This increases the pesticide/herbicide exposure from dust and runoff from nearby agricultural operations that impact the health of Tribal members.

During periods of drought, decreased stream flows into Clear Lake reduce dilution, thus concentrating pollutants, leading to increases in microbes and pathogens in the lake, which in turn affects public health. Additionally, drinking water sources are impaired and with 18 water purveyors pulling water from the lake, the increased cost is passed to the Tribal consumer. Partnering with Tracking California, which compiles and analyzes data about public health and the environment, Big Valley tested private drinking water systems on Clear Lake for cyanotoxins, nitrates, coliform bacteria and herbicides, all contaminants of concern for private drinking water systems (BV EPA, 2017b). During the most recent testing between June and October 2021, twenty of the thirty-six homes tested had detectable cyanotoxins and 13 were above the USEPA health advisory level of 0.3 µg/L (micrograms per liter). The highest level sampled was 3.85 µg/L. In November 2021 forty-one homes were tested and cyanotoxins were found in 22 samples; of those 10 were above the USEPA health advisory (Cal-WATCH, 2022). The Tribe is also developing a program to measure groundwater in local wells to have a better understanding of the variations in groundwater storage to ensure sustainability.

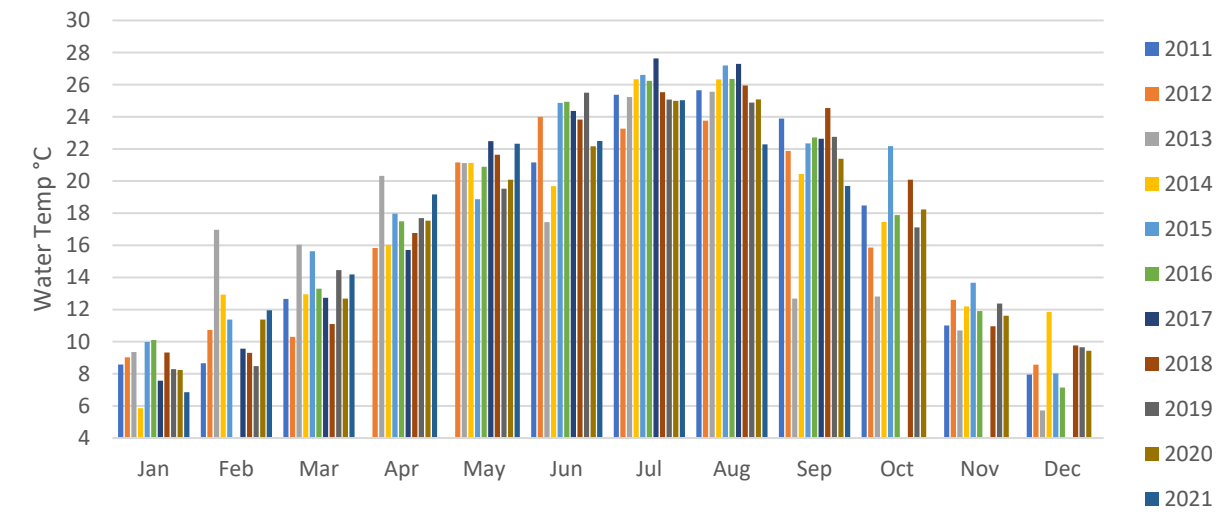
Figure 6. Children playing in a tule boat

Declining lake water levels in Clear Lake due to drought have exposed cultural resources, such as arrowheads. This has exacerbated the problem of non-natives actively searching for these resources to sell. These items are Tribal property and taking them is disrespectful and disturbs the Tribe as a whole. Artifacts found need to be honored and left in place or returned to the Tribes (BVBPI and MRPI, 2021).

Lake water temperature

Figure 7 presents annual average lake surface water temperature between 2011 and 2021 at a sampling site (BVCL6), an area of Clear Lake of particular importance to the Tribe. Six total sites offshore of Big Valley Rancheria were selected for analysis (shown circled in yellow in Figure 8). All six sites showed similar results, so only data from BVCL6 is displayed. This site has seen monthly average water temperatures that are highly variable across years, marked by exceptionally warm temperatures in certain years: for example, notably warm temperatures were observed from February to April in 2013, in December 2014, and in October 2015.

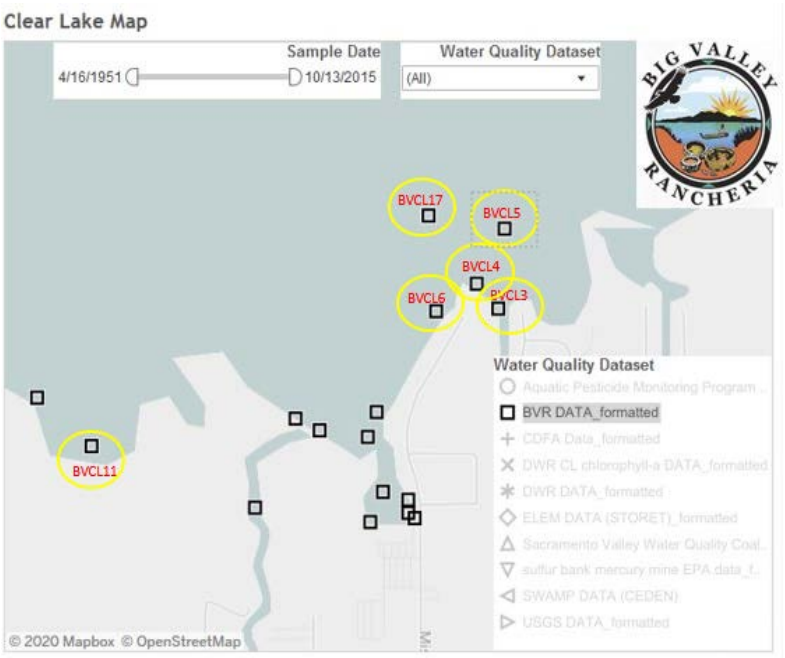
Figure 7. Monthly average lake surface water temperature by year at sampling site BVCL6 in Clear Lake (2011-2021)



Note: No sampling Oct-Dec, 2021 due to low lake levels

Source: BV EPA, 2022b

Figure 8. Location of Big Valley offshore monitoring sites



Source: BV EPA, 2022

Even seemingly small increases in water temperature can significantly affect key physical and biological processes in lakes. As the lake is impacted, so is the Tribe. Fish and other aquatic species often do best within a certain range of water temperatures. As water temperatures rise, native populations of fish and other species which are important to the Tribe might not thrive, while introduced species that previously would not survive in the lake are absent their natural predators. Balance is key for a healthy lake.

Figure 9. Map showing concerns relating to some creeks that drain into Clear Lake

Source: BVBPI and MRPI, 2021

Changing lake temperatures affects the habitat and distribution of fish. Figure 9 shows creeks feeding into Clear Lake in the Big Valley area (BVBPI and MRPI, 2021). Clear Lake Hitch, a threatened species of "immeasurable ecological and cultural value" (CDFW, 2014) migrate from Clear Lake into tributary streams such as Kelsey Creek and Adobe Creek (indicated with yellow stars on the map) for spawning (Feyrer et al., 2019). In 2014 Hitch were only observed spawning in these two streams.

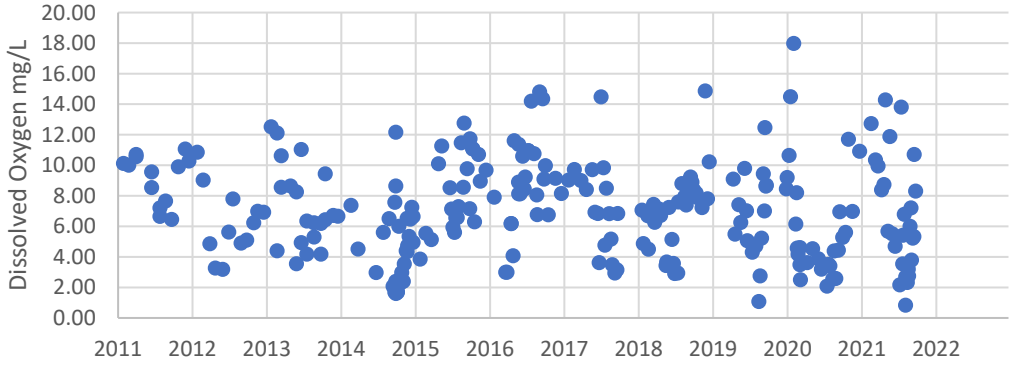
While there is no water quality standard for cool water temperature ranges in Clear Lake, there is a standard that the lake has no more than a 5˚F difference from receiving stream temperatures (BV EPA, 2017b). A temperature differential greater than 5˚F leads to negative impacts on fish which are important to the Tribal diet. Warming waters are associated with lower levels of dissolved oxygen (DO) in the water, which poses risks to aquatic species. Precipitation also impacts the level of DO in the waters of Clear Lake. DO is the most important health indicator of a water body and its capacity to support a balanced aquatic ecosystem of plants and animals. Oxygen from the atmosphere and photosynthesis dissolves into the upper level of all bodies of water.

The amount of DO in a water body decreases with depth, rising water temperatures, and the oxidation of organic matter and pollutants. Erosion and sedimentation caused by high precipitation events carry organic, oxygen-consuming pollutants into Clear Lake leading to a reduction in DO. Sediments also carry nutrients that promote HABs. Low levels of precipitation, and lower surface flow into Clear Lake reduce dilution and increase the concentration of organic pollutants in Clear Lake, also leading to a decrease in DO.

Data collected by multiple agencies over the last several years on Clear Lake show extended periods of time throughout the lake where DO was suppressed, leading to fish kills that have been investigated by California Department of Fish and Wildlife who have confirmed that low DO was the cause (BV EPA, 2017a). The Upper Arm of Clear Lake, where the Tribe and monitoring station BVCL6 is located has shown lower DO and increasing frequencies of hypoxia since 2000 (UCD, 2010).

Big Valley Rancheria has developed a set of water quality objectives that for DO are outlined by three beneficial uses: (1) warm freshwater habitat - uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates; (2) cold freshwater habitat - uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates; and (3) warm spawning, reproduction and/or early development – uses of water that support high quality aquatic habitats for reproduction and early development of fish (BV EPA, 2017a). These water quality objectives dictate that DO concentrations in Clear Lake should not fall below 5.0 mg/L for warm habitat and 7.0 mg/L for both cold habitat and warm spawning habitat. Figure 10 shows DO levels at site BVCL6 over the past 10 years. During that time DO dropped to extremely low levels (below 2.0 mg/L) 6 times, below 5.0 mg/L 71 times, and to below 7.0 mg/L 128 times.

Figure 10. Dissolved Oxygen (DO) mg/L at Clear Lake Sampling Site BVCL6, 2011-2021



Source: BV EPA, 2022b

Culturally important species

Climate change has impacted species of cultural significance to the Big Valley Band of Pomo Indians. The Tribe is seeing fewer, quail, otters, turtles and other animals that are important to the Tribe. These species have diminished due to the cascading impacts of climate change on their habitat (BV EPA, 2022a). Additionally, the Tribe has observed fewer flicker and red-wing blackbird species. These are important birds because the Tribe uses the feathers in regalia and other important cultural activities. With the loss of these birds, the passing on of skills, vocabulary, and ceremony to younger generations is impacted. This constitutes a larger loss than just having to change which feathers the Tribe uses for regalia; it constitutes a loss of culture and an important part of Tribal identity and long-standing traditions (BVBPI and MRPI, 2021). Twenty eight percent of the native aquatic fish species in Clear Lake have become extinct in the last century (UCDNAR, 2022).

The Asian clam (*Corbicula fluminea*) was historically invasive to this area but over time became a staple food source for the Tribe and others living around Clear Lake. Tribal members have observed changes in the size and availability of Asian clams in Clear Lake. Asian clams are short-lived filter feeders, consuming large quantities of phytoplankton (Sousa *et al.*, 2008). As such they are susceptible to contaminants such as mercury and cyanotoxins, which pose serious health risks to people who consume Asian clams.

Figure 11. Clear Lake Hitch

Photo by Richard Macedo

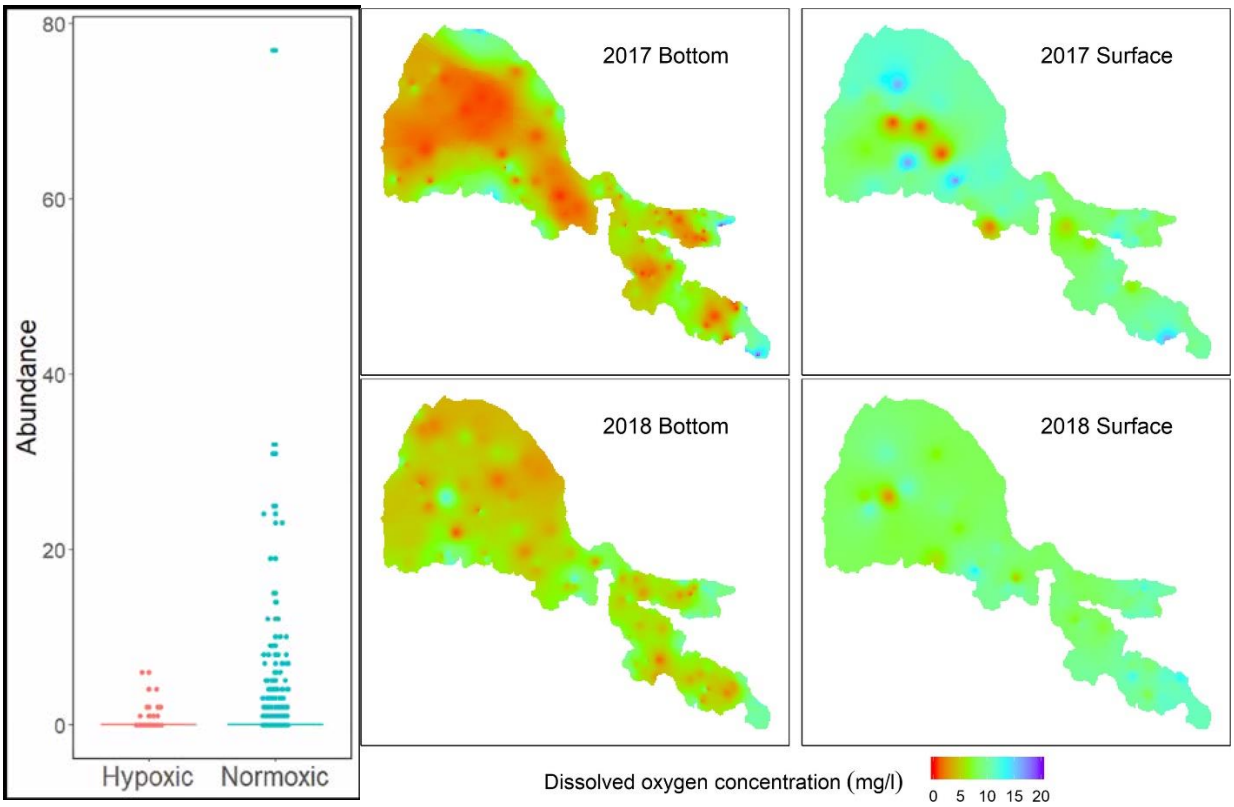
One native species of concern is the Clear Lake Hitch (pictured below), a large minnow, 14-16 inches long found only in Clear Lake and its tributaries. Hitch typically live 6-7 years. Unlike salmon that die after spawning, Hitch normally return to Clear Lake at the end of their spawning season. Hitch were formally listed as a threatened species under California's state Endangered Species Act in 2014 due to significant decline in numbers of Hitch, and the fish's disappearance from most former spawning streams. Clear Lake Hitch have been impacted by reduced stream flows from drought and decreased precipitation, loss and degradation of spawning habitat, water pumping, barriers to fish migration (such as dams), pollution, and competition from invasive fish (Center for Biological Diversity, 2017; Feyrer, 2022).

Elders of the Big Valley Tribe have seen Hitch numbers decline in their lifetime. In the 1960s and 1970s, Hitch were so numerous that they made the water appear to boil in area creeks and streams (BVBPI and MRPI, 2021). Hitch now spawn regularly in only two streams, Adobe Creek and Kelsey Creek. One Big Valley Elder reported that while Hitch used to be plentiful in Kelsey Creek, which runs behind his home, he has not seen Hitch in the creek since 2010. He also noticed that the spawning season has shortened. Traditionally Hitch would spawn for about 6 weeks and now the spawning season

seems to be about three weeks. Another Elder explained that the Hitch were dried and kept for use throughout the winter and was a valuable trade item with Coastal Pomo Tribes for resources such as seaweed, clam shells and abalone. Hitch were also a major food source for ceremonies (BVR, 2013). The Clear Lake Hitch are a culturally and biologically important fish. The loss of this fish impacts the community, the history, and the culture of the Pomo people. Restoring their habitat and numbers will also improve the health of Clear Lake overall as they are also an important food source for numerous birds, fish and other wildlife.

Clear Lake Hitch avoid areas with low levels of DO. A survey done by the USGS in 2017 and 2018 identified abundance-habitat relationships for juvenile and adult Hitch. Results of this study showed that DO concentration was the most important habitat feature measured. The figure below, right, shows DO concentrations in Clear Lake in 2017 and 2018. The graph on the left shows the number of Hitch detected and if they were found in low DO (hypoxic) or normal DO (normoxic) areas.

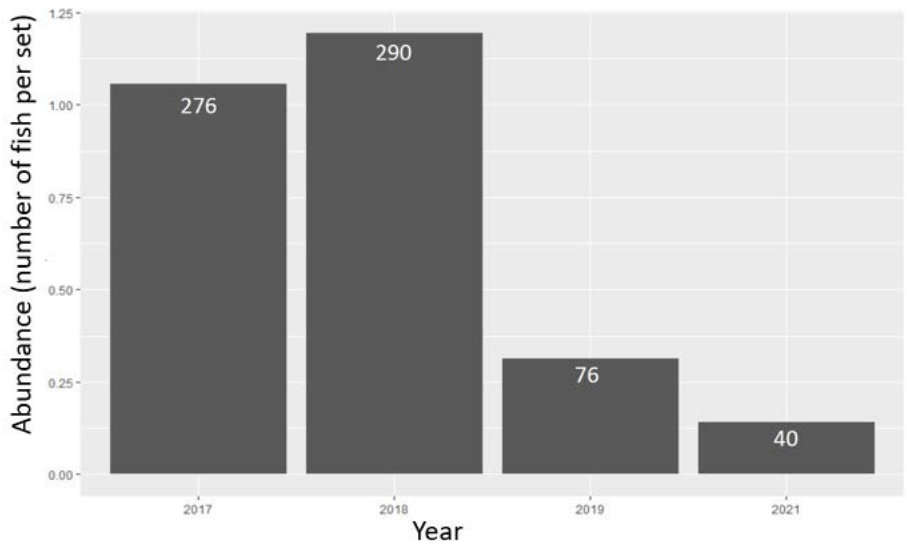
Figure 12. Abundance of Clear Lake Hitch in normal and low DO areas in Clear Lake 2017-2018 (left panel); the spatial distribution of DO concentrations in waters at the surface and lake bottom in 2017 and 2018 (maps on the right)



Source: Feyrer et al, 2020

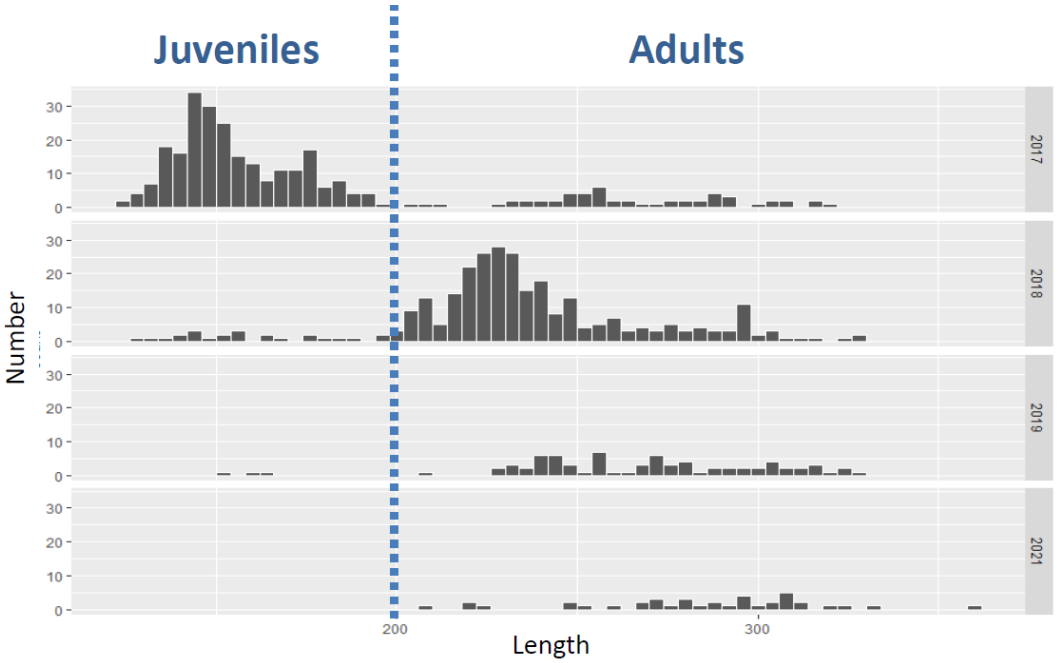
Monitoring of the Hitch in Clear Lake, (Figures 13 and 14) shows a troubling pattern, not only are fewer Hitch in Clear Lake, but the number of juveniles, are declining.

Figure 13. Hitch abundance in Clear Lake 2017-2021



Source: Feyrer, 2022

Figure 14. Numbers of adult and juvenile Hitch in Clear Lake 2017-2021



Source: Feyrer, 2022

Clear Lake Hitch have been forced to adapt to a very brief period of suitable stream conditions for their annual spawning run, as water diversions and a changing climate have caused streams to prematurely dry. Hitch typically spawn in the Spring during periods when creek and groundwater levels are now lower as a result of drought,

agricultural irrigation, and the use of pumped water for frost protection. These low water levels are also impacting overall Hitch numbers. Increased drought and rapid climate change due to warming temperatures will likely accelerate this trend, causing further spawning failures. The spawning runs from 2013 to 2015 had an annual average of fewer than 1,000 spawning fish in the entire Clear Lake basin. Since 2013 the average number of spawning fish in the last two tributaries, Kelsey Creek and Adobe Creek, has been under 1,700 fish annually (Center for Biological Diversity, 2021). Spawning, the process of releasing the eggs and milt, is only part of the success or failure of the Hitch to thrive. The fry must also hatch and survive long enough to travel back to Clear Lake and then live long enough to reproduce for the fish numbers to begin to rebound (Feyrer, 2022).

Figure 15. Hitch spawning at Bell Hill Road Crossing on Adobe Creek

Photo by Richard Macedo
CA Department of Fish and Game

Figure 16. Clear Lake Hitch rescue by Tribal staff and CDFW

Source: BPBP and MRPII, 2021

Big Valley, the nearby Robinson Rancheria and Habematolel Pomo of Upper Lake have been working together to study and protect Clear Lake Hitch since 2005. In 2015 Big Valley Rancheria received an award from the Bureau of Indian Affairs (BIA) to conduct a Water Resource Climate Adaptation Plan on Adobe Creek for the Recovery of Hitch (*Lavinia exilicauda*) in Clear Lake (Bureau of Indian Affairs, 2015). Clear Lake area Tribes are also working with non-tribal agencies to help with Hitch recovery efforts, but to date these efforts have no regulatory authority, and as a result may not effectively restore Hitch populations.

Fish consumption by Big Valley Tribal members is often higher than among recreational anglers. A person who eats fish occasionally from sport fishing or commercial fish sources will also consume fish from multiple sources, thereby limiting exposure to contaminants found in a specific location. Tribal members eat large quantities of fish from Clear Lake during ceremonies or as a regular food source. Additionally, the Tribe consumes fish caught in different areas of the lake than recreational anglers.

Tribal Elders have observed a large reduction in the abundance of other native fish species which Tribal members eat, such as blackfish, sculpin, and sunfish.

Tules, an important plant for the Tribe, are used to build boats, for weaving, in traditional ceremonies, as a food source, and for various household uses, are also at risk from a changing climate and area development. Roughly 85% of the shoreline tules have been lost already (BVBPI and MRPI, 2021).

Tules have been impacted by drought and warming temperatures which stresses tules, making them more likely to be impacted by pests, disease, and invasive species. One such invasive species is water primrose, which has taken over where many tules used to grow along Clear Lake's shoreline. Tules help buffer against wind and water, allowing the establishment of other types of plants and reducing erosion. Tules have roots at or under the waterline and play an important filtration role in Clear Lake's ecosystem. These tule wetlands filter out much of the nutrient load and other chemicals found in storm water runoff before they enter the lake. Tules also provide habitat, food, and nesting materials for terrestrial and aquatic species.

> *"The Tule is part of our Traditional Tribal history, it was used for ceremony inside the Roundhouse as a ground cover and mat for the people to sit upon, The Big Head Dancers wore skirts made of Tule for our regalia, clothing for our women were made of Tule, Tule Mats were used as sleeping mats in our Hut made of a willow frame and a covering with Tules, men made a Tule Shirt worn in colder weather, we ate the Tule Roots for food, The health of the Tribe and the health of the Tules are interrelated. It is important to bring notice to and make others aware of the problems we are seeing in the quality of our lake waters and how it is affecting our cultural practices, our subsistence fishing, birds and loss of plant life (Tules) on the shores of our rancheria."*
> *~Ron Montez, Tribal Elder and Tribal Historic Preservation Officer*

The use of plants such as tule, sedge, dogbane, and willow does not just benefit the user, but the ecosystem as a whole. Stands of plants are tended and groomed to make them more useful for basketry and other uses and that grooming helps strengthen riverbanks and reduces soil erosion. The plant bases go from short and knotty, to straight, long and strong. This grooming also promotes access for riparian animals who can more easily access the water in well-tended areas (Pearce, 2022).

Manzanita, a culturally important plant, produces berries that are eaten raw, used to sweeten other foods, or ground for flour; its bark and flowers are used to make a medicinal tea (Pearce, 2021). Manzanita is now seen as a fire risk by some and has been cleared by non-tribal members for fire mitigation and to clear land for vineyards. Removal of manzanita constitutes a loss of traditional food and medicine, as well as a loss of habitat and food for other species.

Angelica root is another culturally important medicinal plant that has been impacted by drought and erosion from flooding. The Tribe has tried to harvest Angelica from areas where it may no longer thrive and propagate it in areas where it grows better or is more accessible to the Tribe. Basketry materials such as willow, redbud, and dogbane have also been impacted by the changing climate. Traditional gathering areas have been reduced due to vegetation changes, wildfire, and the privatization of lands (BVBPI and MRPI, 2021). As the Tribe has seen a reduction in culturally important plants, they have seen a rise in invasives such as star thistle, Scotch, French and Spanish broom (BVBPI and MRPI, 2021).

Harmful Algal Blooms

Harmful algal blooms (HABs) are colonies of algae and/or cyanobacteria that grow out of control, threatening fisheries, aquatic ecosystems, public health and economies. HABs produce toxins that contaminate waterbodies used for recreation or drinking water sources, and the shellfish, fish and wildlife living within them. Even without producing toxins, HABs damage aquatic environments by suffocating fish, blocking sunlight, or depleting oxygen in the water (COST, 2016; WHO, 1999).

Climate change affects the factors that drive HAB formation (US EPA, 2017a). Warmer water temperatures, drought conditions, increased carbon dioxide and alternating periods of storms and drought are all known to promote HAB formation (Lehman et al., 2017; Power et al., 2015). Anthropogenic inputs of nutrients like phosphorus and nitrogen also promote HAB formation.

Tribal members and locals around Clear Lake report that HABs have become much more prevalent over the last few decades. HABs are regularly observed in Clear Lake; these blooms damage the environment and produce levels of cyanotoxins that are harmful to humans. The main cyanotoxin produced in Clear Lake is microcystin, which has been known to kill pets and other animals, and cause skin, gastrointestinal and liver impacts in humans. Tribal members are exposed to microcystin through interactions with the water such as swimming, cultural ceremonies, the consumption of aquatic organisms, and drinking water.

HABs on Clear Lake produce very high levels of microcystin and the lake is often posted with recreational advisories from April through October. The California Cyanobacteria Harmful Algal Bloom (CCHAB) Network has adopted tiered cyanotoxin trigger levels for posting recreational waters. For microcystin these advisory levels are 0.8 micrograms per liter (µg/L) (Caution - keep away from visible algae), 6 µg/L (Warning – no swimming) and 20 µg/L (Danger – do not contact the water or eat aquatic organisms). All advisory levels warn people to keep their pets and small children away from the water and shoreline and to avoid shellfish and wash fish filets before cooking

them. The Big Valley Band of Pomo Indians and the Elem Indian Colony have been actively involved in sampling and monitoring their waters. Results of the monitoring for 2014-2021 are shown in Table 1 below.

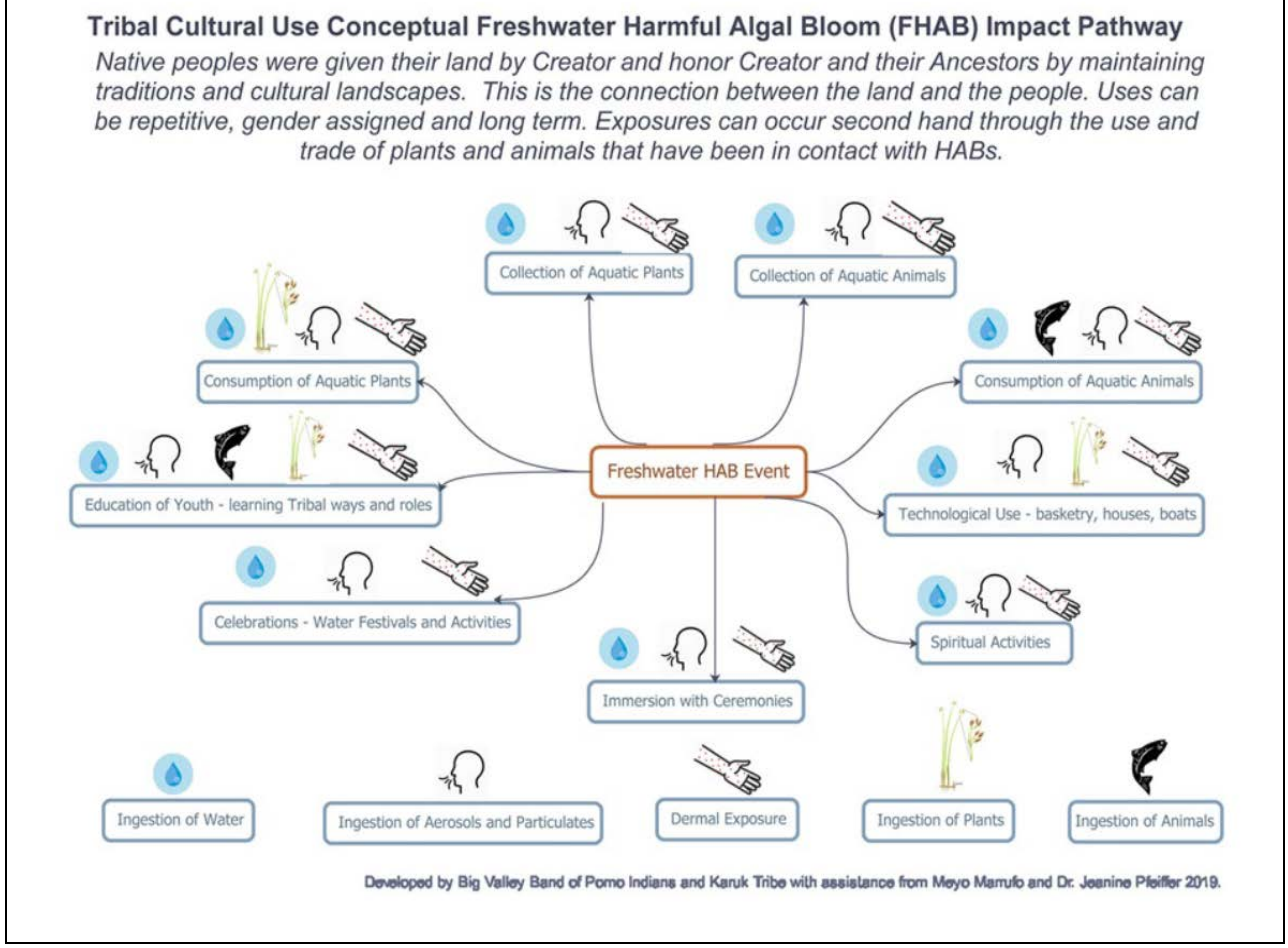
Table 1. Highest Concentrations of Microcystins in Clear Lake Waters

Arm of Clear Lake	Highest Level of Microcystins (µg/L)							
	2014	2015	2016	2017	2018	2019	2020	2021
Upper Arm	878***	Trace	0.3	4*	13**	0.3	1,146***	5,910***
Oaks Arm	16,920***	278***	0.7	46***	4,800***	0.9*	79***	1,449***
Lower Arm	769***	10,162***	0.3	1*	230***	150***	902***	160,377***

Source: BV EPA, 2022b

Notes:
**Above CCHAB Caution Trigger Level of 0.8 µg/L*
***Above CCHAB Warning Trigger Level of 6 µg/L*
****Above CCHAB Danger Trigger Level of 20 µg/L*

Figure 17. Tribal Cultural Use Conceptual Freshwater Harmful Algal Bloom (FHAB) Impact Pathway



When advisories are posted at Clear Lake, Tribal Members can't safely participate in Tribal activities that require them to be in the lake. Important Tribal activities that are prevented by trigger level advisories include spiritual activities, water immersion for ceremonies, using plants for ceremonies and basketry, and the collection and consumption of fish and other aquatic organisms. Tribal members are also be prevented from swimming or playing in the water, which is important for heat relief. In 2021, cyanotoxin was monitored from April through December. During that time there was never a period in which the whole lake was safe for contact (BV EPA, 2022b). Figure 17 illustrates the potential routes of exposure to HABs based on Tribal uses and practices involving Clear Lake.

HABs create sludge that clogs drinking water intakes in Clear Lake (Figure 18). This leads to higher operating and electrical costs due to filters needing to be flushed more frequently. It also increases the cost due to the need for sludge disposal. When microcystin is present in raw water, water treatment plants must make sure this toxin is kept out of the finished drinking water. In Clear Lake more carbon filters have been required to remove the cyanobacteria and toxins, which also increases costs.

Figure 18. HABs at Clear Lake, September 2021

Photo credit: Justin Sullivan / Getty Images

A 2015 CalEPA Environmental Justice grant funded the Big Valley Rancheria to measure microcystin in Tribally important fish from Clear Lake. Fish and shellfish from ten species were collected over several years. Analysis of 91 fish tissue and 32 fish liver

samples found detectable amounts of microcystin. Summaries of the average microcystin toxin levels per fish species are shown in Table 2.

Table 2. Microcystin (MC) concentrations in fish from Clear Lake (2010 – 2018).

Species	Tissue MC ng/g Avg (Count)	Liver MC ng/g Avg (Count)
Black crappie	4 (8)	19 (5)
Blackfish	7 (1)	83 (1)
Blue gill	ND (2)	7 (2)
Carp	14 (2)	34 (2)
Catfish	2 (6)	10 (6)
Hitch	10 (8)	16 (7)
Largemouth bass	2 (7)	6 (2)
Tule perch	6 (10)	35 (8)
Crayfish	4 (23)	
Mussel	10 (26)	

Source: WRCB, 2022

Concentration is at or above OEHHA's state-wide Action Level for microcystin in fish consumed by humans (10 ng/g).

The Action Level for fish consumption recommended by CalEPA's Office of Environmental Health Hazard Assessment (OEHHA) based on total microcystin in fish and shellfish is 10 nanograms per gram (ng/g) and is calculated for a 70 kg person eating at the sport fish and shellfish consumption rate of one 8-ounce meal per week (Butler et al, 2012). Many Tribal members eat fish and shellfish at a higher weekly consumption rate. Based on a higher consumption rate and a similar risk level, the recommended maximum level for total microcystin would be lower than 10 ng/g. OEHHA is working with the Big Valley Band of Pomo Indians' Environmental Protection Department to calculate Action Levels for Tribal members.

The occurrence of HABs causes great economic losses. A study from 25 years ago estimated that HABs resulted in $7 – 10 million in lost tourist revenue annually in Lake County (Goldstein and Tolsdorf, 1994). Clear Lake is a large-mouth bass fishing destination and other water activities, such as water skiing, jet skiing, and swimming are popular at the lake. Economic loses today are likely much greater.

To mitigate HABs and fish kills on Clear Lake, Big Valley Environmental Protection Department, with the assistance of a Bay Area Council California Resilience Challenge grant, has acquired and installed two Tribally-managed water quality data loggers. This monitoring program for HABs and fish kills creates a real-time, open-access Clear Lake water quality data monitoring portal, to analyze and address aquatic species die-offs impacting Tribal beneficial uses (BV EPA, 2021).

Additionally, the Big Valley Band of Pomo Indians is partnering with Tracking California to carry out the California Water: Assessment of Toxins for Community Health Project, or Cal-WATCH. The project is working to increase the ability to reliably track and prevent harmful algal bloom illness statewide, with a special emphasis on Clear Lake.

Alongside the climate change impacts causing HABs at Clear Lake, is the closed Sulphur Bank Mine, a flooded open pit mercury mine 23 acres long and 90 feet deep located 750 feet from Clear Lake. The site is filled with a combination of contaminated mine waste and natural geothermal water that seeps mercury into the lake. While the mine closed in 1957 it was not declared a Superfund site until 1991 (USEPA, 2017b). OEHHA has established fish advisories for Clear Lake based on high levels of mercury in fish (OEHHA 2018).

In 2015, Big Valley's EPA measured the mercury levels in several species of fish in different locations around the lake. Mercury levels measured in certain fish in 2015 were found to exceed fish tissue goals established by the Water Board (WRCB, 2015).

In February of 2021, the USEPA updated the local community on the Sulphur Bank Mine's Superfund Site's status. The USEPA estimated that they were within four years of beginning the main clean-up project, which will be broken up into two phases: consolidation and capping. Initially, the plan involves moving smaller piles of mining waste onto large piles to shrink the area that needs to be removed before installing a heavy cap to act as a barrier over the site. The cap will then be covered with clean soil so that plants begin to grow and rehabilitate the area (USEPA, 2021b).

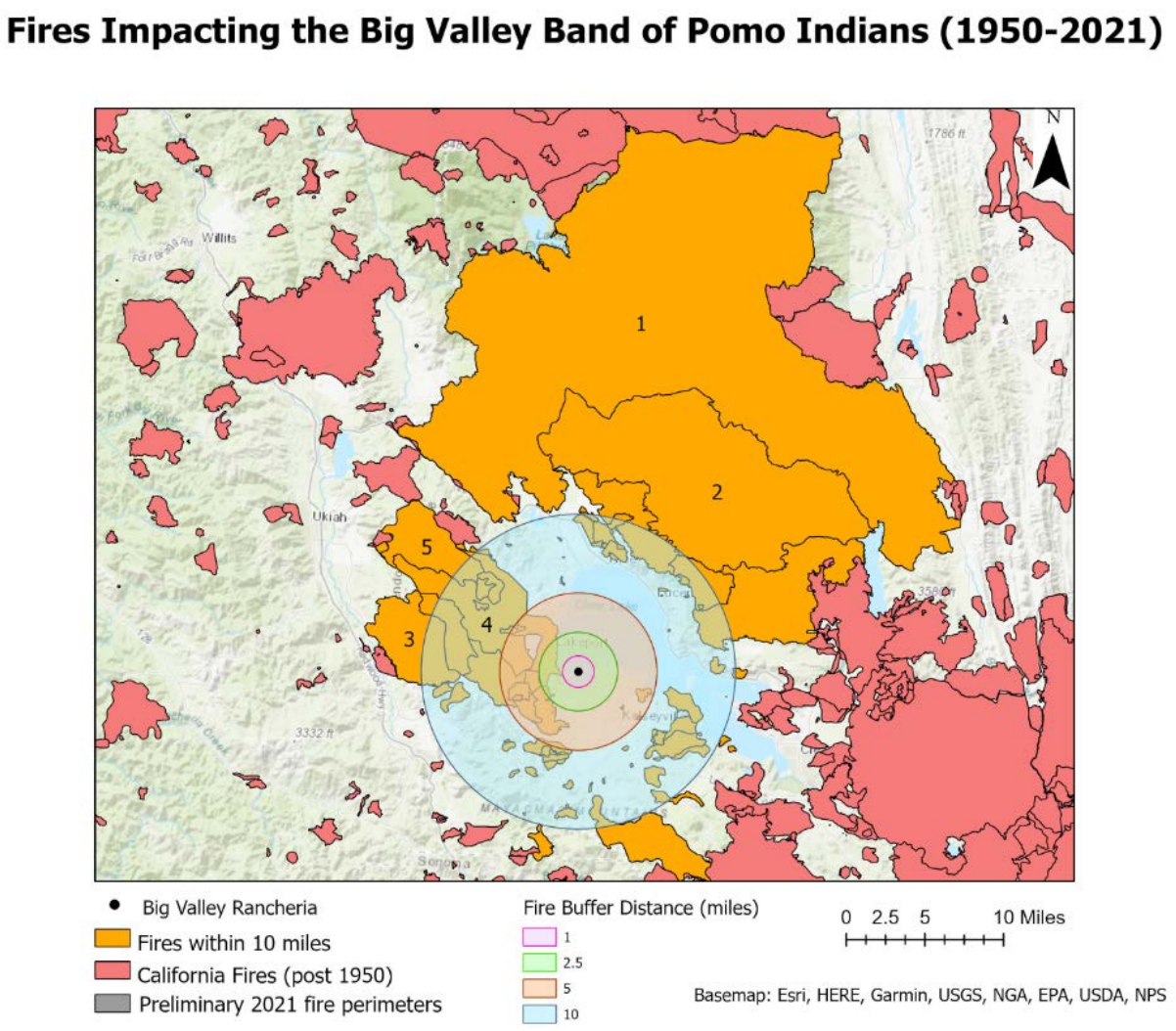
Wildfires

Figure 19 shows California wildfires around the Big Valley Rancheria from 1950 through 2021. In 2018 the Ranch and River fires began during the Tribe's annual Tule Boat Festival, and eventually merged into the 459,123-acre Mendocino Complex Fire (#1 on the map), California's largest wildfire on record at the time.

The Big Valley EPA Director recounted *"People were having trouble breathing on the rancheria. We have a lot of people with asthma and respiratory illnesses. We went to the local stores and tried to get some air purifiers, but everybody was sold out. A neighboring Tribe, the Middletown Rancheria of Pomo Indians, helped Big Valley acquire seventy air purifiers."*

Wildfires are a natural function of California's ecosystems and are important for shaping ecosystem structure. Human influences and policies, however, have worked to prevent natural wildfires and cultural burning practices. Combined with drought, this has led to an increase in the intensity, duration, and frequency of large-scale wildfires which destroy habitat, human infrastructure and livelihood, and harm human health.

Figure 19. Fires within 10 miles of the Big Valley Rancheria.



Source: CAL FIRE, 2022

Historically the Pomo would have conducted cultural burns, low intensity burns on designated parcels which, under the right conditions, reduce the risk of wildfire by consuming dead wood and other fire fuels on forest floors (Miller et al., 2020).

While cultural burning is gaining respect and use, current levels of agency-prescribed burns and tribal cultural burns are too low to make a significant impact on millions of acres left untended for a century and a half. As a result, Tribal members today encounter a surge of catastrophic wildfires their great-grandparents never experienced. Wildfires pose unique and heightened challenges to Tribes, given their relationships to the land. Further, non-Native government officials often the lack an understanding of tribal customs and priorities (Pfeiffer, 2021).

Figure 20. Mount Konocti in clouds.

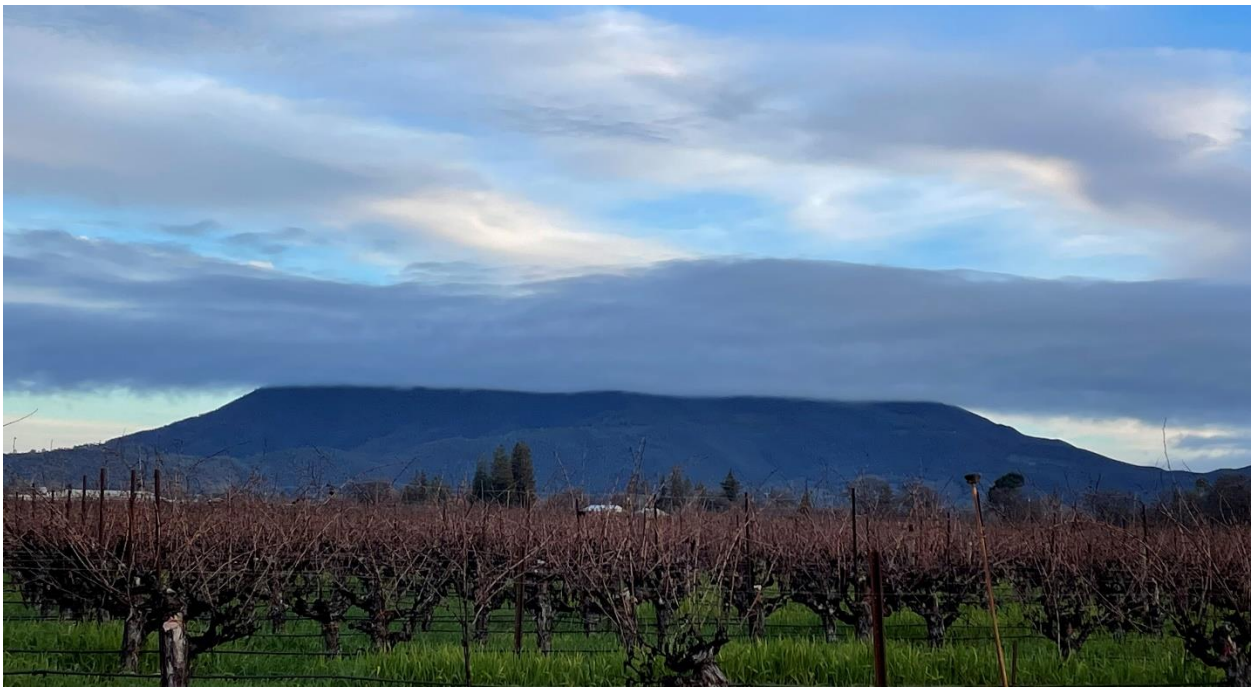


Photo: L Monserrat, OEHHA

Climate change has created shifting conditions for species and created new opportunities for invasive species in what were previously unfavorable climatic regions. Human activities are responsible for habitat and biodiversity loss, land use changes, anthropogenic climate change, forest management and the loss of cultural burning. The resulting droughts, fires, flooding, increases in HABs and other climate threats are impacting our Tribe.

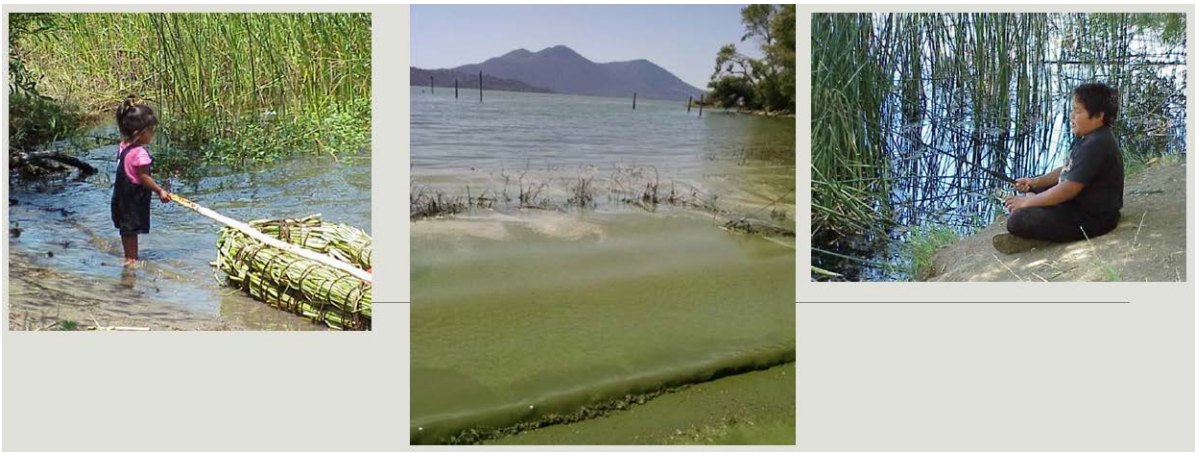
Human Health

The health of the Big Valley Band of Pomo Indians cannot be separated from the health of their environment. Increasing temperatures, increasingly variable rainfall, wildfires and exposure to smoke, pesticides, mold, the loss of important plant and animal species, and exposure to mine waste from the nearby Sulphur Bank Mine Superfund site all impact the health of the Tribe. Exposure to cyanotoxins is a human health concern for the Big Valley Tribe. Tribal members have always used the lake for food, drinking water, ceremony, and recreation (Figure 21). Thus, potential exposures to HABs that produce cyanotoxins include unique pathways that do not apply to non-tribal individuals (Figure 17). Cultural activities that require the use of the lake have had to be postponed or moved due to a lack of tule and other ceremonial material and poor lake water quality. Poor water quality limits Tribal members' access to the lake, an important cultural resource as well as threatens access to safe and clean drinking water.

Climate change has exacerbated food insecurity and the nutrition of the Tribe. There are fewer native wildlife species on which the Tribe has relied on for food such as Indian

potato, clover, acorn, pine nuts, edible mushrooms such as chicken of the woods (*Laetiporus sulphureus*), Clear Lake Hitch, clams, prickly sculpin, crayfish, and tules.

Figure 21. Scenes from Big Valley.
Left, child at Tule Boat Festival. Center, HABs impacts at Clear Lake. Right, a child fishing in the tules



Source: Big Valley EPA

Summary

The Big Valley Band of Pomo Indians has been living alongside Clear Lake and managing their ecosystem since time immemorial. Big Valley Tribal members, like other Tribes have similar challenges as non-tribal members. Temperatures are warming, rain is less predictable, the environment is stressed. The Tribe is working to restore the balance in their environment. Pomo Tribal members have historically been careful about the balance of consumption and restoration of the environment. The Big Valley Tribe is working both internally and with outside agencies to help to restore a balance and provide a more sustainable and certain environment for future generations.

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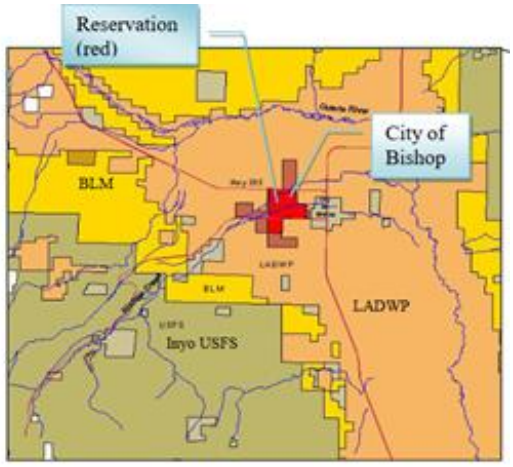
IMPACTS OF CLIMATE CHANGE ON THE BISHOP PAIUTE TRIBE

Rising temperatures and drought compounded by over pumping of groundwater are impacting the physical, cultural, and spiritual health of the Tribe, its habitats, and ecosystems.

Background

The Bishop Paiute Tribe is a federally recognized tribe living in Inyo County at the foot of the Eastern Sierra Nevada mountains, in the Owens Valley, just west of the city of Bishop. They are the fifth largest tribe in California with ~2,000 enrolled members and have one of the smallest land bases (879 acres) (BPT, 2018). Payahuunadü, or land of flowing water, is the Paiute word for the Owens Valley and Eastern Sierra region of California.

Figure 1. Bishop Paiute Reservation (red) within the city of Bishop (brown)



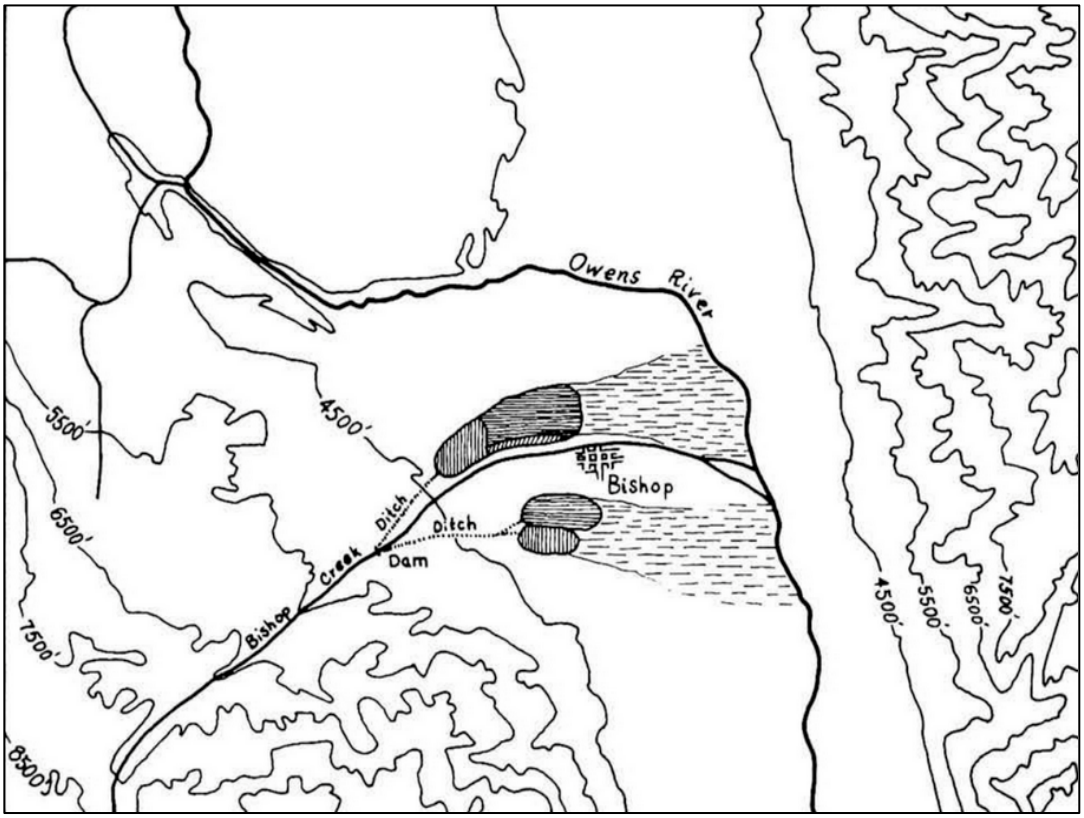
Source: BPTEO, 2018

The people of the Bishop Paiute Tribe are descendants of the "Nüü-Mü," the original people of the Owens Valley who have lived in the area since time immemorial and whose ancestral lands encompassed over 2 million acres of the greater Owens Valley (BPT, 2018). In 1912 under pressure by the US Government, the Bishop Paiute people entered into a treaty in which the US Government reserved 67,120 acres of land in the Owens Valley named the Casa Diablo Indian Reservation for Indians of the area. However, the Paiute were never allowed to move to this Reservation. This treaty was broken in 1933 when President Roosevelt revoked the agreement (Executive Order 6206) and the lands were placed in watershed protection for the City of Los Angeles (OVIWC, 2021). In 1936, the City of Los Angeles and the federal government "traded" the 67,120-acre Casa Diablo lands for the 879 acres that now comprise the Bishop Paiute Reservation (BPT, 2021a).

Historically, the Paiute dug irrigation ditches that routed runoff from melting Sierra Nevada snow into the Payahuunadü. But unlike modern irrigation practices, the Paiutes did not channel the water onto farms or specific plots of land. Bishop Paiute Tribal Elder and water protector Harry Williams explained "We looked at everything as a garden. The natives made this place bloom like a rose. The water was used to irrigate 'wild' seed plants" (Williams, 2016).

Water was so important to the tribe that they had an elected position called the Tuvaiju who oversaw irrigation. The Tuvaiju would use an irrigating tool known as a “pavado” to direct water into the ditch network in the Payahuunadü.

Figure 2. Drawing of traditional Paiute irrigation system at Pitana Patii, near present-day Bishop, Owens Valley, California.



Source: Lawton et al., 1976

The Paiutes' valley was divided by the Bishop Creek into northern and southern plots. As is shown in Figure 2 above the Tribe created a dam system designed so that only one of the areas would receive water each year; the plots were purposefully alternated to conserve soil fertility. The irrigation helped the growth of grass nuts and tubers that made up a significant part of the native diet. The ditches also funneled native fish into areas where they were easy to catch. The irrigation canals distributed the water across the Payahuunadü (Wei, 2016).

Figure 3. Owens Lake and Vicinity between 1905-1911 and as seen from space in 2011

Sources: USGS, 1939 and NASA, 2011

Owens Lake had held water continuously, and at times overflowed to the south, for at least the 800,000 years prior to 1913 (Smith et al., 1993). In 1913 the Los Angeles Department of Water and Power (LADWP) began pumping Owens Lake, which at the time spanned 108 square miles (~1/3 the size of Lake Tahoe), to provide water to Los Angeles. By 1926 the lake was dry (Reheis et al., 1995). In 1970, a second aqueduct that mainly pumps groundwater from the Owens Valley for use in Los Angeles was added. This ongoing water export has intensified the effects of precipitation changes and drought caused by climate change in the Eastern Sierra. (BPT, 2020).

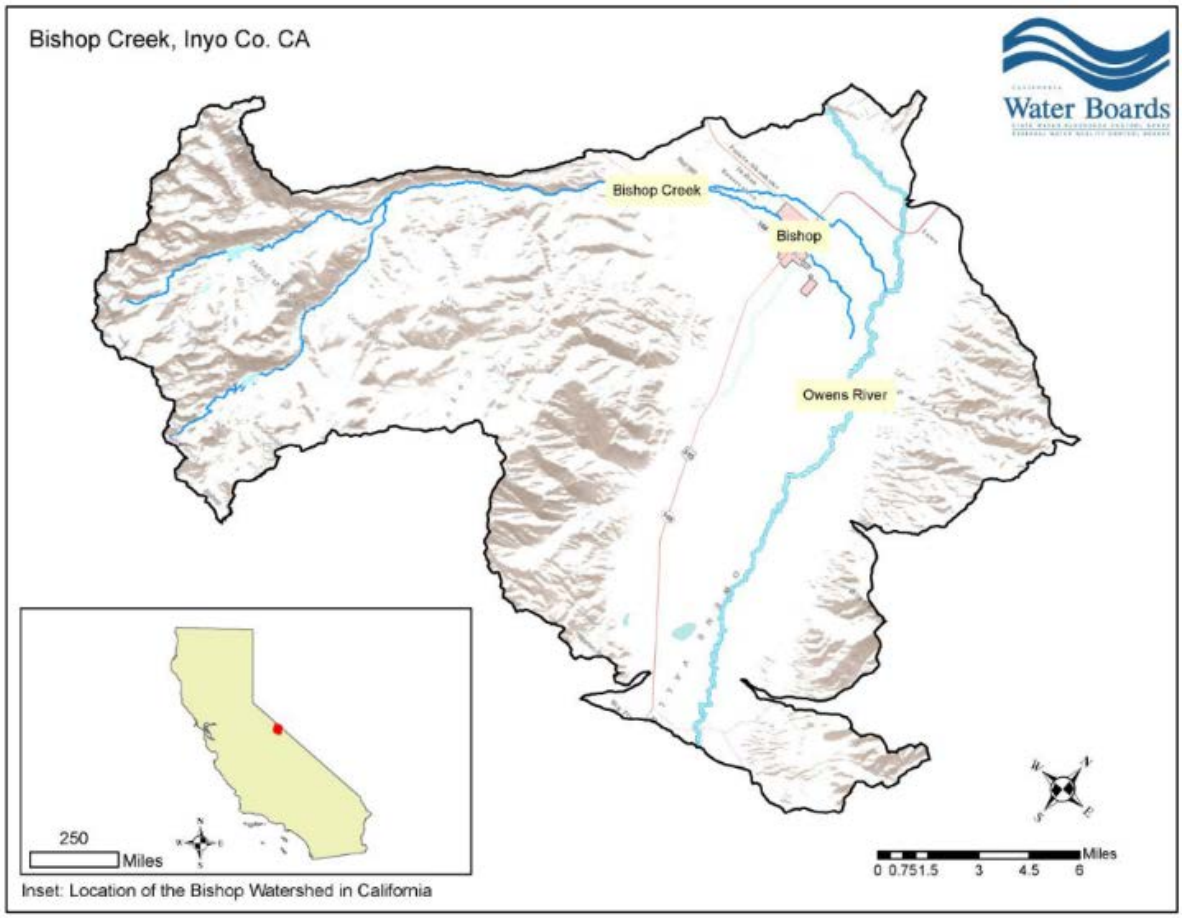
Figure 4. Dry winds blow sand across what used to be the north shore of Owens Lake

Photo credit: David McNew

This change to the Owens Valley climate has also caused a troubling rise in the level of PM10, inhalable particles with diameters that are generally 10 micrometers and smaller. Owens (dry) Lake is currently the largest source of PM10 in the United States, thirty tons of which is arsenic and nine tons of which is cadmium. USEPA estimates that 94% of the PM10 in the Owens Valley comes from the now dry Owens Lake (USEPA, 2017). Research has linked exposures to relatively low concentrations of particulate matter with premature death. At greatest risk are Tribal Elders and those with pre-existing respiratory or heart disease, lung disease, asthma or chronic obstructive pulmonary disease (USEPA, 2017).

The current Reservation ecosystem is over the Bishop Cone, an area characterized by a shallow water table with depths ranging from 1 to 10 feet below ground level. This substantially enhances vegetation coverage including a variety of pasture grasses and several types of deciduous tree species. As shown in Figure 5, both North and South Forks of Bishop Creek traverse the Reservation. With the exception of relatively recent increases in bacterial levels in South Fork stream water quality is excellent and supports a 5-mile-long riparian forest corridor providing a rich habitat for a variety of flora and fauna (BPT, 2018). Additionally, there is a wetland in the southeast corner of the Reservation within the Conservation Open Space Area (COSA).

Figure 5. Bishop Creek and surrounding Watershed, Inyo County, CA



Source: LRWQCB, 2020

In 1988 the Bishop Paiute Tribe established the COSA which serves as important habitat for native plants and animals. Furthermore, the COSA is currently being utilized to increase populations of threatened and endangered plants and animals, such as the Owens Valley Checkerbloom and the Inyo County Mariposa Lily. The Tribe has been working to introduce the Owens pupfish to the COSA via a Federal Safe Harbor Agreement, which would provide these culturally important fish with another refuge.

Because the impacts of climate change do not start and stop at the Reservation borders, and because the culture of the Bishop Paiute Tribe is tied to all their traditional lands, this report covers both the changes seen on the Reservation lands

Figure 6. Petroglyphs at the Volcanic Tablelands

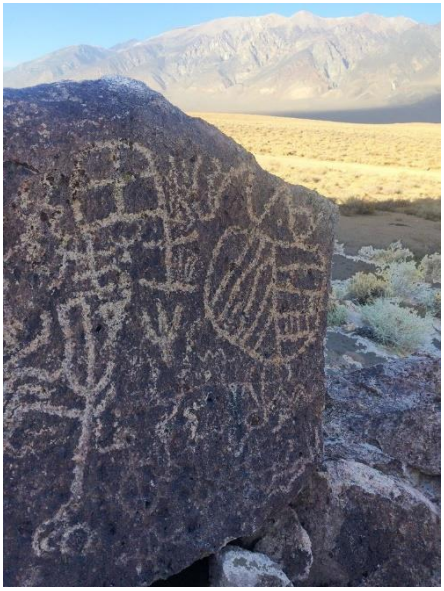


Photo credit: Sarah Rea

as well as on traditional lands of the Bishop Paiute such as Volcanic Tablelands and Fish Slough. Petroglyphs within the Volcanic Tablelands are shown in Figure 6.

Cultural and Spiritual Health

As the climate changes the cultural and spiritual health of the Bishop Paiute Tribe are impacted. You cannot separate the health of the earth from the health of the Bishop Paiute Tribe. The Tribe has seen a loss of gathering areas and ceremonial locations, a reduction in traditional medicines and foods, impacts on culturally important fish species, and a loss of the Bishop Paiute's traditional waters through both drought and groundwater pumping for export by LADWP. The Tribe has observed pumping is causing local streams and springs to die which has a cascading and compounding impact on the surrounding insects, fish, mammals, and vegetation (BPT, 2020).

The Bishop Paiute Tribe has created a web of interconnected efforts aimed at responding to the complexities of climate change. They are protecting their natural resources with a combination of mitigation efforts, such as installing rooftop solar panels, increasing food sovereignty, and invasive plant removal, as well as adaptation strategies such as protecting Tribal waters, providing cooling for elders, and educating Tribal members (Kapp, 2019).

CLIMATE CHANGE IMPACTS

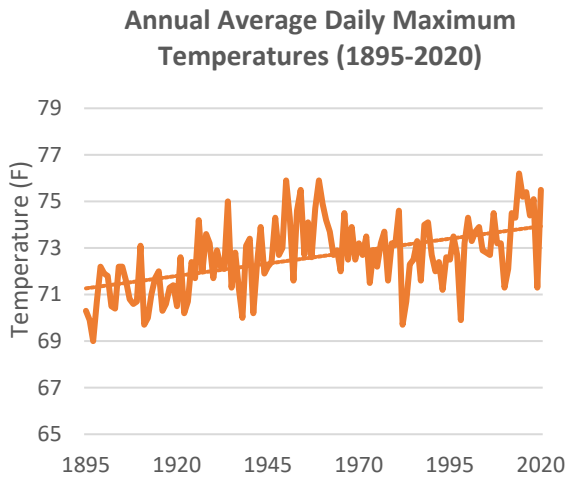
Climate change in the Bishop Tribal lands in the Eastern Sierra has impacted wildlife, native vegetation, and culturally important foods such as pine nuts, acorns, fish, and wild game. Drought in the area, along with beetle infestations, have caused an increase in tree mortality. The build-up of dead trees in the National Forest area at Indiana Summit and the increase of perennial weeds, shrubs, and other flashy fuels have increased the fire danger over time. Sporadic heavy rains in the winter and spring increase the growth of vegetation which then dry and become fuel in the hot summers (BPT, 2020).

Elevated Temperatures

Temperatures have been increasing in Bishop. Elevated temperatures affect human health, mental health, cultural and spiritual health, socio-economic health, as well as the plants and animals that are part of the Bishop Paiute's ecosystem. Elders, children, outdoor workers, and those with existing medical conditions are particularly susceptible to these impacts.

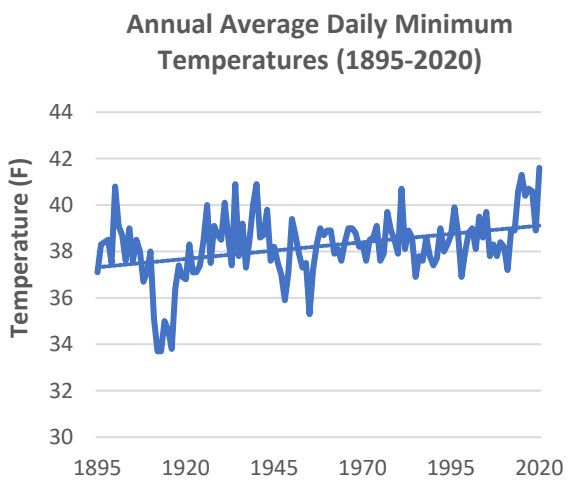
As shown in Figures 7 and 8 both the annual average daily maximum (daytime) temperatures and the annual average daily minimum (nighttime) temperatures are rising at Bishop, with the daytime temperatures rising faster.

Figure 7. Daytime temperatures at Bishop



Source: PRISM, 2021

Figure 8. Nighttime temperatures at Bishop



Source: PRISM, 2021

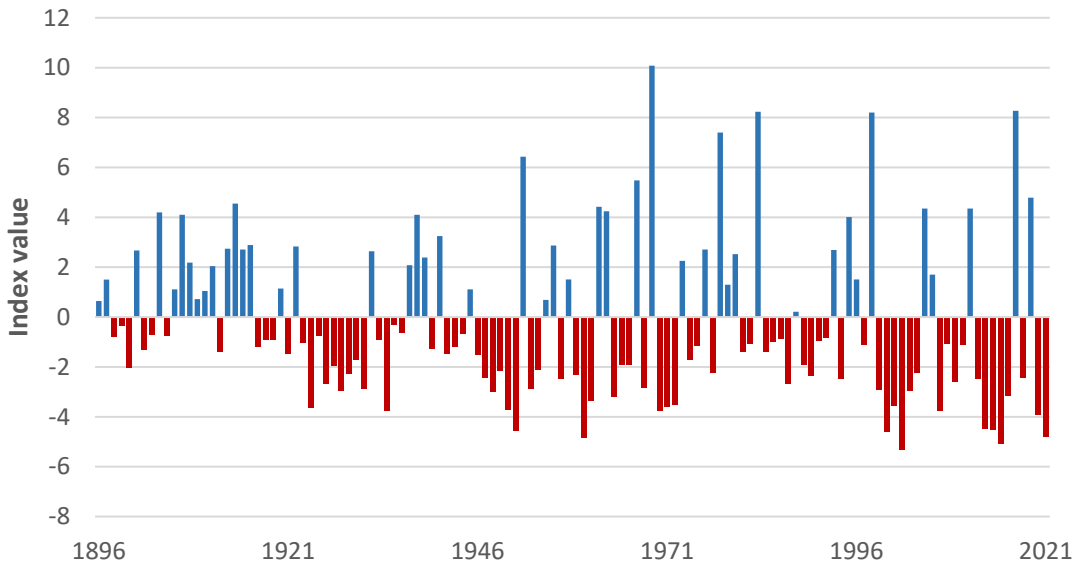
Warming temperatures are considered a high-risk exposure for the Bishop Paiute Tribe. As is evident from the increasing minimum temperatures, the cooling nights that the Bishop Paiute community has been accustomed to are warming over time. The combination of warmer daytime and nighttime temperatures is impacting both the human and the plant communities. As temperatures have increased, the Bishop Paiute Environmental Department has observed declining areas of important habitats including native grasslands, wetlands, riparian, and upland habitats and increasing levels of non-native grasses and shrubs (BPT, 2020). The conditions caused by drought and the over pumping of groundwater also allow invasive species to take hold (e.g., invasive weeds such as Pepperweed, Cheatgrass, Non-native Asters, and Tumbleweed).

Drought

The impacts of drought are intensified in the Owens Valley due to ground and surface water pumping by LADWP to supply water to Los Angeles (ICWD, 2021a). No matter how much snow or rain falls in the Eastern Sierra, the water needs of Los Angeles remain and will increase as populations increase, further burdening the Bishop Paiute community.

As is shown in Figure 9, Bishop is having more frequent, and more intense, dry years. The graph shows a commonly used measure of drought, the Palmer Drought Severity Index (PDSI), which combines both temperature and precipitation data to provide a measure of relative dryness (drought) on a scale from +10 (wet) to -10 (dry). The lower the number the drier the conditions. Prior to 1958, dry years (with PDSI values below zero) occurred 37 times, only one of which was classified as extreme drought (PDSI at or below -4). From 1959 to 2021 Bishop experienced 43 dry years, including 7 years of extreme drought (Abatzoglou et al., 2022).

Figure 9. Palmer Drought Severity Index at Bishop for the years 1895-2021



Source: Abatzoglou et al., 2022

As detailed in the history of the Bishop Paiute, water holds a strong cultural significance for the Paiute people. A lack of water impacts the survival of plants and animals, which hold cultural importance to the tribe.

Impacts to Vegetation

Climate change in the Bishop Tribal lands in the Eastern Sierra has negatively affected native vegetation, including culturally important medicines and foods such as pine nuts and acorns. Drought in the Eastern Sierra, along with beetle infestations by the mountain pine beetle (*Dendroctonus ponderosae*), have caused an increase in tree mortality. As trees become stressed by drought, their vigor and defense mechanisms weaken, making them more vulnerable to attack. High temperatures exacerbate already stressed conditions for tree survival. (BPT, 2020).

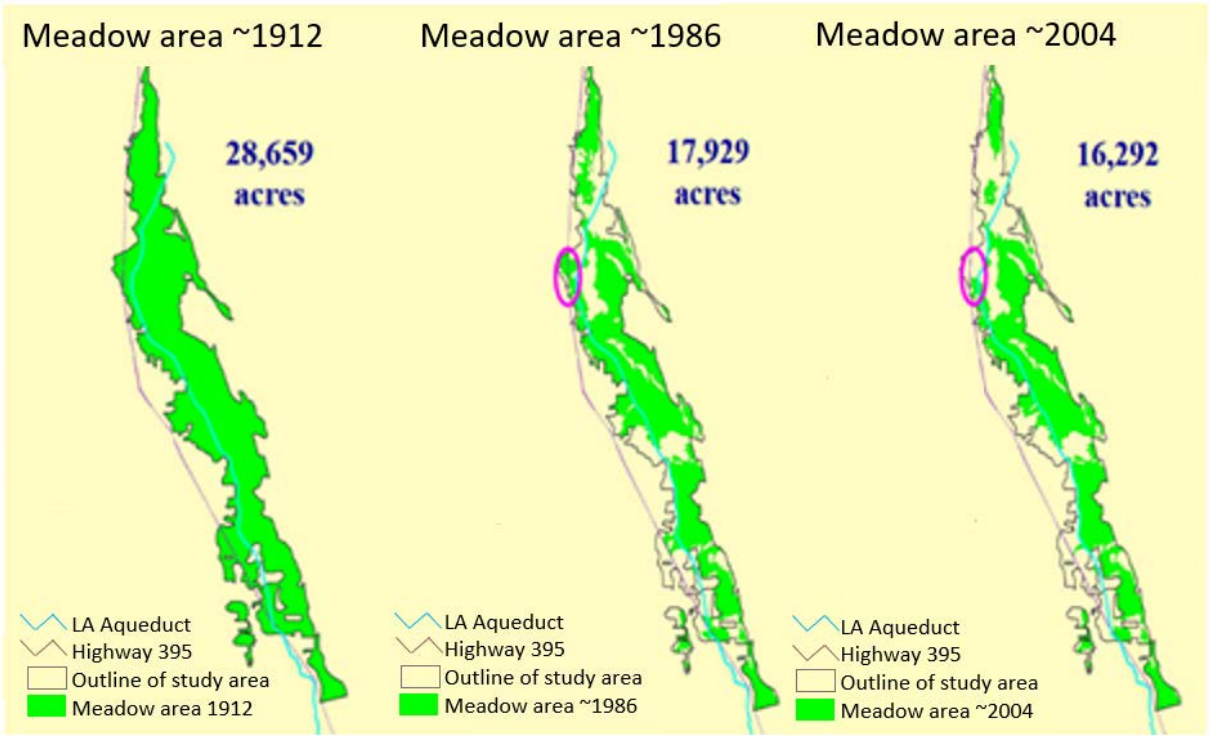
In addition to the decreased availability of acorns, the Bishop Paiute Tribe and other Eastern Sierra Tribes reported a change in the taste of the flour made with local acorns. With the decrease in water and increase in temperatures in the Eastern Sierra, the Tribe has seen the local vegetation change from water-loving plants to shrubs. As these plants change, the animals that rely on them must necessarily change too (BPT, 2020).

Bishop Paiute's ecosystems have suffered from water deficits during years of low precipitation, exacerbated by the anthropogenic drought caused by pumping of the Owens Valley groundwater for use in Los Angeles. The entire region experienced a 6-year drought (1987–92), during which annual precipitation was below the 50-year median of 7.12 inches (USGS, 1998). Elmore et al. conducted a 16-year study which documented an increase in the depth to the groundwater table—associated with increased groundwater pumping—and analyzed changes in vegetative cover. The study

found plant cover to be correlated with groundwater depth, indicating that pumping exacerbates drought impacts to vegetation in the Owens Valley (Elmore et al., 2006).

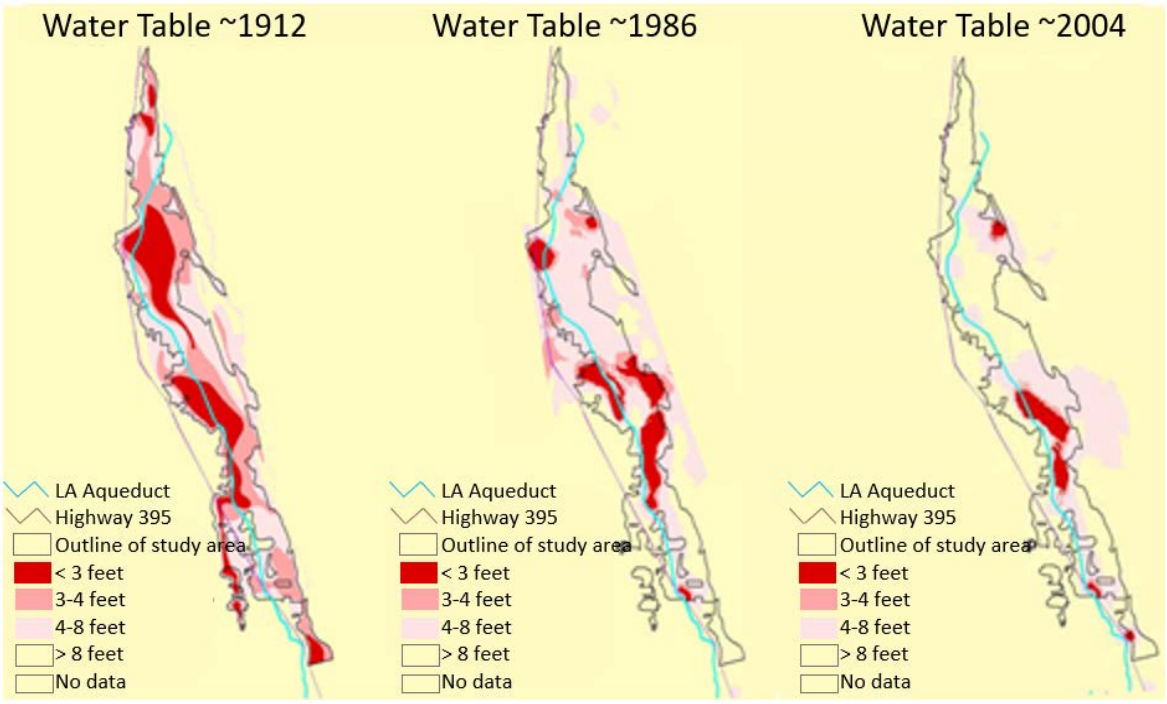
As the Owens Valley climate continues to change, becoming warmer and dryer, the Valley meadows are disappearing, and the Tribe is seeing a desertification of the area. The Tribe knows that with sufficient water in the area, the meadows and grasses would thrive again (Bengochia, 2021). As shown in Figures 10 and 11, reductions in meadow vegetative cover have occurred with dropping water table levels. In 1912 a former United States Geological Survey (USGS) hydraulic engineer created maps showing ground water depths and vegetation types (Lee, 1912). Digitized versions of these maps are used here to compare ground water and meadow ecosystems. The maps in Figure 10 allow a comparison of the area occupied by meadows in 1912, 1986, and 2004. The 1912 map shows the baseline of the grasslands. The 1986 and 2004 maps, based on monitoring by LADWP, show substantial grassland loss with the area known as Blackrock 94 (see photograph, Figure 12) highlighted in pink. Figure 11 shows the water table levels in the same area. Due to groundwater pumping, water tables have gotten deeper and areas with shallow groundwater (less than 3 feet) have decreased substantially. The lack of groundwater corresponds to the lack of meadow in the same area.

Figure 10. Maps showing areas occupied by meadows (shown in green) in the Owens Valley in 1912, and reductions in 1986 and 2004. Blackrock 94 is highlighted in pink.



Source: Manning, 2012; digitized maps from Lee, 1912

Figure 11. Maps showing depth of water table in the Owens Valley



Source: Manning, 2012; digitized maps from Lee, 1912

The photographs in Figure 12 show the Blackrock 94 area in June of 1988 (top) and June of 2007 (bottom). In 1988 the area had 33% vegetation coverage, dominated by green grass with 4% shrubs. By 2007 vegetation coverage was reduced to 15% in the same area, consisting of ~11% shrubs and ~3% grass.

Maps more recent than 2004 showing data that can be compared to Figures 10 and 11 are not currently available. This is partly due to changes in the methods of data collection. It is noteworthy to mention that some groundwater data recently collected from County of Inyo Water Department suggests that comparing years 2021 and 2022 the average basin groundwater table was reduced by an average of approximately two (2) feet

Figure 12. Comparison of Blackrock 94 area June 1988 (top image) and 2007 (bottom)

Source: Manning, 2021

(ICWD, 2021b). The Owens Valley is a closed basin that has been drained over the past 100 years and the continuation of pumping is leading to a reduction of vegetation diversity including culturally important plants in the Payahuunadü.

Though it is generally rare in California, alkali meadow is a major vegetation type in Owens Valley, and on the Bishop Paiute Reservation. The Owens Valley has 67% of the alkali meadow in California. In the 1980s, LADWP biologists mapped at least 70,000 acres of Valley floor as dominated by California native grasses, supported by Owens Valley's naturally shallow groundwater (Davis *et al,* 1998). These meadows are home to species of cultural importance and conservation concern, both plants such as the Owens Valley checkerbloom and the Inyo County star tulip, and animals such as Owens Valley vole, northern harrier and red shouldered hawk (Elmore *et al,* 2006).

Meadows are a biodiverse habitat that sustain common as well as rare species. Owens Valley meadows are dominated by one or both native perennial grass species: saltgrass (*Distichlis spicata*) and alkali sacaton (*Sporobolus airoides*). Both are hardy species, with roots growing to approximately 2 meters. Other common grasses in meadows include Beardless wildrye (*Leymus triticoides*), Baltic rush (*Juncus balticus*), scratchgrass (*Muhlenbergia asperifolia*), basin wildrye (*Leymus cinereus*), and, to a lesser extent, alkali cordgrass (*Spartina gracilis*). Irises, lilies, and broad-leaved herbaceous plants intermingle with the grasses.

Other meadow species include:

- Alkali mallow (*Malvella leprosa*)
- Fish Slough milk vetch (*Astragalus lentiginosus ssp. Piscinensis*)
- Hall's meadow hawksbeard (*Crepis runcinata ssp. Hallii*)
- Inyo County star-tulip (*Calochortus excavatus*)
- Nevada blue-eyed grass (*Sisyrinchium halophilum*)
- Owens Valley checkerbloom (*Sidalcea covillei*)
- Saltmarsh bird's-beak (*Cordylanthus maritimus* Nutt. ex Benth.)
- Stinkweed (*Cleomella*)
- Wild licorice (*Glycyrrhiza lepidota Pursh*)
- Yerba mansa (*Anemopsis californica*)

Native shrubs include:

- Rabbitbrush (*Chrysothamnus nauseosus*)
- Nevada saltbush (*Atriplex lentiformis ssp. torreyi*)
- Greasewood (*Sarcobatus vermiculatus*)
- Sagebrush (*Artemisia tridentata*)

Of these species, the annual species *Malvella*, *Cleomella*, *Cordylanthus* are less tolerant of changes to water and are more likely to be lost as meadows are deprived of water. The Tribe has translocated many of these species to the COSA to attempt to preserve them.

Wetlands provide some of the richest habitat on the Bishop Reservation, supporting many species of plants and animals. There are approximately 25 acres of federally designated wetlands located in the eastern section of the Reservation (BPT, 2021b). One observable way the area has changed in the last 20 years is that much of the alkali meadow portion of the wetlands has been invaded by perennial pepperweed (*Lepidium latifolium*). This plant, not native to Owens Valley, has proved extraordinarily difficult to control. It propagates by seed and has very deep roots (BPT, 2021b).

The Bishop Paiute Tribe has long been attuned to seasonal variations related to planting and stewardship of plants. Jen Schlaich, Food Sovereignty Program Specialist for the Tribe, reported “Several Elders have noted changes in harvest times for traditional foods. Community members have also mentioned changes in seasons such as out of the ordinary weather patterns, warmer fall weather and colder spring weather” (Kapp, 2019).

In addition to the overall decline in the quality and abundance of native vegetation due to climate changes, the Bishop Paiute have seen a decrease in culturally important food species such as “wai” (Indian Ricegrass), tule, acorn and pine nut (BPT, 2020).

Impacts to Wildlife

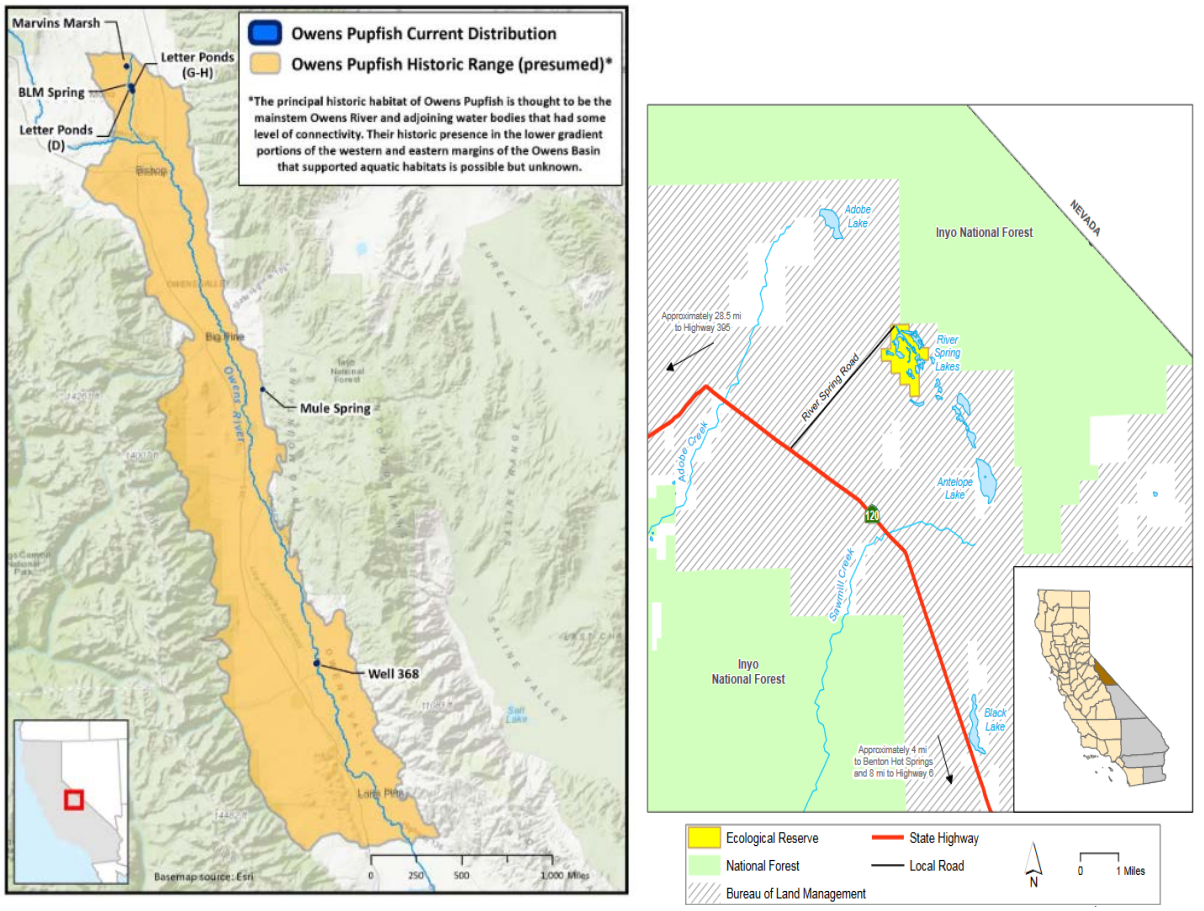
Impacts from climate change threaten the Bishop Paiute’s access to traditional foods such as fish, game, and wild and cultivated crops. These resources have provided sustenance as well as cultural, economic, and community health for generations.

Figure 13. Owens Valley pupfish

Source: UCD, 2021
Phot credit: Joe Ferreira

The Bishop Paiute have cared for and been nourished by desert fish including the Owens pupfish (Figure 13) since time immemorial. The Owens pupfish (named for its playful nature) is a 2.0 inch long, silver-gray fish that turns a bright, florescent blue during spawning season. Historically, the pupfish was a staple food item for the Paiute people in the Owens Valley, who caught the fish by the hundreds and dried and stored them. The Tribe continues to try to protect and care for these threatened fish but as their habitat shrinks due to climate change, land use practices, and extensive water development, they are now limited to the small areas shown in Figure 14 below (CDFW, 2020a) and a newly designated area called the River Springs Lake Ecological Reserve (CDFW, 2021).

Figure 14. Maps of historic range and current distribution of Owens pupfish in Mono and Inyo counties (left), and of River Spring Lakes Ecological Reserve (right)



Source: CDFW, 2021

Shell mounds of freshwater mussels (*Anodonta nuttalliana*) and surveys on the Bishop Paiute lands including the creeks and Owens Lake indicate the historic use of mussels as a food source. Mussels are no longer found in Owens Lake because it is dry, but they have been found in the Bishop Creek canal, which diverts water from the Owens River for use by LADWP, as recently as 2014 (Blevins et al., 2017), (CDFG, 2015). Freshwater mussels have also been seen in LADWP dredge piles (Klingler, 2021), but due to reduced numbers they are no longer used as a source of food for the Paiute people (Bengochia, 2021).

Figure 15. Freshwater mussels in a canal dredge pile. The different sizes/ages classes indicate they were reproducing in the recent past.

Photo credit: Ceal Klingler

The Owens Tui Chub (*Siphateles bicolor snyderi* or *Gila bicolor snyderi*) is endemic to the Owens Basin, Mono and Inyo Counties. It was a food source for the Bishop Paiute people but is now found in only six sites, including the COSA, all created for the preservation of the species on the Bishop Paiute lands. The COSA Tui Chub are hybridized. The Toikona Tui Chub is the original species and is now only found in isolated conservation areas to prevent hybridization (CDFW, 2020c).

The Owens speckled dace (*Rhinichthys osculus ssp*.) historically occupied most small streams and springs in the Owens Valley. By the 1980's the stream-fed ponds and springs that the Owens speckled dace lived in were depleted or destroyed by the construction of and pumping for the LA aqueducts, and they were extirpated from most of their historic range. The COSA on the Bishop Paiute lands is one of three remaining, isolated habitats left for these culturally important fish (Mussmann, et al. 2020).

The Paiute still hunt both large and small game and have noticed a decline in culturally important species. Rabbits, especially black-tailed jackrabbits and cottontail rabbits, used to be plentiful in the area. The Tribe has seen a decline in both species. As the area has suffered from drought and desertification, food on which the rabbits depend has become less available (Bengochia, 2021).

Mule deer is a culturally important species for the Bishop Paiute Tribe. Mule deer are in decline across the west, their migration patterns and food availability impacted by drought and other aspects of climate change (Aikens et al., 2020). In 2017, 120 mule deer that were migrating to their winter grounds in the Valley ran into persistent snow and ice sheets, not normally found in the area, and slid to their deaths. This type of event has only happened twice before that the Tribe knows of and never on this scale (Brown-Williams, 2017).

In 2020 the Bishop Paiute Tribe entered into an agreement with the California Department of Fish and Wildlife allowing the Tribe to take 16 deer for cultural education purposes. This agreement was the first of its kind and it recognizes the Tribe's authority to protect wildlife resources (CDFW, 2020b).

Some of the other impacts to wildlife the Tribe is experiencing include:

- Declining numbers of native fish such as Owens pupfish, Owens tui chub, Owens speckled dace, Owens sucker and tui kona tui chub
- Increasing stream temperatures
- Increasing bacteria levels (E. coli, cyanobacteria) in surface waters on the Reservation and associated adverse effects on local wildlife
- Decrease in bird species such as yellow-headed black bird, red-winged black bird, eagles, and swallows
- Decline in numbers of bats

The Tribe has also observed increases in non-native species that have the potential to take the place of native species as the climate of the Owens Valley warms and dries, such as:

- Barred Owl
- Black Witch moth (native to Mexico)
- Bullfrogs and mud snails
- Rainbow trout, largemouth bass, catfish, and perch

The Bishop Paiute lands provide habitat for many threatened or endangered species such as Western Meadowlark (*Sturnella neglecta*), Owens Valley vole (*Microtus californicus ssp. vallicola*), a myriad of insects and spiders, and many other animals. The Northern Harrier (*Circus cyaneus*) and Red Shouldered Hawk (*Buteo lineatus*) are year-round residents, breeding in Owens Valley and foraging in meadows. As discussed earlier, the meadows that these species rely upon are threatened by climate change impacts that continue to lower the water table (Manning, 1997).

Wildfire

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 2021). Since 2007 there have been 10 fires over 100 acres in size that have impacted the Bishop Paiute. The Reservation is in an area designated as a High Fire Severity zone (BPT, 2018).

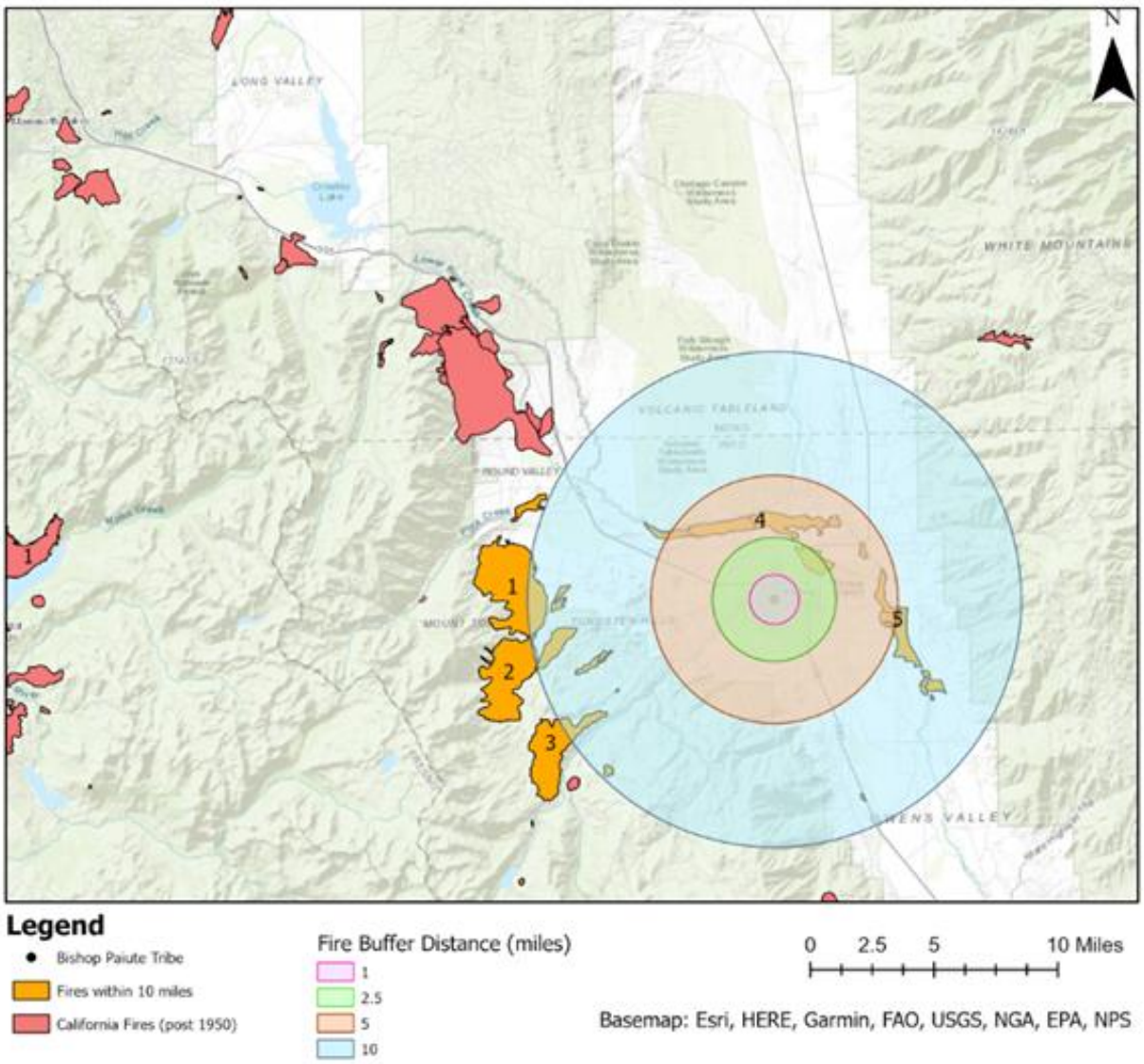
Table 1. Wildfires Impacting the Bishop Paiute Tribe 2007-2020

Year	Fire	Acres
2007	Inyo Complex (#1)	35,000
2009	Fort Fire (#4)	5,000
2009	Forks Fire	3,268
2011	Center Fire	850
2014	Bridges Fire	113
2015	Round Fire (#3)	7,000
2018	Pleasant Fire	2,070
2019	Cow Fire	1,975
2019	Taboose Fire (#2)	10,400
2020	Beach Fire (#5)	4,000

Source: CAL FIRE, 2021

The map in Figure 16 shows fires within 10 miles of the current Bishop Tribal lands that occurred between 1950 and 2020; the five largest fires are numbered. While the Reservation itself has not been burned by large wildfires, there have been impacts to the soils, riparian habitat, air, and water quality (BPT, 2018). Fires increase soil erosion, particularly in denuded watersheds. Wildland fires that eliminate forest areas affect soils, watershed value and habitat. Fires that burn hot and destroy most of the vegetation are also destructive to aquatic habitats.

Figure 16. Fires Impacting the Bishop Paiute Tribe 1950-2021



Source: CAL FIRE, 2021

Years of drought, declining snowpack, over pumping of groundwater, and increasing temperatures, combined with more than a century of fire suppression and attendant changes in forest composition, have significantly increased fire severity, frequency, and size throughout the Eastern Sierra (Dettinger et al., 2018). The Tribe has noted that a build-up of dead trees in the National Forest area at Indiana Summit and the increase of weeds, shrubs, and other flashy fuels have increased the fire danger for the Tribe (BPT, 2020).

During the 2019 fire season, the overlap of smoke from fires such as the Taboose Fire shown in Figure 17, and dust from windstorms caused a build-up of respirable particulate matter (less than 10 micrometers in diameter; PM10) that was documented

by the Bishop Air Quality Monitoring Program (BPT, 2020). In 2021 there were 12 wildfires ranging in size from the 25-acre Pine Fire to the 963,306-acre Dixie fire that caused wildfire smoke exposure to the Tribe (BPT, 2021c).

Short-term exposures to PM10 have been associated primarily with worsening of respiratory diseases, including asthma and chronic obstructive pulmonary disease, leading to hospitalization and emergency department visits (CARB, 2021).

Figure 17. The Taboose Fire, 2019

Source: NWCG, 2019

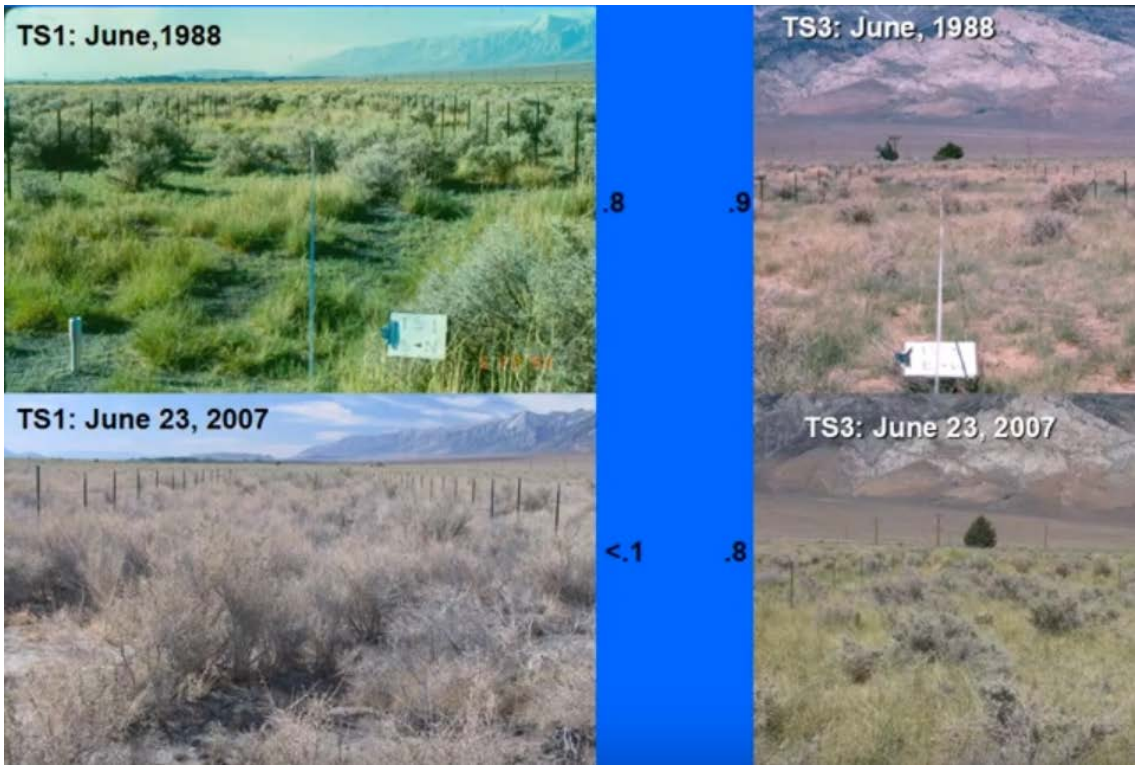
Many mountain meadows below the elevation of 7,500 feet, including the meadows of the Eastern Sierra, are not truly natural but were influenced for millennia by Tribal burning practices. Native people altered the size and composition of meadows through periodic burning. Setting fires in the areas surrounding the meadows discouraged the encroachment of more wet-tolerant vegetation. Periodic burning within the meadow boundaries influenced the species composition, density, and abundance of native plant populations. Certain meadow plants such as deergrass, yampahs (a genus of wild carrot) and clovers were favored and maintained through burning (Anderson, 2005).

Historically, the Paiute conducted cultural burns on their lands. Controlled burns are no longer practiced by the Bishop Paiute. The population of the Bishop area has grown over time and federal land agencies control much of the lands the Tribe used to steward. On the Reservation the reduction of agricultural lands and densification of single-family homes (2000 members live on just 879 acres) have created a matrix of fuels that are unsafe to control with prescribed burns (BPTEO, 2021).

Burning was also used to increase foods such as wild onions and elderberries, and to clear out the underbrush to bring in new growth for the animals. The Owens Valley Indians also grew tobacco and burned the fields where the tobacco grew (Padilla, 2004).

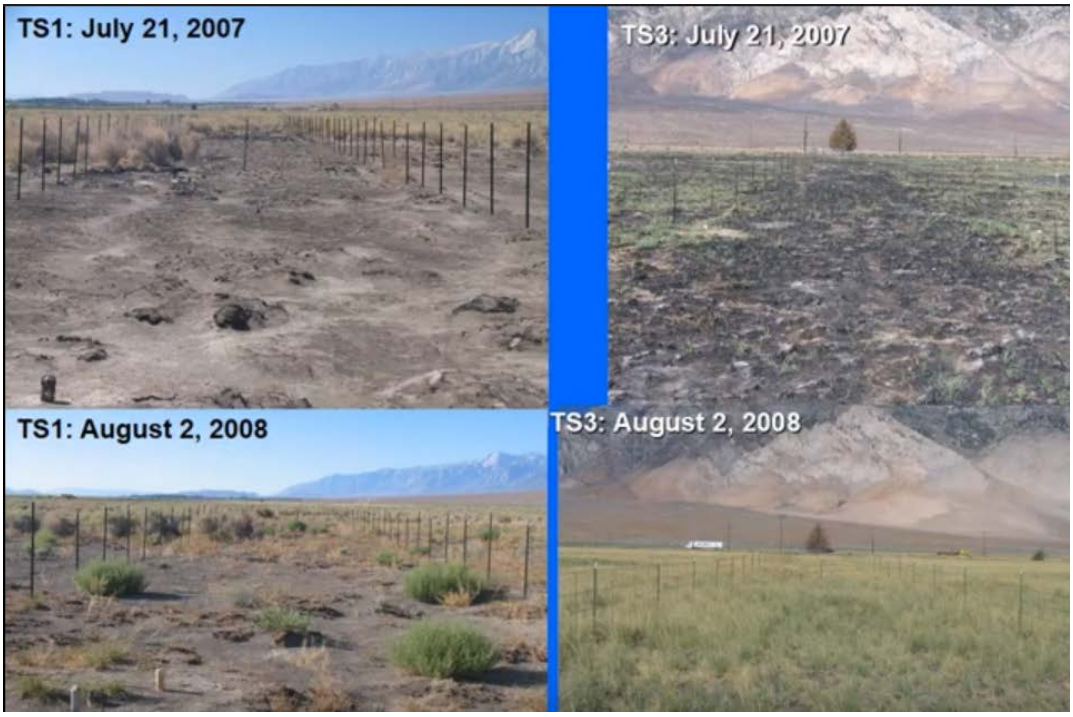
As non-native vegetation dominates, the Valley is less resistant to fire. The roots of meadow grasses have evolved to tap into the historically shallow (8 feet) ground water of the area, while the roots of the encroaching shrubs can burrow deeper for water. In early July 2007, the Inyo Complex fire burned over 35,000 acres including a vegetation study area. Figure 18 shows two sites in the study area (TS1 and TS3) in 1988, when the grass-to-shrub ratios were similar in both locations (0.8 in TS1 and 0.9 in TS3). By 2007 site TS1 had been over pumped, and this anthropogenic climate change impact had promoted the growth of shrubs such as tumbleweed, resulting in a grass-to-shrub ratio of less than 0.1. In site TS3, an area that had been better managed and allowed more water, native grasses were nearly as abundant as they were in 1988. The top photos of Figure 19 below shows both the TS1 and TS3 areas soon after the Inyo Complex burned through the area. A year later (bottom photos) area TS1, which had been populated by non-native shrubs, still looked barren while area TS3, populated by native grasses, had nearly recovered.

Figure 18. Study areas TS1 and TS3 pre fire. The numbers shown in the middle panel next to each photo are the grass-to-shrub ratios: for TS1, 0.8 in 1988, <0.1 in 2007; for TS3, 0.9 in 1988, 0.8 in 2007.



Source: Pritchett and Manning, 2009

Figure 19. Areas TS1 and TS3 after the Inyo Complex Fire



Source: Pritchett and Manning, 2009

Summary

Climate change is impacting the culture, lives, environment, and health of the Bishop Paiute Tribe. These changes are compounded by LADWP's diversion of water from the Payahuunadü.

The Bishop Paiute people continue to work to protect and enhance the natural resources and habitat of the Owens Valley. Because climate change is deeply affecting the environment and altering and disrupting the ecosystems within and around the Owens Valley, the Bishop Paiute community is actively working to understand, adapt to, and mitigate the effects of climate change and other impacts to their lands. Their goal is to continue to manage and protect their traditional lands and limit the impact climate change is having on the Bishop Paiute people's right to hunt, fish, and gather from their land—something that is integral to their culture, well-being and livelihood.

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IMPACTS OF CLIMATE CHANGE ON THE KARUK TRIBE

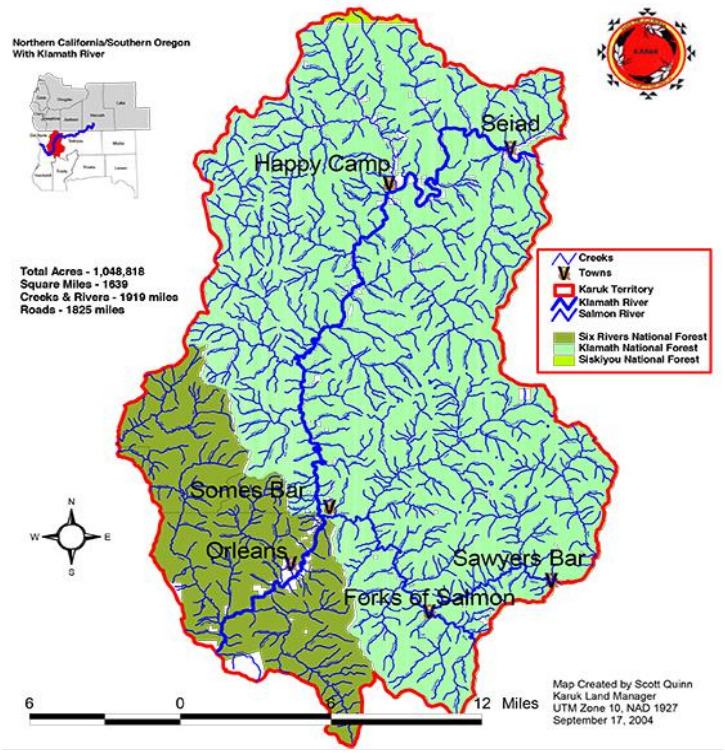
Self-described as "fix the world people," the Karuk Tribe has relied on fire and ceremony to manage their lands since time immemorial. The threats of climate change, acting alongside non-climate factors, are an opportunity for the Tribe to return to traditional management, which includes the use of 22 key cultural indicator species to gauge ecosystem health and to guide appropriate action.

Background

The Karuk Tribe is a federally recognized Tribe comprised of Karuk araráhih (upriver people) located along the Klamath River in the northwestern corner of the state, in Humboldt and Siskiyou Counties. The Karuk Tribe is one of the largest tribes in California with 3,744 members and 5,271 descendants (Karuk Tribe Enrollment Department).

Since time immemorial, the Karuk have lived in the Klamath-Siskiyou Mountains in the mid-Klamath River region of northern California (Figure 1). With an Aboriginal Territory that includes over a million acres, the ancestral Karuk people resided in more than one hundred villages along the Klamath and Salmon Rivers and tributaries. Thriving with a subsistence economy supported by rich natural endowments and a strong culture-based commitment to land stewardship, Karuk environmental management has shaped the region's ecological conditions for millennia. Through carefully observing natural processes, the Karuk have developed traditional management regimes based on a landscape-level ecosystem approach. Self-described as "fix the world people," the Karuk continue ceremonies that restore balance and renew the world.

Figure 1. Map of Karuk Aboriginal Territory



Source: Karuk Tribe
Climate Vulnerability Assessment, 2016

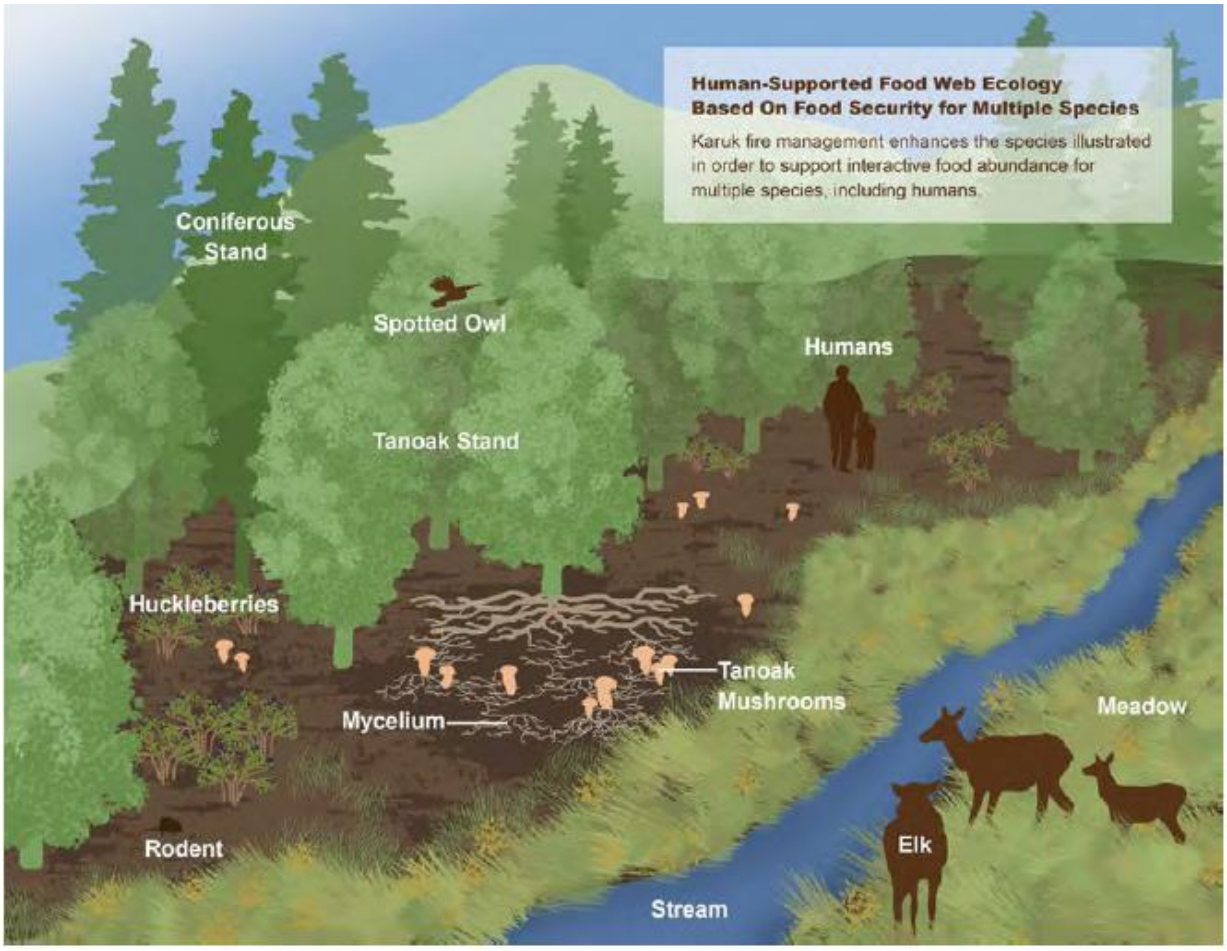
The Karuk People have historically been wealthy from tending of the land. Traditional ecological knowledge provides the Karuk with foods—including acorns, salmon and deer—and fibers such as hazel, willow, and bear grass which they use as materials for their well-known basket-weaving skills. Medicinal plants were also abundant. This rich and diverse cultural landscape was made possible through the use of fire and ceremony.

The mid-Klamath ecosystem has co-evolved with the Karuk people and culture over millennia. Multiple species of importance to the Karuk people play vital roles as cultural indicators for appropriate human actions within the Tribe's system of traditional management. For countless generations, Karuk people have observed the behavior of particular plants and animals to understand ecological dynamics, and have used this as a guide for necessary human management. The return of particular migrating birds signals the timing of the eel run, the appearance of Pleiades in the night sky denotes the time for cultural burning, while the behavior of other species warns of danger. This knowledge gained from attending to the land over generations is inscribed in ceremonies and prayers.

Karuk culture is directly reliant on fire as a tool to manage the environment for cultural sustenance and well-being. Karuk fire management practices include burning at a specific season, frequency, and intensity at a variety of severities. This frequent, low-intensity fire is linked with various fire-adapted vegetation communities and is necessary for the maintenance of cultural resources. Fire is especially critical for restoring grasslands for elk, managing food sources including tanoak and black oak acorns, maintaining quality basketry materials, producing smoke that shades the river for fish, and more. While fire can be incredibly dangerous, it is an inevitable part of natural ecosystems, especially in lightning-prone forested areas such as the mid-Klamath. Forested areas in northern California have become adapted to the frequent occurrence of relatively low intensity fire from human and natural ignitions for more than the past 1,000 years. Karuk's use of fire has been central to the evolution of the flora and fauna of the mid-Klamath (see Figure 2).

Gold mining started on the Klamath and Salmon Rivers around 1850, ushering in Settler Colonialism for the region and its devastating effects to the people and land. The Karuk People have always resisted Settler Colonialism, whether through armed rebellion as with the 1855 Red Cap War, legal action and protests such as the G-O Road Struggle and the Un-Dam the Klamath Campaign. The longstanding human-ecological relationships and practices have been interrupted by European settlement and its consequences: attempted genocide, displacement, resource extraction and the imposition of non-Native land management policies and ways of understanding the world. The policy of fire suppression has been especially significant. While these interruptions have been substantial and have taken place over an extended period of time, cultural and ecological information is retained today in ceremonies, stories, collective memory and the land itself.

Figure 2. Karuk Cultural Burning Produces Species Abundance



Source: Karuk Climate Adaptation Plan, 2019
(Credit: Figure courtesy of Kirsten Vinyeta)

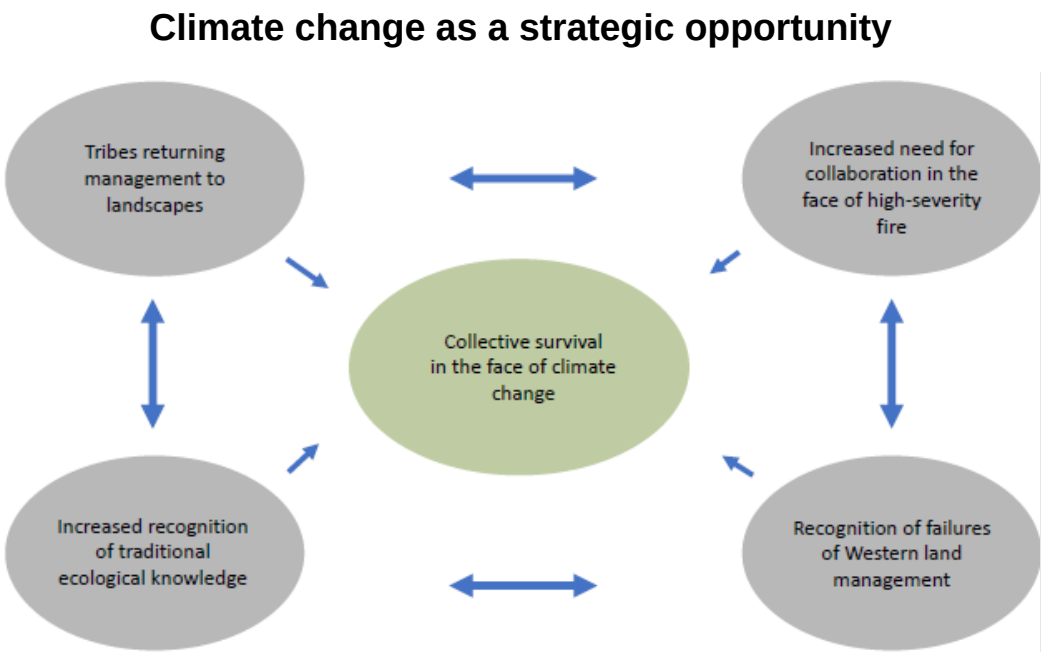
Karuk Tribe and Climate Change

Within Karuk aboriginal territory, the effects of climate change are immediate and occurring now. Climate change poses a threat not only to the Klamath ecosystem, but also to Karuk culture, which is intimately intertwined with the presence, use and management of cultural use species. The Karuk are fortunate to retain relationships with hundreds of species they consider their relations: foods, medicines and fibers that are embedded within cultural, social, spiritual, economic and political systems, and daily life. Impacts to such culturally significant species in the face of climate change thus have more direct impacts on the Karuk people than on communities that do not have such intimate connections in the natural world. Part of the increased vulnerabilities Karuk people face as the climate changes are a direct result of the strength of these connections. For example, the loss of acorn groves that have been family gathering sites for generations is much more than an economic impact. In addition, the social justice challenges that have impacted the Tribe since European influx are ubiquitous today in the form of low economic opportunity and restricted access to traditional

cultural resources, employment, schools, food sources, medical facilities, and emergency evacuation routes in this remote area.

Climate change is viewed by the Karuk as the product of unsustainable Western land management practices and the rise of political and economic systems for which indigenous people hold little to no responsibility. The impacts of the changing climate interact with existing ecological stressors such as water diversions and fire suppression.

Figure 3. Diagram illustrating how Tribes can lead efforts toward collectively addressing climate change



Source: Karuk Climate Adaptation Plan, 2019
(Credit: Sara Worl)

Nevertheless, the crisis posed by climate change presents a strategic opportunity for tribes to retain cultural practices and return traditional management practices to the landscape, and for all land managers to remedy inappropriate ecological actions. There is increasing recognition of the importance of indigenous burning as an ecosystem component and restoration technique. Traditional ecological knowledge, the need for collaboration in addressing high severity wildfire, and a recognition of the failures of Western land management, have combined to create an exciting political moment in which tribes are uniquely positioned to lead the way toward collective survival in the face of climate change (see Figure 3). In the mid-Klamath region specifically, many goals in the Forest Service's own management plan can be best achieved through restoring Karuk tribal management.

The Karuk people have long been part of the ecosystem. Adapting to climate change is about restoring human responsibilities and appropriate relationships with species and ecosystem processes. Karuk tribal knowledge regarding the use of fire can be utilized to manage cultural resources, promote biodiversity, and mitigate catastrophic wildfires, thereby protecting public as well as tribal trust resources. The Karuk Tribe's work on restoring traditional fire regimes holds the potential to inform both climate adaptation and mitigation efforts, given that wildfires themselves generate carbon emissions, and a reduction in high severity fires could result in a reduction in forest emissions.

The Tribe's adaptation approach to climate change centers around the revitalization of Karuk cultural management, the restoration of traditional fire regimes, the reduction of impacts from intervening factors, the expansion of Karuk tribal management authority and capacity, community engagement and public education, increased interjurisdictional coordination, and expanded research and monitoring. Utilizing Karuk Traditional Ecological Knowledge alongside western science, climate adaptation will center on the revitalization of 22 focal species as cultural indicators for human responsibilities and necessary human management actions. "These species have stories to tell, lessons in terms of how to get back to traditional management. They serve as indicators of relationships, responsibilities and of when and where to burn" (Bill Tripp, Deputy Director of Eco-Cultural Revitalization).

Climate Change and Its Impacts

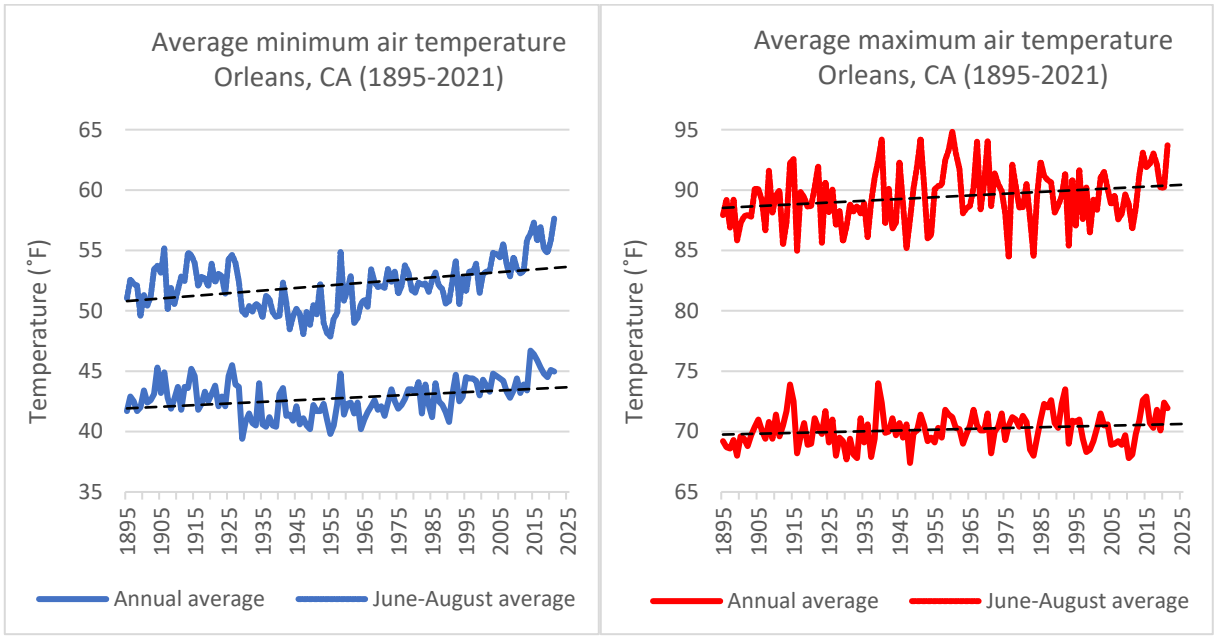
Trends in the Pacific Northwest Region of the United States include rising air temperatures, changing patterns of precipitation, and associated changes in snowpack, soil moisture, length of growing season, fire behavior and more. Similarly, the mid-Klamath region of California has experienced warming, changes in precipitation patterns, increased droughts, increased frequency and severity of wildfires, and disease and pest outbreaks in forests. Observed changes and impacts are summarized below. Unless otherwise stated, the Karuk Climate Adaptation Plan is the basis for the information presented (Karuk Tribe, 2019).

Changing Temperature Patterns

Air temperatures have been increasing in California over the past century (see Air Temperature indicator). Common measures of air temperature include annual average air temperatures, nighttime summer and winter minimum temperatures, number of days per year that exceed 86 degrees Fahrenheit, number of frost-free days (a measure of the length of growing seasons), and measures of extreme heat events. Both across California and in the North Coast region specifically, these temperature increases have been greatest in the summer months. Minimum nighttime temperatures have been increasing faster than either maximum daytime highs or average temperatures. Not only are there overall increases in air temperatures across these measures, but more variable temperature patterns are observed. Future projections in temperature-related metrics are presented in the Adaptation Plan.

Temperature data for Orleans, California are presented in Figure 4. Warming trends are evident. Notably, minimum temperatures, which occur at night, have risen at more than twice the rate of maximum temperatures. Temperatures during the warmer months rose at a faster rate compared to yearly rates: maximum temperatures for the months June through August warmed almost 2.2 times faster than maximum temperatures averaged over the year, and minimum temperatures for June through August warmed more than 1.6 times faster (PRISM 2021).

Figure 4. Average Temperatures at Orleans, CA.



Source: PRISM, 2022

The Adaptation Plan reported the total number of days above 86°F as 49.8 days for 1971-2000, and the number of days without freezing temperatures as 282.5 days. For the period between 1991 and 2020, these have increased to an average of 99 days/year above 86°F and 340 days/year above freezing (32°F) (PRISM, 2021).

Warmer temperatures have been associated with changes in hydrology, including decreased snowpack (particularly at low elevation sites), earlier snow melt and spring runoff, decline in total runoff occurring in the spring, rising river and stream temperatures, and increased variability in streamflow. These changes have occurred in conjunction with changing precipitation patterns, discussed in the next section.

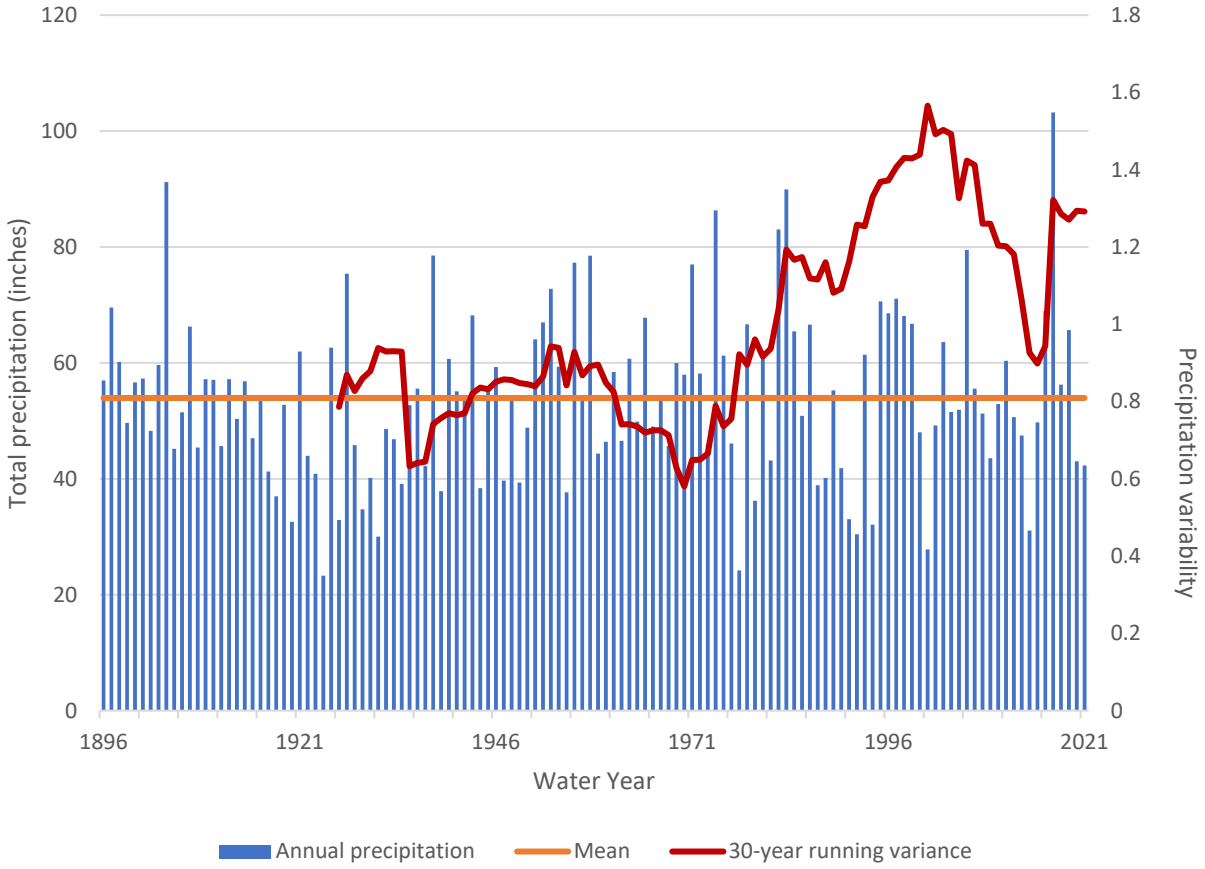
In addition, warmer temperatures may increase the spread of tree diseases (such as sudden oak death) and pest infestations (such as bark beetles); delay autumn migrations of certain species such as black-tailed deer; increase fire risk as vegetation dries with reduced soil moisture and increased evapo-transpiration. Rising temperatures also pose health concerns, including heat stress and heat-related deaths, respiratory

effects from increased pollution and pollen, and from food and water contamination, particularly from toxic algae.

Changing precipitation patterns and drought

Precipitation patterns are changing in the Klamath basin and across the Pacific Northwest. Key measures of precipitation include total annual precipitation, timing of winter and summer precipitation, and the total amount of precipitation in individual storm events. Annual precipitation measured by water year in Orleans, California, is presented in Figure 5. Year-to-year precipitation is highly variable, while showing no trend in the annual amount over time.

Figure 5. Annual precipitation at Orleans, CA



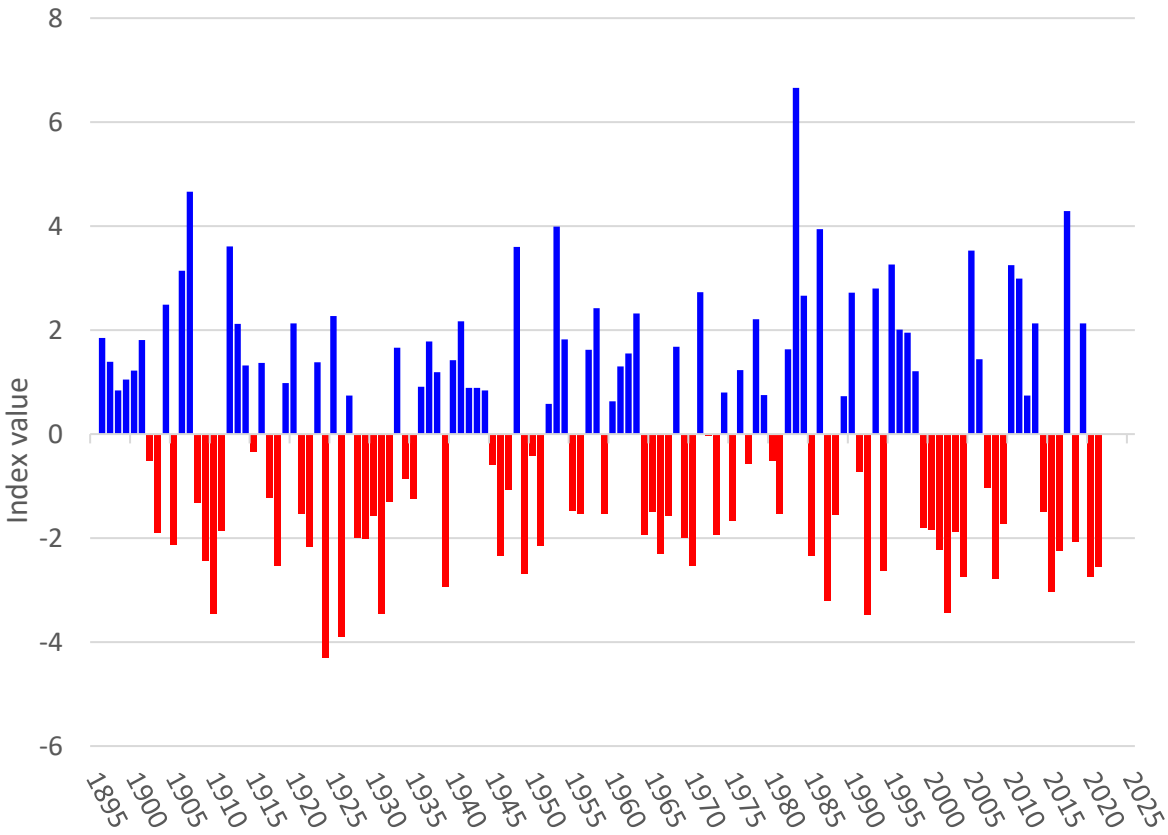
Source: PRISM, 2022

Warmer winter temperatures result in more precipitation falling as rain instead of snow. For the North Coast as a whole, the average spatial extent of snow on April 1st has declined from 60 to 50 percent at elevations above 3,000 feet between 1951-1980 and 1981-2010, with the greatest loss of snow occurring in the Klamath-Siskiyou Mountains. In Karuk Aboriginal Territory, the average snow water equivalent (a measure of

snowpack) on April 1st between 1971-2000 was 10.3 inches. This is predicted to decline significantly by the end of the century.

Figure 6 presents a commonly used metric to track drought, the Palmer Drought Severity Index. The index reflects relative dryness based on readily available temperature, precipitation and soil water content data. Positive values (blue bars) denote wet years; negative values (red bars), dry years. Values below -3 represent severe to extreme drought. Twelve of the last twenty years were dry, with two severely dry years in 2002 and 2015.

Figure 6. The Palmer-Drought Severity Index showing drought patterns at Orleans, CA (1895-2021)



Source: WRCC, 2022

Changing patterns of precipitation, along with warming, translate into decreasing flows and increasing stream temperatures. Prolonged drought will generally reduce stream flows, and may cause permanent streams to become intermittent. Flows in the Salmon and Klamath Rivers are projected to decline, while stream temperatures are projected to increase, affecting habitat for aquatic species such as salmon. Low summer base flows exacerbate toxic algae bloom conditions, and increase the likelihood of tribal members' exposures to the toxin microcystin through contact with contaminated water or consumption of food and water.

Less precipitation – particularly in the form of snowpack – can lead to vegetative stress, for example weakening sugar pine. Drought will lead to more severe wildfires and their cascading impacts on habitats in the region. There is concern that less predictable and reduced precipitation may constrain windows to apply fire.

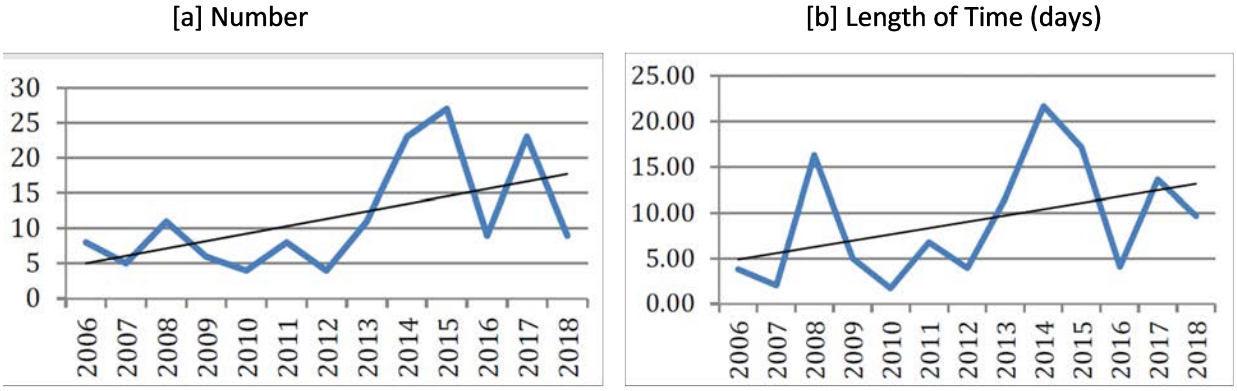
Changing patterns of fire behavior

The Klamath Basin has experienced increasingly frequent, large-scale, intense fires in recent years as a result of both climate change and increased fuel loads resulting from federal land management practices and the cessation of indigenous burning. Invasive species such as scotch broom, star thistle, Himalayan blackberry, non-native grasses and many others are well established within Karuk Aboriginal Territory, adding to the fuel load. Many of these invasive plant species exacerbate fire behavior through the production of long flame lengths.

Changing patterns of fire behavior are among the most pressing of the local dimensions of climate change within Karuk Aboriginal Territory. As shown in Figure 7, the number and length of time of fire weather watches or “red flag warnings” between 2006 and 2018 in the two fire zones that make up the Territory have increased. A Red Flag Warning is issued for weather events which may result in extreme fire behavior that will occur within 24 hours

The increasing frequency of high severity fire threatens individual species, alters the habitat, and disrupts ecosystem dynamics. Fires cause direct mortality to plant and animal species, reducing the availability of food sources; they consume snags and logs used by woodpeckers for nesting, roosting, and foraging. Fires during the flowering and fruiting season may affect harvest and plant reproduction. Trees stressed by fire injury are susceptible to bark beetle and other insect infestations which, in turn, can increase future fire severity.

Figure 7. The [a] number and [b} duration of fire weather watches/warnings, Fire Zones 204 and 280.



Source: Karuk Tribe, 2019

Fire suppression actions have produced adverse impacts. The firefighting tactic of "burning out" along the fire lines creates areas of very high severity fire. Timber fallers often intentionally cut chinquapin and black oaks preemptively because they may have cavities in which fire can smolder; these cavities are important habitat for Pacific fisher. In the immediate aftermath of high severity fires, activities such as salvage logging and associated road building can impact forest stands.

High severity fires in the Klamath region pose immediate health implications during emergency situations, as well as impacts on physical and mental health from smoke exposure. Exposure to smoke is strongly associated with increasing respiratory symptoms which tend to occur during the fires; the deterioration of existing respiratory diseases, hospital admissions, and deaths from respiratory causes impact the Tribal community.

Fires also impact critical tribal infrastructure including the electrical grid, transportation systems, water supply, communication systems, and emergency services.

Impacts on human health and well-being

The Klamath River and its tributaries, forests, grasslands and high country are essential for the cultural, spiritual, economic and physical health of Karuk people. Among the physical health impacts of warming temperatures are: heat stress (many homes do not have air conditioning systems, and those that do are at risk of power outages); increasing rates of asthma and allergies due to increased particulate matter and pollen; and food and water contamination from toxic blue-green algae. Increased residence time of water in the Copco and Iron Gate Reservoirs in the mid-Klamath basin due to drought and low summer flows create ideal growing conditions for the algae (Microcystis aeruginosa) that produces microcystin, a liver toxin. Exposures to the toxin can occur through consuming contaminated water and traditional foods, recreation, bathing or cleansing, and ceremonial activities. The World Renewal Ceremonies in which the medicine man traditionally bathes and drinks Klamath River water overlaps annually with the highest levels of microcystin.

There are serious negative health consequences of smoke inhalation. Large-scale, high severity fires burn much longer than traditional cultural burns, leading to more significant health impacts. In addition to smoke exposures, other potential health concerns include disrupted access to emergency vehicles and to medical care. Poor visibility during periods of thick smoke creates hazardous conditions for air craft operations for firefighting as well as for emergency medical transport. Additional damage to important gathering sites can occur from firefighting tactics. Wildfires are in and of themselves disturbing events in which people may lose or fear the loss of their homes and important sites in the landscape, and normal home and work routines as well as cultural and subsistence activities are disrupted. Irritability or "cabin fever" can set in when people need to stay indoors for prolonged periods.

Biophysical changes across the landscape – including those related to climate change – have affected access to many important food, fiber and medicinal resources. Salmon, acorn, elk, deer, berries and teas are among the traditional foods that are vitally important to the Karuk people, and their consumption prevents diet-related diseases such as diabetes and heart disease. About 50 percent of tribal members in Karuk Aboriginal Territory secure food by hunting, fishing or gathering; 40 percent reported climate and availability as barriers to acquiring sufficient healthy quantities.

Access to an intact natural environment and participation in one's culture are widely recognized as vital for psychological well-being. Cultivating, harvesting, processing, preserving and consuming traditional foods and medicines provide the framework for the Karuk eco-cultural socialization process and religious belief. These practices perpetuate Karuk traditional ecological knowledge and confirm Karuk occupancy on the land. Sharing food is a social obligation, and food related activities strengthen intergenerational relationships within families and the community. Such activities include the Pikyávish ("Fix the World") Ceremonies which are carried out to ensure abundant harvests and restore social and personal balance, and the First Salmon Ceremony, which invokes the spring salmon run.

Not only are ties to the natural world particularly strong for many Native people, but there are extensive disruptions of social, cultural and spiritual systems from ecological change and denied access to management. Karuk Tribal members have expressed grief, shame, stress and powerlessness from the loss of species, and from their inability to manage the ecosystem in accordance with their cultural practices and spiritual responsibilities. The cultural impacts of climate change are just the latest in a long thread of stressors affecting the mental and emotional health of the Karuk araráhih. Indigenous people in the U.S. already contend with the daunting task of processing centuries of historical trauma resulting from colonialism, a fact that has led to high rates of substance abuse, suicide, and violence within indigenous communities (Karuk Tribe, 2019). Many tribes and tribal organizations are turning to traditional healing practices to restore mental health and spiritual well-being to their communities.

Impacts on vegetation and wildlife

As described above, climate change is altering habitat conditions in Karuk territory. As a result, the biodiversity of ecosystems is threatened. The impacts of climate change are compounding those resulting from non-climate related stressors such as dams, fire suppression, and timber harvesting.

Karuk land management reflects a culture-centric perspective on vegetation zones, organized by elevation bands with different timing and purpose in relation to fire management: low elevation forest below the zone of smoke inversions; middle elevation forest within the zone of smoke inversions; and high elevation forest above the elevational gradients in which smoke inversions occur. Additional habitat zones are riverine, riparian, grasslands and wet meadows. These seven habitat zones are

experiencing climate change related impacts that include: changing patterns of precipitation, increasing temperatures, decreasing winter snow pack, changing fire behavior, increasing frequency of high severity fires, drought, and species invasions.

While different habitat zones face distinct threats in light of the changing climate, it is important to recognize their connections to one another. For example, wet meadows supply water to lower elevations where tanoak stands are critical winter foraging habitat for elk who are in turn needed to sustain wolf populations. Each habitat zone is influenced by fire regimes, which have been altered by fire exclusion practices. Fire regimes impact the tanoak stand dynamics of low elevation forests which help shape riparian and riverine habitats. Fire management has shaped the structure and composition of middle elevation forest zones, and has been used to lower stream temperatures.

This section summarizes the impacts of climate change on vegetation and wildlife in the seven habitat zones, as described in the Karuk Adaptation Plan. Certain plant and animal species of importance to the Tribe play vital roles as cultural indicators to guide appropriate human actions. Many species occur across multiple zones, or move across zones seasonally. These 22 cultural indicator species are mentioned in the relevant habitat zone discussion in this section. The Appendix describes each species, organized by habitat zone. More details can be found in the Karuk Adaptation Plan.

<u>Low elevation forests</u>
The low elevation forest habitat lies below the elevational zone (roughly 500-3,000 feet) in which smoke inversions form within Karuk ancestral territory and homelands. This habitat zone is characterized by the presence of tanoak trees (xunyê'ep), and contains an abundance of other species of direct importance for Karuk food, fiber and medicine. Species in this zone are also important for their use as clothing, regalia, and implements, as well as for their role in shaping ecosystems and in informing where and when to burn. The cultural indicator species in this elevation zone are tanoak (xunyêep), tanoak mushrooms (xáyviish), elk (íshyuux), huckleberry (púrith), pileated woodpecker (iktakatákaheen), and wolf (ikxâavnamich). The presence of these cultural indicator species – particularly plentiful tanoak mushrooms and abundant tanoak acorns – is an indicator of balanced ecosystem process and function.

Tanoak forests face primary climate threats from increasing temperatures, decreasing precipitation, lower soil moisture, increased frequency of high severity fires, and expanding forest pathogens such as Phytophthora ramorum, which causes sudden oak death (SOD). The SOD pathogen – which has destroyed millions of oak and other trees and caused twig and foliar diseases in other plant species across California since the 1990s – and other lethal invasive forest pathogens can increase fire danger in coming years.

The composition and overall stand structure of low elevation tanoak forests are the direct result of their long-term intensive management by Karuk people through the use of fire. Frequent fires have traditionally been used to limit the encroachment of competing shrubs and conifer species, providing the open structure that is important for many other species including madrone, white oak, princess pine, pileated woodpeckers and elk. Today, these low elevation forests have been significantly impacted by conifer encroachment, targeted herbicide treatment to reduce competition with conifer plantations, and the past 100 years of fire exclusion. In these stands, meadows are non-existent, conifers such as Douglas fir encroach upon oaks, huckleberries are highly dense but without berries, and elk are not present. Other non-climate stressors to tanoak forests include firefighting activities that can damage the tanoak's mycelium net, as well as salvage logging and associated road building following high severity fires.

In addition to the direct importance of this habitat zone to particular species, the stand dynamics and fire regimes of low elevation tanoak forests significantly shape riparian and riverine health.

Middle elevation forest

The middle elevation forest zone is characterized by the elevational band (roughly 2,500 to 4,500 feet) in which smoke inversions form. Species occurring within this cultural management zone are important for Karuk people as a food source and for use in regalia. Pine roots and needles are used in basket making and are represented in ceremony as the tree of life. The cultural indicator species in this habitat zone are chinquapin (sunyíthih), black oak (xánthiip), pacific fisher (tatkunuhpíithvar), porcupine (kaschiip), and black tailed deer (púufich).

Middle elevation forests with black and other oaks, chinquapin, Douglas fir, hazel, and gooseberry would traditionally be burned every five to seven years. Federal fire management over the past century has led to declines in black oaks and other fire-dependent species and facilitated the growth of conifers, leading to the alteration of the structure and composition of this forest zone and making it vulnerable to high severity fires. A century of fire exclusion and a changing climate has impacted the practice of setting fires on Offield Mountain with the full moon in August as part of the World Renewal Ceremonies. This practice reduced the potential for high severity, high impact events, protecting the village sites below. August fires also cooled riverine systems at the peak of summer temperatures, triggering upstream salmonid migration and cooling the system for fish runs already in the river.

Changing patterns of precipitation and temperature, increased frequency of high severity fire, and species invasions, especially from forest pathogens such as the sudden oak death pathogen (*Phytophthora ramorum*), are climate-related threats for this habitat zone. Forest pest dynamics that appear to be driven or enhanced by climate change in the Klamath Region include the fir engraver beetles that are associated with Shasta Red Fir mortality and *Phytophthora ramorum*.

When it comes to restoration of cultural fire regimes, sites with the combination of huckleberry, chinquapin, and black oak are key sites for management. While sugar pine is often seen at higher elevations, it can occur in middle elevation zones. Sugar pine in this zone is a key indicator of cultural vegetation characteristics, denoting places for management. In ancestral practice, sugar pines were the most prized ignition source, especially because of their yield of pitch and needles. The presence of pines in specific landscapes shows human management. In many cases these remnant pine stands are located in areas central to landscape/resource specific ignition patterns (Tripp, Watts-Tobin and Dyer 2017).

High elevation forest

High elevation forests occupy the zone above which smoke inversions form. It is also defined as forests above the chinquapin band and extending into the high country (defined elsewhere as montane and into the subalpine zone). Processes within this habitat zone are critically important to the health of other parts of the ecosystem. Like their lower elevation counterparts, the high elevation forests within Karuk ancestral territory and homelands are biologically rich and incredibly species diverse. Key Karuk foods and cultural use species in this zone include the sugar pine, gooseberry and beargrass (which especially occurs towards the coast where fog is present). The shrub form of chinquapin may be found at these elevations. Karuk cultural burning enhances species in the high elevation forest zone, making nutrients available in soils, releasing the seeds from sugar pine cones, stimulating growth and flowering of beargrass, and minimizing fuel loads to protect from high severity fires. Cultural burning at roughly five- to ten-year intervals across the landscape creates multiple gathering areas for beargrass.

The high country is key for Karuk cultural and spiritual activity. Especially during summer, families and individuals journey from lower elevation zones to harvest and process foods, materials and medicines, to hunt, fish, and pray. Karuk people have traditionally used fire to tend this habitat zone. Burning in these areas often occurs along trail networks, targeting meadow areas and patches of particular food and cultural use species such as huckleberry. Some foods, fibers and medicines of particular importance in this zone are wild onion, beargrass, huckleberry, princess pine, Oregon grape, and sugar pine. Much of Karuk high country is under wilderness designation, with fire suppression as a primary intervening stressor; logging is also a stressor.

High elevations forests are being impacted by changing patterns of precipitation and temperature, and the resulting changes in snowpack, soil moisture levels, and fire frequency and seasonality. While this forest zone benefits from regular low severity fire, high severity fires can, in the long term, convert the forest to brush fields. Species invasions and forest pathogens including White Pine Blister Rust and Port Orford Cedar Root Rot are also of concern. Using fire in high elevation forests is critical for getting back to historic fire regimes and an overall manageable, fire-safe system, particularly in

light of the increasing pressures from decreased snowpack, drought, and fungal pathogens.

Ironically many of the most culturally and spiritually important places throughout Karuk Territory have been the site of particularly intense alteration as a result of fire suppression. One example is the construction and operation of observation stations or "lookouts" to detect and report fires beginning in the 1920s. Some of these were constructed on tribal sacred sites used as prayer seats, thus affecting tribal land use practices, especially traditional setting of fires at culturally significant habitats. In other instances, the use of bulldozers to create fire lines has destroyed not only physical tribal artifacts, but also the vegetation mosaic of the ridge system which had served as an archive of land stewardship and part of cultural knowledge. The Tribe has lost the ability to learn from the ancestors and the land.

Wet meadows

Karuk ancestral territory and homelands contain a number of wet meadow systems scattered throughout the higher elevation forest and high country. The cultural indicator species for this zone is the leopard lily (Mahtáyiith).

Climate related drivers including changing patterns of precipitation, temperature, fire and species invasions are the dominant threats to these systems. Wet meadows are a highly threatened ecosystem with a severely reduced range due in particular to fire exclusion. In the absence of fire, the encroachment of conifers into wet meadows leads to a cycle in which the water table drops, the meadow dries up, and the drier soils become more conducive to Douglas fir and other hardwood trees that were formerly excluded by high soil moisture. Numerous wet meadows within Karuk ancestral territory and homelands are being lost through this process, especially at the middle to high elevations. Non-climate stressors to wet meadows include channelization from grazing, as well as the introduction of invasive species from grazers.

Wet meadows not only provide critical habitat for many species of importance – including bear, trailing blackberry, Mariposa and Panther lilies, wild turnip, and multiple kinds of Indian potatoes (e.g. Brodiaea coronaria) – they are critical for hydrologic, ecological and fire dynamics across the landscape, especially in lower elevations. Wet meadows supply water and provide higher summer base flows and cold water to lower elevation riverine and riparian systems; for example, the Haypress meadow complex supplies cold water to the Wooley, Ti, Irving, Stanshaw, and Sandy Bar watersheds.

Riverine systems

Karuk ancestral territory and homelands encompass several hundred miles of riverine habitat along the middle portion of the Klamath River, the lower portion of the main stem Salmon River, and many key tributaries. Species from riverine systems hold significant cultural or spiritual significance and provide over fifty percent of the calories and protein of traditional Karuk diets. They are also important for food, culture and ceremonies. The

cultural indicator species for the riverine zone are spring Chinook salmon (Ishyá'at) and Pacific lamprey (akraah).

Riverine systems are especially at risk due to changing patterns of precipitation, increasing temperatures, and decreasing winter snow pack. These changes directly impact stream flow and water temperatures. Elevated stream temperatures can cause fish mortality, support fish pathogens and diseases, and enhance the suitability of the habitat for non-native fishes.

Non-climate stressors that threaten riverine systems result from non-Tribal management actions, including: dams (such as Iron Gate) that trap sediment, block access to cold water habitats, and stop processes that shape habitat and cool water downstream; fire suppression, which has removed the cooling effect of smoke on river waters during critical periods for Chinook fall migration and spawning; and water quality impairments from agricultural inputs, fire retardants, logging activity and others

Riparian systems

Riparian areas – lands along water courses and water bodies – are key sites for many food, fiber and medicinal species of importance to Karuk people.

Species from riparian systems serve as indicators of healthy systems; they signal when management steps, including burning, need to be taken. The riparian zone cultural indicators are the Pacific giant salamander (púfpuuf), aquatic garter snake (asápsuun), beaver (sahpihnîich), and yellow-breasted chat.

Riparian habitat is threatened by changing patterns of temperature, precipitation, fire behavior and species invasions. Prolonged drought, which reduce stream flows, may cause permanent streams to become intermittent; increasing temperatures may dry forest floors, thus reducing the area of moist refugia in the terrestrial riparian zone; more severe winter or spring rains may cause flooding events that increase siltation and alter aquatic riparian habitat structures; and warmer climates may increase the spread of diseases and increase the susceptibility of amphibians and other species to diseases. Aside from climate stressors, riparian systems are already threatened in the mid-Klamath area by dams, water diversions, species invasions, logging, roads and fire suppression. The health of riparian habitat zones is important for the functioning of riverine and forest systems.

Grasslands

Grasslands, also known as prairies or glades, historically occurred in mid to upper montane areas on ridges, in both large and small patches. Until about 1850, grasslands were so extensive they covered nearly one-fifth of California. Today a majority of the grasslands that once existed within Karuk Aboriginal Territory have disappeared due to lack of fire. Frequent burning is required to maintain the open prairie structure. Burning prevents conifer encroachment and enhances conditions for key food species, such as

many of the species known as Indian potatoes (tayiith). The presence of Indian potatoes indicates where the Tribe traditionally burned and managed grasslands. Traditional Karuk knowledge about grasslands is still being recovered.

Grasslands have been historically significant for many species of broad-leaved herbs, native annual and perennial grasses, insects, birds, mammals, reptiles, and amphibians. Among these are important Karuk foods such as elk, as well as iris and other grasses used for twine, and Indian potatoes. Indian potato and bumblebees are the two cultural indicators for this habitat type.

With the changing climate, drought and species invasions are a particular concern in this habitat type. Probably the main non-climate stressor to grasslands comes from their severely reduced range due to fire exclusion and from the transport and spread of non-Native species. Grazing is another key intervening stressor for grassland systems.

Summary

Karuk araráhih have co-evolved with the mid-Klamath ecosystem and its diverse landscapes since time immemorial using multiple species of importance as cultural indicators for various traditional management practices. The Tribe has managed the landscape with controlled burning for countless generations, however the policy of fire suppression at the state and federal levels interrupted these practices and ultimately led to greater wildfire risk. The effects of fire suppression and other non-climate stressors – notably the construction of dams and logging – along with a changing climate, have altered habitat conditions and disrupted ecosystem process in Tribal territory. The Karuk Tribe and its Natural Resources Department are actively working to understand, adapt to, and mitigate the effects of climate change. As the landscape and cultural indicator species are impacted by the effects of that changing climate, the Karuk people will continue to adapt using the environmental stewardship knowledge collected over countless generations of Karuk araráhih to protect their landscape, resources, culture, and the health of their people.

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Appendix. Karuk Cultural Indicator Species by Habitat Zone

For countless generations, Karuk people have observed the behavior of particular plants and animals to understand ecological dynamics, and as a guide for necessary human management. Cultural and ecological information is retained today in ceremonies, stories, collective memory and the land itself. Today, the Karuk Tribe is centering on the revitalization of 22 focal species, described below, as cultural indicators for human responsibilities and necessary human management actions in the face of climate change. The descriptions and images are taken from the Adaptation Plan.

Low elevation forest

Source: Karuk, 2016

Xunyêep (Tanoak, Lithocarpus densiflorus) is an ecologically, culturally, and economically important species. Tanoak acorns (xuntápan), a staple food for Karuk people, traditionally constituted a high percentage of the calories and protein of their diets. The roots of tanoak trees support the growth of another important food, tanoak mushrooms. Xunyêep is a key cultural indicator for when and where to use fire. There are specific times to burn in a tanoak stand to maximize the quality and abundance of the acorn yield, not only for people but other species including deer, elk and many birds.

The most critical environmental factor determining the fate of tanoaks is fire. Another factor is the spread of the sudden oak death pathogen, which increases in warmer and wetter environments.

Púrith (Evergreen Huckleberry or Vaccinium ovatum) is an important Karuk food source with many nutritional and health benefits. Púrith is a slow-growing, shade-tolerant

understory shrub that is most abundant in forests with a higher level of canopy cover. Flower and berry production increases with light and soil moisture where forest gaps have been produced by moderate disturbance related to fire, timber harvest, or thinning. Infections by the sudden oak death pathogen (Phytophthora ramorum), while not lethal, produce lesions that reduce their suitability for tribal use. The infections may also prompt land managers to remove infected plants to protect tanoak stands. Warmer and wetter environments are likely associated with increased spread of the pathogen, and the lack of cultural fire appears to increase púrith's vulnerability to the disease.

Huckleberry is a cultural indicator for when and where to burn. Burn timing is indicated by the burn timing of tanoak acorn, which is in turn related to insect management. Emerging scientific studies indicate the presence of chinquapin may be a sign as to where one should burn for huckleberry. The Tribe defines púrith as a key cultural indicator of socio-ecological resilience of sustainable harvest and landscape management to ensure food security for both humans and animals that consume huckleberry.

Xáyviish (Tanoak Mushroom, Tricholoma magnivelare) is prized as a traditional food and medicine. It is also highly prized in the global market, making it vulnerable to overharvest by outsiders. In Northern California, xáyviish can be found scattered or growing in groups in well-drained soil or duff under tanoak, golden chinquapin, madrone, or pine trees with which it forms a mycorrhizal, symbiotic relationship. In addition to rainfall, this mushroom requires low temperatures, and a pattern of warming and cooling. Tanoak mushrooms are connected to tanoak trees, elk, huckleberry, deer, wolf and chinquapin and other species in complex ways. The presence of plentiful tanoak mushrooms is an indicator of treatment success from the standpoint of soil impacts and host tree retention.

High-severity fires burn or destroy mycelial mats, preventing them from fruiting into harvestable mushrooms and compromising the survivability of the population. Xáyviish may struggle to repopulate areas if entire stands of host species have been destroyed by high severity fire. Additionally, the moisture and cool temperatures that xáyviish depend on may be less available in forests with repeated high-severity fire.

Xáyviish is threatened by logging machines, which have damaged or severed the mushroom's mycelium, and harvesting of the mushrooms for economic gain. This species serves as an important indicator of responsible human use. While Karuk tradition emphasizes reproductive success by picking mushrooms with at least 50 percent of the veil open to assure the release of spores, and allowing access by other species before human use, economic gain is maximized when the mushrooms are picked with their veils closed.

Iktakatákaheen (Pileated Woodpecker, Hylatomus pileatus) is seen as an ecosystem engineer that creates cavities that can then be used by up to 20 species of birds and mammals. It also promotes nutrient cycling in the forest through its excavations. The

process of harvesting the species for regalia is intricately tied to land management. The largest woodpecker in North America, Iktakatákaheen typically resides in older deciduous or mixed deciduous-coniferous forests. High severity fires consume snags and logs used by pileated woodpeckers for nesting, roosting, and foraging, and reduce insect populations as well as nut and berry sources that are vital to the woodpecker diet.

Íshyuux (Roosevelt Elk or Cervus occidentalis) are important for their use as food, clothing (hides), regalia, and implements, as well as for their role in shaping ecosystems. The management of elk populations, and the protection and restoration of habitats that elk depend on are of vital importance to the Karuk Tribe. The reproductive needs for elk are an important cultural indicator for management. Íshyuux require a mosaic landscape that combines open areas for foraging, and forested areas for cover. Much of the habitat for winter range and calving is now overgrown with mid-mature dense stands and plantations due to fire exclusion. Following a mixed (moderate to high) severity burn in a riparian area in 2015 (in the West Simms unit), elk moved in and started calving in it almost immediately. Differences were significant between the cultural prescribed fire and impacts of an adjacent wildfire.

Ikxâavnamich (Wolf, Canis lupus) once inhabited Karuk territory, but by the 1920's were decimated by Euro-American hunting, trapping and poisoning. It is likely to make a return to California as a result of federal protections. The wolf is important to Karuk tribal spiritual practices and ecosystem stability. Intricate relationships exist between wolves and other species in the low elevation forest zone, including elk, deer, tanoak, huckleberry, chinquapin and tanoak mushroom. Ikxâavnamich habitat tends to be more prey-dependent than land cover-dependent. In the West, wolves are known to follow large ungulate herds from their lowland wintering grounds to their upland pastures. Burns that destroy entire stands may force ungulates to seek new forested areas, straining the herd and thus affecting wolves' diets. Ikxâavnamich creates its own den in meadows near water, rock outcroppings, under tree roots, or even old beaver lodges. Wildfire could kill pups in the den or elsewhere. To succeed as a pack, wolves need large, remote areas free from much human disturbance.

Middle elevation forest

Source: Karuk, 2016

Tatkunuhpíithvar (Pacific Fisher, Pekania pennant) has experienced significant declines in Karuk territory. The fur of tatkunuhpíithvar is traditionally used in Karuk regalia. It is well represented in world renewal ceremonies as the quiver that carries the arrows used to wake up the world. Tatkunuhpíithvar represents the need for balance among dense and open habitats with large fire scarred growth hardwoods. It prefers hardwood forests with significant canopy cover, with large trees and snags where it converts large cavities into a den. The species is currently facing habitat losses due to habitat changes resulting from both climate and non-climate stressors: fire management, high severity fires, insects and pathogens, logging, and rodenticide poisoning from marijuana farms.

Sunyíthih (Chinquapin, Castanopsis chrysophylla) is an evergreen member of the beech family that can grow quite tall and live up to 500 years. Also known as a high elevation species, its presence at other elevations indicates places where one may want to treat for huckleberry. The nuts of sunyíthih are important to the Karuk traditional diet and also provide food to many bird and mammal species. Sunyíthih is particularly competitive in dry, infertile sites. On sites with more moisture and fertile soil conditions, disturbance such as fire is necessary to preserve a chinquapin forest component. Rarely does chinquapin occur in pure stands. Sunyíthih provides important cover for birds and small to medium mammals. Fisher and martens may use them for their natal dens. Diseases and insects have little impact on giant chinquapin, although it is susceptible to heartwood-rotting fungi such as Phellinus igniarius; the filbert worm (Melissopus latiferreanus) may impact reproduction. Chinquapin has recently been identified as a host of sudden oak death pathogen.

Kaschiip (Porcupine, Erethizon dorsatum) are critical food sources for mountain lions and pacific fisher. Kaschiip's quills are used by Karuk people in basketry and regalia.

Ideally the quills are harvested via non-lethal methods, and then the porcupine is re-released. Kaschiip has historically held important ecological roles as a species that maintains oak woodlands and reduces conifer encroachment. The Karuk Tribe aims to restore a healthy local porcupine population, which may in turn assist the recovery of other habitats and species (Karuk DNR 2010). Weavers reported seeing many porcupines in black oak stands while gathering as late as the early 1970's. Seeing a porcupine in Karuk Territory today is a very rare event. As a result of habitat loss, naturally low reproductive rates, and former Federal and State eradication programs to protect timber harvests, porcupines are now rare in much of California. The porcupine diet consists of herbaceous plants, twigs, and particularly in the winter, coniferous bark and needles. Fires can affect porcupine food sources and habitat, increase the chances of porcupine predation, and kill individuals who are unable to escape.

Xánthiip (Black oak, Quercus kelloggii) occurs in mixed-conifer forests as well as in mixed hardwood forests. In the highly diverse Klamath-Siskiyou area, black oak has many overstory plant associates. While tanoak acorns are the most prized among Karuk people, black oak acorns are also an important traditional food. Having various acorn sources in the forest ensures dietary diversity and resilience in the event of impacts to any one species.

Historically, black oak stands were ignited at a massive scale in February to promote early spring greens and to protect the most susceptible slopes above the villages from excessive fuel accumulation in the summer months. California black oak appear highly adapted and may experience range expansion as a result of predicted increases in temperature and fire activity. High severity fires may destroy acorn bearing stands of black oak that are culturally vital. There is some speculation that increasing temperatures could influence acorn production. Sudden oak death (Phytophthora ramorum) is a major climate stressor for this species and is already impacting black oak in coastal regions.

Púufich (Black Tailed Deer, Odocoileus hemionus) is among the most important traditional Karuk foods and sources of utilitarian and ceremonial items. In 2005, over 65 percent of Karuk households reported hunting púufich for food. The meat, sinew, bones, hide/skin, fur, antler, and hooves have been used extensively for traditional functions. The Deerskin Dance, which is part of Karuk World Renewal Ceremonies, depicts how burning for deer relates to salmon migration and woodpecker habitat and other connections. Deer health and abundance, as well as their movement and habitat selection across the landscape are indicators of appropriate fire management activities. Karuk management of this species includes the use of fire to promote rotational grazing and to draw them away from freshly sprouting basket materials. Tribal management also pays closer attention to allowing for opportunities for reproduction and promoting genetic mixing.

Smaller patches of high severity fire that maintain more open shrub, fern, forb, and grasses promote higher quality forage and dispersal for deer. By contrast, high severity,

large-scale fire may burn a significant portion of black-tailed deer's home range and reduce cover from predators. Oak groves burned by such fires can reduce deer diets rich in acorns. Existing stressors include agricultural expansion, habitat loss, disturbance of migration, fire suppression, and barriers (such as fencing, roads and reservoirs). Warming temperatures can affect the availability of food sources and alter patterns of seasonal migration. Delayed autumn migrations may leave púufich at greater risk of sudden winter storms and predation. Warming temperatures and increased humidity may increase spread of parasites and bacteria to which púufich are vulnerable.

<u>High elevation forest</u>

Source: Karuk, 2016

Ússip (Sugar pine, *Pinus lambertiana*) occurs in mixed-conifer forests. In Karuk country, it is of particular value when occurring within or adjacent to tanoak or black oak stands. It reproduces via large, heavy seeds held within cones. It can take sugar pines around 150 years to become good cone producers. The seeds are not highly mobile, and unless moved by animals do not stray far from the parent tree. Sugar pine is often viewed as a high elevation species, but when found at other elevations, it serves as an indicator of specific management actions. It is used by Karuk people for ceremonial and subsistence purposes. The snags possess high quality “black pitch” which is not only a traditional form of money, but is also utilized in the ignition of cultural burns. Sugar pine groves were family owned and managed for nuts (food), pitch (medicine), and roots (basketry).

The presence of sugar pine is a notable indicator of past fire management actions and may be associated with other culturally relevant information or activity. Ússip are often found in strategic places on ridges where they would have been managed to serve as ignition sources. Today it is rare to find an open grown sugar pine tree that is accessible for nut collection. Trees grown in the open develop differently than woodland grown trees, typically developing full crowns and a wide branch structure with large limbs growing from further lower on the trunk. As a future indication of landscape scale fire regime restoration, pine trees with large branches less than 15 feet from the ground and adequate limbs to climb from there will be important.

Decreased snowpack, earlier spring snowmelt and warmer temperatures threaten the health of sugar pines directly, or make them susceptible to beetle infestations and fungal pathogens. High severity fires can not only decimate individuals and stand, but also limit seed dispersal and establishment in burn areas.

Panyúrar (Beargrass, *Xerophyllum tenax*) is a perennial, subalpine herb that inhabits upper slopes, often near or beneath coniferous forests. Beargrass flower stalks are browsed by ungulates such as deer and elk. It is an important plant species for Karuk basket weavers and regalia makers. Blades are considered best for basket weaving the first year after a fire. Panyúrar is traditionally burned every three to seven years, especially in the fall following World Renewal Ceremonies when people bring fire down from the high country. Burning for panyúrar is part of landscape dynamics, and necessary for returning fire intervals across the larger landscape. Along with other important cultural species including hazel, panyúrar grows back particularly strongly after low to medium intensity fire. A combination of frequently burned beargrass and filtered light through a moderately dense canopy maintains an open understory free of brush and other materials typical of fueling large wildfires. The conditions this type of burning maintains can also promote species like salal and saddler oak which are important for gathering and browse for large ungulates. Burning too hot can make basketry materials brittle. High severity fires can burn duff into soil deep enough to destroy beargrass rhizomes; damage to forest duff from very hot fires can delay or prevent the re-establishment of beargrass.

Wet meadows

Source: Karuk, 2016

Mahtáyiith (Leopard Lily, *Lilium pardalinum* ssp. *Wigginsii*) is the cultural indicator for wet meadows. Mahtáyiith is among the most prized bulbs in the Karuk diet. It is dug in the fall and is traditionally cooked in an earth oven like many other bulbs. In the Klamath Mountains, leopard lily is found in high country wet meadows, especially on serpentine soils. This rare and endangered herb grows from bulbs that are small and often clustered, and typically blooms in July. Fire of varying intensities removes competing shrub and tree vegetation which would promote lily flowering.

Riverine systems

Source: Karuk, 2016

Akraah (Pacific lamprey or eel; *Lampetra tridentata*) are related to humans as a food source, related to fire cycles for their well-being, and related to bears and birds upslope by virtue of taking nutrients back up the hill to feed plant life, similar to salmon. They have a long life cycle in which adults live in the ocean and return to freshwater to spawn. The larvae reside and filter feed in silty or sandy substrates for up to seven years before migrating to the ocean. Adult Pacific lamprey follow the scent of pheromones released by juvenile lamprey (ammocetes), not necessarily returning to their natal river systems. This highlights the importance of ammocete habitat in the Klamath, which depends on sediment deposition and fire processes to create favorable conditions. The Scott River, the largest source of fine sediment to the main stem Klamath above the Trinity River, is a snow pack driven river system that is threatened by climate change. Furthermore, Iron Gate Dam has cut off the sediment supply to the upper Klamath River.

Ishyá'at (spring Chinook salmon, *Oncorhynchus tshawytscha*) is a key cultural indicator sensitive to stream temperatures. Their presence is an indicator of both riverine and forest habitat quality. Fresh, cool water temperatures are critical to Ishyá'at, as are spring to early summer high water flows they need to reach summer holding areas, to access spawning grounds, and to reproduce. Climate change and changing weather patterns such as drought cycles and high severity storm events have had direct implications on the species. On the Klamath, "spring creeks" that originate in volcanic terrain are perfect for production of juvenile salmon because of their stable flows and cold water temperatures year-round. However, nearly all spring creeks on both the Klamath and Shasta are locked up behind dams.

Riparian systems

Source: Karuk, 2016

Púfpuuf (Pacific Giant Salamander, *Dicamptodon tenebrosus*), while not a Karuk food source, is central to Karuk culture. They are a keeper of water that is critical to life. In Karuk beliefs, púfpuuf is a spiritual being who transformed into a salamander to monitor spring and creek water quality and quantity. Their presence is indicative of a healthy riparian and aquatic fresh water ecosystem. Púfpuuf is perhaps the most important cultural indicator for identifying the need for emergency management actions. Karuk traditional practitioners report that if púfpuuf is in peril, we are on the verge of system collapse, and the immediate application of fire is recommended to lower acutely high air and water temperatures.

Asápsuun (Aquatic Garter Snake, *Thamnophis atratus*) is a cultural indicator of healthy aquatic and riparian systems. As fire regimes are restored in Orleans and the Black Mountain area, paying attention to this species may become more important. Asápsuun is an aquatic snake that uses water for both foraging and protection. In Karuk territory, people have reported seeing fewer and fewer "water snakes," a fact that they attribute in part to the impact of fire suppression on aquatic systems. With climate change, increased temperatures may dry forest floors and reduce moist refugia for this species in terrestrial habitats.

Sahpihnîich (Beaver, *Castor canadensis*) alters ecosystems in ways that benefit other species. Karuk people value beaver as a teacher of how to intervene in natural processes for the greater good. Sahpihnîich is considered nearly locally extirpated and in need of reintroduction. Habitat destruction and degradation, and a lack of riparian vegetation (their food sources) are climate change-related threats to the species. Restoring historic fire regimes will benefit sahpihnîich by promoting the growth of riparian vegetation, and reducing the threat of high severity fires. Sahpihnîich can play a role in drought mitigation by storing water and maintaining areas of open water. Their dams can moderate stream temperatures, reduce peak flows in flooding events, create complex aquatic habitats for many other species, trap suspended sediment, and restore incised streams to more complex channel and ponds systems.

Yellow-Breasted Chat (*Icteria virens*) is a migratory bird that nests in the spring. In Karuk stories, it is welcomed as the true harbinger of spring. Karuk culture says the chat is tied to the responsibility of humans to realize that something has to be done about fire. The return of the chat and other birds to nest is a signal to stop burning. Chats are numerous in Northwestern California, with the highest densities found along the Klamath and Trinity Rivers. The chat depends on riparian areas, especially sandbars, with willow trees. It nests in dense thickets, and uses larger trees as singing perches. A return of cultural burning at proper intervals will maintain riparian willow and cottonwood habitats. Maintaining riparian floodplain habitat by discouraging channelization of streams will also benefit chat. Chat may also be susceptible to changing wind conditions along migration routes to and from the

tropics. The yellow feathers of its breast have traditionally been a part of tribal regalia.

Grasslands

Source: Karuk, 2016

Tayiith refer to a variety of geophytes (including *Brodiaea* spp., *Dichelostemma* spp., *Triteleia* spp., *Calochortus* spp., *Lilium* spp., and *Fritillaria* spp.) commonly called Indian potatoes. The Karuk people harvest their bulbs and tubers for consumption. *Brodiaea coronaria* serves as a good indicator for other Indian potato species, as it tracks soil moisture. Indian potatoes grow in prairies and meadows in a variety of settings. Historically, species of Indian potato grew thick as grass in certain valleys in California. Karuk and other Native Californians know proper harvesting techniques that further proliferate these species by promoting bulblet production. As with many prairie and meadow species, Indian potatoes have experienced declines as a result of land cover change, fire suppression, and a reduction in the ability of indigenous peoples to steward the landscape. Burn timing in regard to this species needs to be refined to account for harvest timing and invasive species.

Bumblebees (*Bombus* and other genera) are important within grassland habitats in Karuk Aboriginal Territory. While bees require grassland habitat which is fire dependent, the specific relationships between bees and fire is less well understood. Loss and fragmentation of grassland habitat, as well as grazing, reduce nesting and foraging habitat quality for bees This is a species for which more traditional knowledge and scientific attention will be beneficial in the changing climate.

IMPACTS OF CLIMATE CHANGE ON THE NORTH FORK RANCHERIA OF MONO INDIANS OF CALIFORNIA

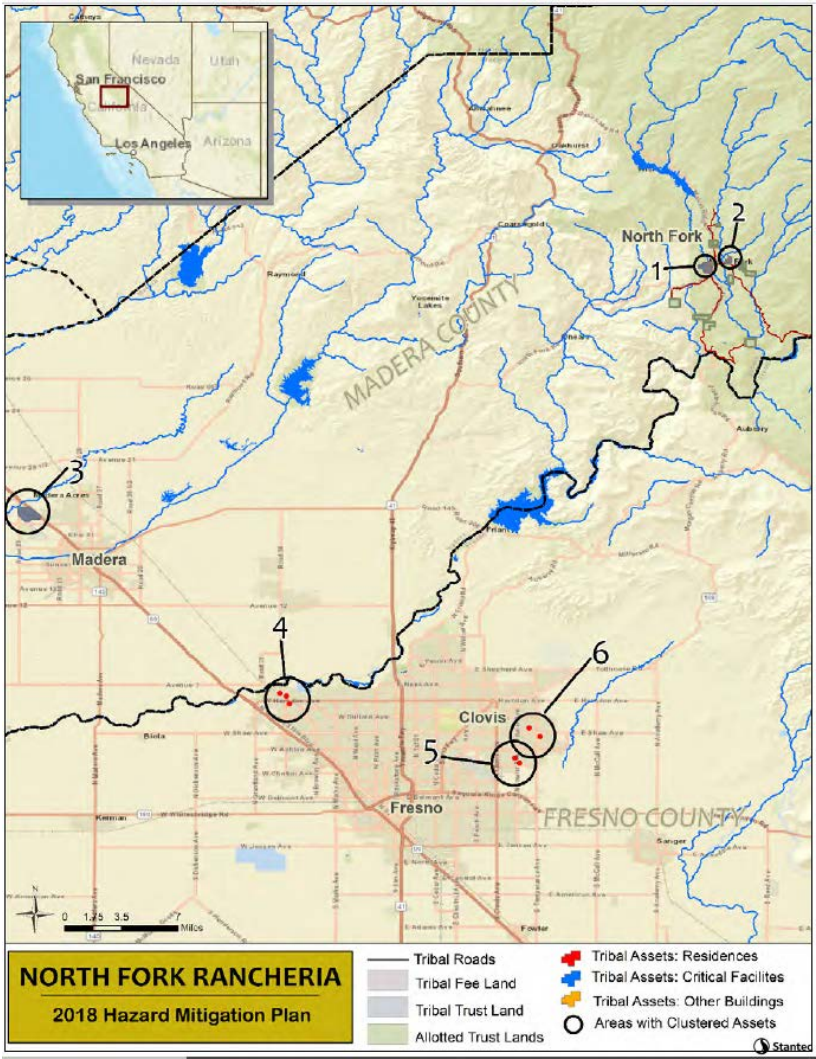
Elevated day and nighttime temperatures, drought, wildfire, and flooding due to increasingly variable precipitation patterns are threatening the physical, cultural, and spiritual health of the Tribe, its habitats and ecosystems, and its built environment.

Background

The North Fork Rancheria of Mono Indians of California (NFR) is a federally recognized Tribe currently located in Madera County, California. The North Fork Rancheria lies in the foothills of the Sierra Nevada Mountains, along the Sierra Vista National Scenic Byway. The Rancheria lies less than 40 miles from Fresno, California. The Western Mono have resided in the San Joaquin Valley for thousands of years (NFRMIC, 2018). However, after non-native encroachment of historical lands, the Tribe's ancestors concentrated around the town of North Fork, from which the Tribe's name was derived (Tatum, 2006). Intermarriage with other local Tribes occurred and sharing of the land and its resources was important for all the Tribes. Western Mono language is part of the Uto-Aztecan language family and is most similar to the Paiute-Shoshone languages.

The Tribe has 2,310 citizens nationwide, with the majority residing in Fresno and Madera Counties, making them one of California's largest native Tribes (NFRMIC, 2018).

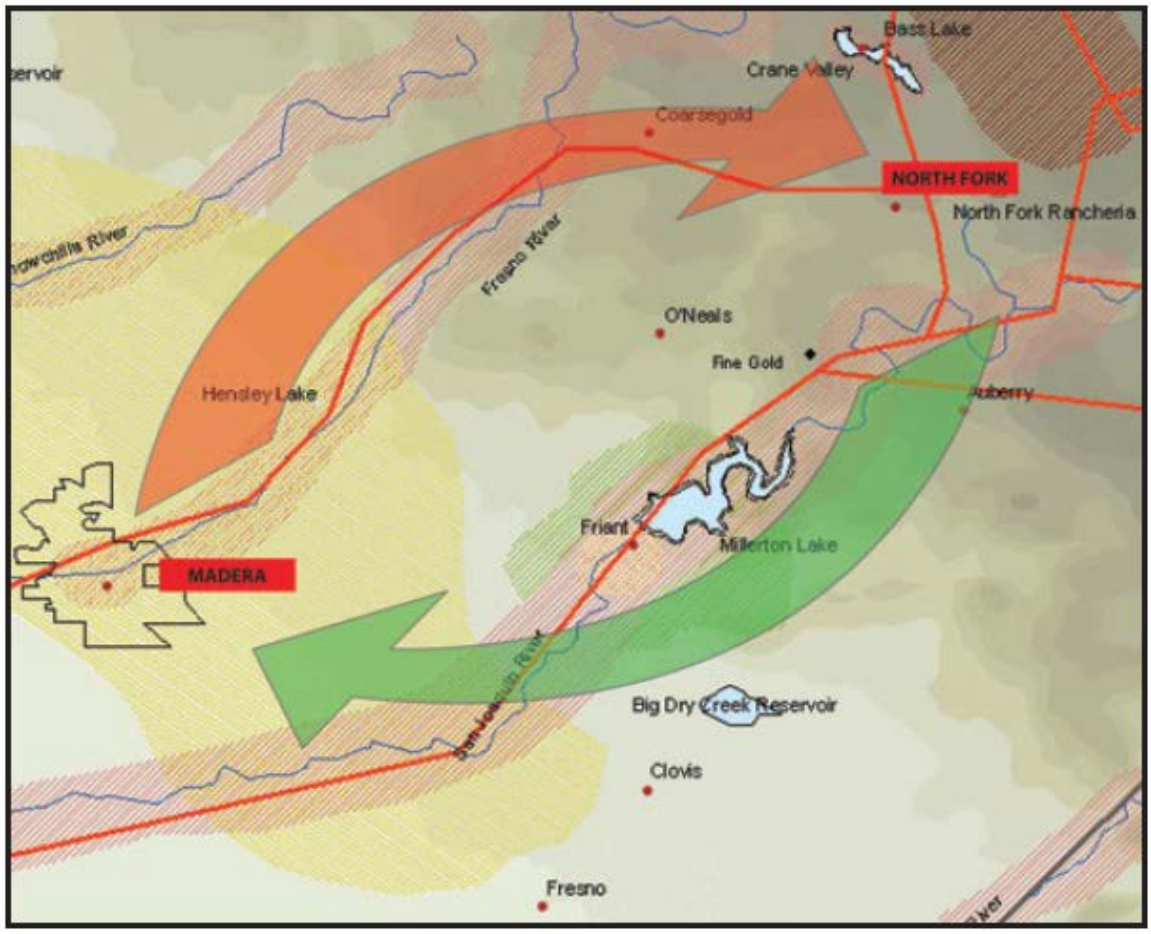
Figure 1. Current North Fork Rancheria Lands and assets



Source: NFRMIC, 2018

The first reservation lands were allotted in 1851 but failed treaty ratifications resulted in the closure of the reservation in 1860 (NFRMIC, 2006). Traditionally, the North Fork Mono travelled between the foothills of the Sierra Nevada and the San Joaquin Valley (Figure 2).

Figure 2. The North Fork Tribe migrated from the foothills down to the Valley for hunting and fishing and worked with other Tribes along the way.



Source: Tatum, 2006

The Tribe also traded throughout the Eastern side of the Sierras and have trail systems that go to Bishop, Yosemite, Mono Lake and through the Pacheco pass. Travel was vital for traditional hunting and gathering, ceremonies, and for trade with other Tribes creating a complex interdependent system of social, political, and economic ties between groups (NFRMIC, 2006). Historically, the weather in the foothills was more hospitable for permanent residence due to the severe heat, drought, and flooding in the Valley. In the Valley, the Mono hunted for large game like elk and antelope, fished for salmon, and gathered roots of the sedge plant found along the riverbanks on the Valley floor (Tatum, 2006). In contrast, in the foothills the Tribe had access to acorns from Black Oak trees, a staple for the North Fork Mono as their acorns made better flour than

those from oak trees found closer to the Valley. Federal recognition as an Indian Tribe was restored in 1983 under a court-approved settlement, and the Tribe subsequently elected a governing body and adopted a Tribal Constitution in 1996. Today, tribal leadership consists of five elected members of the Tribe's citizenry who serve four-year terms elected on a two-year staggered basis. The 80-acre Rancheria is held in trust for descendants of one Mono family; therefore, the Tribe is considered 'landless' and has had to purchase land for its people.

Cultural and Spiritual Health

The wellness of the tribal people is tied to the lands from which the Tribe is from. The water, plants, soil, air, minerals, and other resources provide a connection to the landscape that is not easy to convey in written form. An example would be when a weaver gathers material for a baby basket, they must know where to go for materials, that material must grow in the right conditions, have plenty of water, and once cleaned and ready to use the weaver can be overcome with a feeling of reflection and relaxation as they weave the basket for a child.

Climate Change and Its Impacts

Unless otherwise stated, the *North Fork Rancheria Tribal Multi-Hazard Mitigation Plan* (NFRMIC, 2018) is the basis for the information below.

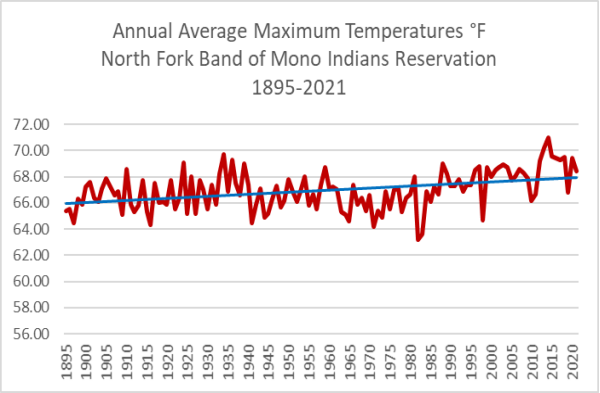
Elevated Temperatures

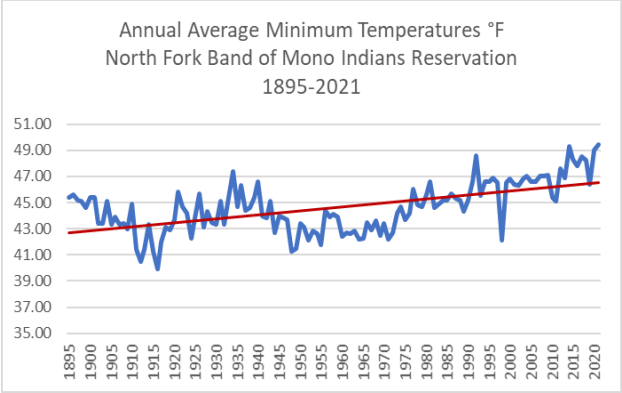
The North Fork have experienced warming temperatures across both the winter and summer months. In general, the area experiences both cold winters with temperatures below freezing as well as hot summers where temperatures exceed 100°F. However, accelerated warming over the last decade has contributed to warmer winters and hotter summers, which has impacted both the health of tribal citizens and the plant and animal resources on which they rely.

What does this indicator show?

At North Fork, both the nighttime temperatures and daytime temperatures have risen steadily since 1895. Looking first to daytime temperatures (Figure 3) we can see that temperatures have remained within 8°F but that the average temperature currently sits at around 68°F. However, in more recent years the temperature has varied more extremely with sharp increases and decreases from 1995 to 2021 (PRISM, 2022). Looking next to nighttime temperatures (Figure 4), we can see that temperatures cover a range of about 10°F, with temperatures remaining consistently above 45°F since 2001. Currently, the annual average minimum temperature is around 48°F. Overall, nighttime temperatures have increased at a much faster rate when compared to daytime temperatures over the last century, at 5°F compared to 2°F.

Figures 3 and 4. Annual Average Minimum and Maximum temperatures at North Fork Rancheria 1895-2020





Source: PRISM, 2022

Why is this indicator important?

Changing temperatures have cascading effects on other climatic variables, like precipitation, drought, and wildfires, further impacting the Tribe. Particularly important to the Tribe has been the decrease in acorn availability. The Tribe on the western side of the Sierra Mountains has depended heavily on acorn as a staple food for thousands of years. However, warming temperatures have decreased acorn availability especially during the drought between 2014 and 2016. During seasons when acorns are plentiful, the health of wildlife in the area benefits as well (McDonald, 2020).

As the climate has changed, the North Fork Rancheria has had to contend with a wide range of pests, disease, and non-native species (NFRMIC, 2018). Warming temperatures and extreme heat events contribute to drought stress on trees. The Tribe has observed instances of tree mortality over the last six to seven years, due to the combined effects of drought and bark beetles (McDonald, 2020). As water competition increases, trees become weakened, thus contributing to susceptibility to bark beetles (Preisler *et al*., 2017). The Tribe is concerned that Sudden Oak Death will become a problem in the area as the climate continues to change.

Warmer temperatures also negatively impact the health of Tribal Citizens. Ground ozone needs heat and sunlight to form, so hot temperatures have worsened air quality by exacerbating ground ozone levels. Data from CalEnviroScreen, California's Environmental Justice Screening Tool, shows that ozone levels in North Fork are ranked in the 67th percentile compared to other areas across the state, meaning that North Fork has higher ozone levels than most of the communities in California (OEHHA, 2021). Vulnerable populations, especially children, the elderly, and the disabled are at the greatest risk of exposure to extreme heat. Those without air conditioning may be at higher risk (NFRMIC, 2018)

<u>Drought</u>

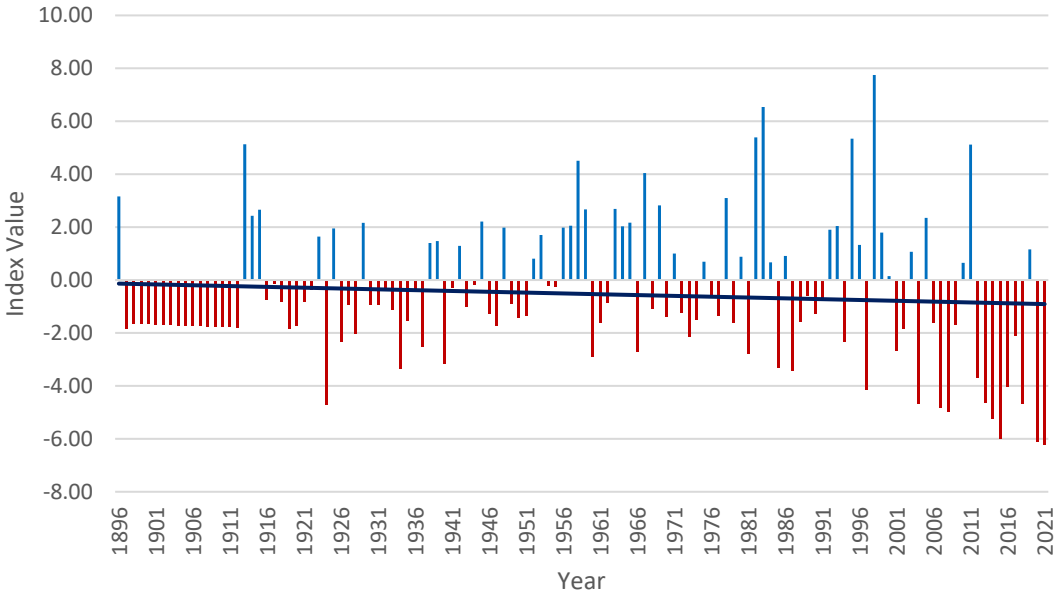
North Fork experiences clear wet and dry seasons, with the dry season lasting from mid-spring to late fall. Historically, the North Fork people have experienced multiple

instances of the destructive effects of drought including failed crops and changes to land-use patterns. Local hazard identification efforts have determined that drought conditions are to be expected across 10 to 50 percent of the North Fork area, with critical severity in terms of property damage, facility shut down, and injuries expected in the next year-ten years (Madera County, 2016).

What does this indicator show?

Using the Palmer Drought Severity Index (PDSI), a value of 0 indicates normal conditions while negative numbers represent drought conditions and positive numbers correspond to wet spells. Looking specifically the North Fork Rancheria, PDSI values show that the Tribe has experienced many instances of extreme drought since 2000 (Figure 5). Over those 21 years, there were nine years of extreme drought (PDSI values below -4) and three years of moderate to severe drought (values between -2 and -3). While the Tribe did experience moderate drought in the 100 years prior, those droughts were milder. The Tribe is seeing a trend of increasingly severe droughts.

Figure 5. Palmer Drought Severity Index (PDSI) for the North Fork Rancheria, 1896-2021



Source: Abatzoglou *et al.*, 2022

Why is this indicator important?

The increase in frequency and severity of drought conditions for the North Fork have important implications for surrounding wildlife and traditional cultural practices. Drought has reduced the availability of materials needed for basket-making, disrupting cultural traditions, and impacting the ability to pass on practices to younger generations (BPT, 2020; McDonald, 2020).

Drought conditions in the area have had significant impacts on tree mortality in the Sierra National Forest, causing large-scale die offs that are fueling other effects such as disease, pests, and wildfire events (Madera County, 2016). As mentioned in the *Elevated Temperatures* section, drought conditions and resulting water competition have made trees susceptible to bark beetle populations, contributing to the mortality observed. Fallen trees in the area have reduced the availability of mushrooms, an important food resource to the Tribe, which grow when forest soil is exposed to air. Along with a reduction in mushroom availability, tribal members also note that access to prime resource areas has been impacted by the abundance of fallen trees, which are blocking paths and access routes (McDonald, 2020).

Drought also impacts other native plants such as the sourberry, used both medicinally and for basketry, which require an ecosystem that is disappearing. Manzanita and Black Oak acorns, other species heavily utilized by Tribal Citizens, have also been negatively impacted by drought. Lack of water reduces the availability of berries and dries out the branches of plants, making them difficult to use for basketry. This can trigger negatively re-enforcing feedback loops where surrounding plants and animals relying on threatened species are unable to survive themselves. Deer herds in the area have been in decline for decades due to forest conditions and forest health. Deer are indicators of forest health; resources that the Tribe uses are also utilized by the deer. Dry conditions additionally facilitate the occurrence of wildfire events further impacting the health of populations and lands.

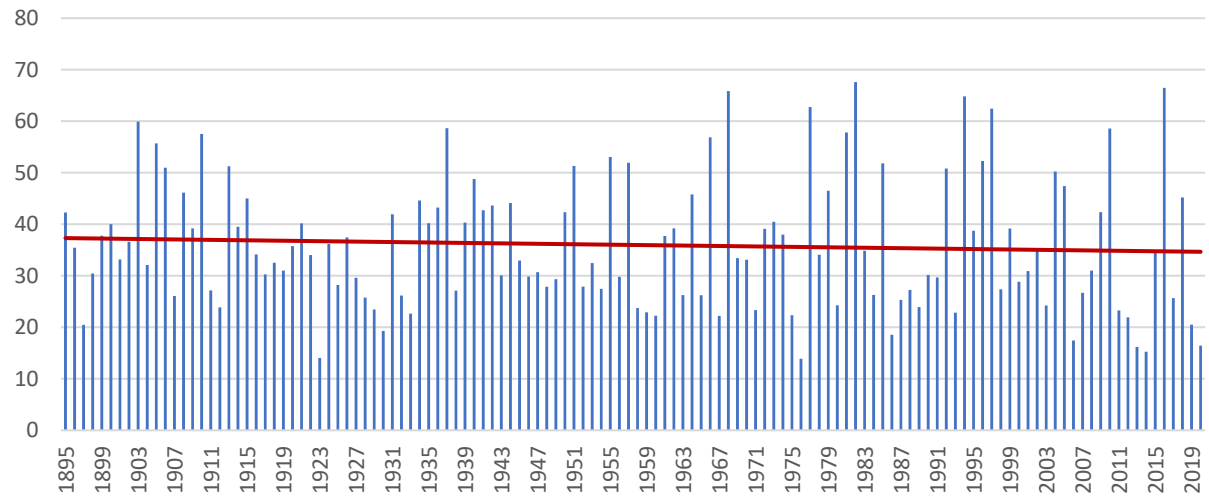
Precipitation

In addition to changing temperatures and instances of drought, the North Fork Rancheria has also experienced changes in precipitation patterns. Extreme precipitation events are expected to continue to impact the Tribe and the ensuing flooding can result in damages to property, roadways, and plant and animal species.

What does this indicator show?

Precipitation in North Fork has become more variable over time (Figure 6). Since 2010, the Tribe has seen large-scale differences from year to year, differences which are expected to continue as the climate continues to warm overall. Additionally, not specifically highlighted in annual rainfall summaries are instances of intense rainfall, which can lead to flooding, as well as periods of prolonged dryness (i.e., drought).

Figure 6 Annual precipitation by water year, North Fork Band of Mono Indians Reservation, 1895-2021



Source: PRISM, 2022

Why is this indicator important?

Changing precipitation patterns have the potential to significantly increase flooding at North Fork. Further, warming temperatures lead to precipitation falling as rain rather than snow, which in turn impacts the volume and timing of snowmelt in the Sierra Nevada mountains, and the sudden onset of early springtime warm temperatures and subsequent snowmelt have the potential to increase flooding (NFRMIC, 2018). Past flooding events have led to mandatory evacuations and have closed roadways – impacting the health and safety of tribal members.

Decreases in precipitation have contributed to lower-than-normal creek flows (BPT, 2020). Tribal members are dependent on water systems, and a reduction in creek flows has limited tribal access to additional clean water. According to CalEnviroScreen, North Fork is ranked in the 97th percentile compared to other areas across the state for drinking water contamination (OEHHA, 2021). This means only 3 percent of communities in the state evaluated by CalEnviroScreen have worse drinking water contamination issues. Aquatic ecosystems have also been affected by changes in precipitation patterns. Reduced creek flows have triggered large scale fish die-offs. This is concerning not only for the health of the aquatic ecosystem, but also for the diet of tribal populations. Central California roach, hardhead, Sacramento pikeminnow, Sacramento hitch, Sacramento perch, and Sacramento tule perch are all culturally important species to the North Fork Mono and the Tribe has seen reductions in numbers due to the diminished quality of aquatic ecosystems (SWRCB, 2014).

Flooding has impacted the gathering of materials for the Tribe. Basketry material such as sedge can be inaccessible during periods of high water and can also be impacted by large flood events, as increased flows can dislodge the root systems. The roots of the

sedge are used for the basket material. Sedge is typically found in sandy areas, which tend to be prone to wash out in high flows.

Wildfire

Wildfires are expected to increase in frequency and severity as the climate warms. Across the entire state, fire season has started earlier in the year and has expanded across more areas. For the Tribe, more frequent and intense fires have enormous consequences on both physical and cultural health and well-being.

What does this indicator show?

Wildfires have had a significant impact of the North Fork Rancheria. Of the five largest fires (in terms of area), three have occurred in the last 20 years (Figure 7, Table 1). These fires, along with many smaller fires, have burned significant portions of North Fork lands and lands surrounding the Rancheria.

Fires Impacting the North Fork Rancheria of Mono Indians (1950-2020)

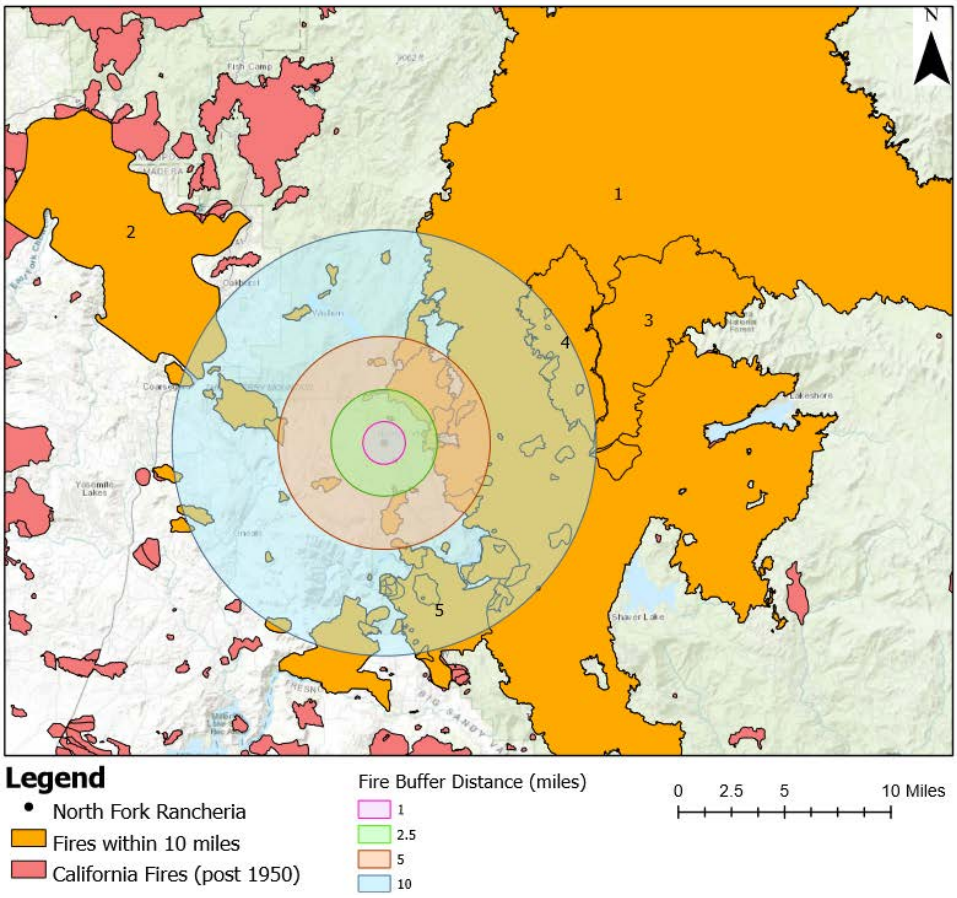


Figure 7. Wildfires that have impacted the North Fork Rancheria between 1950-2021 with fires within a 10 miles radius highlighted in orange. The numbers on the map denote the top five fires by area burned; see Table 1 for more information.

Source: CAL FIRE, 2021a

Table 1. Top 20 fires impacting the North Fork Rancheria of Mono Indians between 1961 and 2021, with the top 5 largest fires highlighted in blue.

RANK	YEAR	FIRE NAME	AREA (ACRES)
1	2020	CREEK	379,882
2	1961	HARLOW	43,331
3	2013	ASPEN	22,938
4	2014	FRENCH	13,832
5	1989	POWDERHOUSE	11,800
6	1982	TEMPERANCE FLAT	7,802
7	2015	WILLOW	5,701
8	2001	NORTH FORK	4,131
9	1968	THORNBERRY #2	3,131
10	1992	ITALIAN	2,157
11	1987	CHAWANAKEE	1,487
12	2017	MISSION	988
13	2015	CORRINE	922
14	1973	HORSESHOE	835
15	1985	MAMMOTH	764
16	1995	POWERHOUSE #2/#3	624
17	1970	LONG RIDGE	598
18	1961	MCALISTER FIRE	590
19	2005	QUARTZ	547
20	2003	NORTHFORK	472

Source: CAL FIRE, 2021b

In 2020 the Creek Fire – ranked the fifth largest wildfire in the state (CAL FIRE 2021a) -- devastated North Fork aboriginal territory. Of concern is the repeated burning of certain areas, as seen with the Creek Fire in 2020, the Aspen Fire in 2013 and French Fire in

2014 (Fires #1, #3 and #4 in Figure 7, Table 1). While it is uncommon for previously burned areas to re-burn, climatic changes are altering fire patterns that could influence the length of time between re-burns (Buma *et al.*, 2020). In total, there have been 73 fires within 10 miles of the North Fork Rancheria between 1950 and 2021. The loss of resources is severe, and it will take generations for the oak, pine, fir, and cedar to regrow.

Why is this indicator important?

Surrounding wildfires have contributed to both poor air and water quality in the North Fork Rancheria. Air pollution from wildfire smoke can lead to negative health outcomes like asthma, cardiovascular disease, and premature mortality. Soil erosion and sediment runoff from areas that have lost vegetation due to fires can degrade local surface water quality. This deposition of sediment, along with soot, can impact aquatic life in local waterways (BPT, 2020). Culturally important sites like the Mono Hot Springs have also been impacted. The alkaline runoff from wildfire soot increases the pH of water and the smoke from the wildfires lowers the temperatures (De Graff et al., 2018). On the North Fork Rancheria, fires have the potential to impact anywhere from 50-100 percent of the Tribe. Wildfires are likely to cause severe property damages, facility shutdowns, and injuries and illness (Madera County, 2016). Heavy rain, especially on wildfire-scarred land where the ground is unstable due to vegetation loss, can catalyze landslide events and severely threaten the health and safety of the surrounding community (NFRMIC, 2018).

The combined effects of multiple environmental stressors have been shown to directly impact wildfire events. Warming temperatures and drought conditions have exacerbated potential for wildfire (CAL FIRE, 2017). Drought and decreased snowpack have weakened trees, making them susceptible to disease and pest infestations; tree mortality in the Sierra National Forest has increased fuel loads, and thus the risk of wildfires (Madera County, 2016).

Another important consequence of increased frequency and intensity of fires across the state is the reduction in the number of days the Tribe can conduct cultural burning and fire ceremonies (BPT, 2020). For the North Fork Mono, regular burning encourages new growth of many species such as deer grass, sourberry and chapparal which are materials needed for basket-weaving. Since these plants are adapted to fire, after burning, the root stock remains intact and can resprout after spring rains. Due to long periods or dryness without regular prescribed burning, forests have become overgrown, causing conditions that could give rise to more extreme and dangerous fires. Additionally, vegetation management by Pacific Gas and Electric to remove brush and protect power lines has resulted in a loss of resources for the Tribe.

Summary

Warming temperatures, drought, wildfires, increasingly variable rainfall – and ensuing floods and erosion – have impacted the people of the North Fork Band of Mono Indians and their environment. In addition to exposures to temperatures much warmer than they are acclimated to, these changes have altered and disrupted the ecosystems within and

around North Fork, impacting many species of cultural importance to the Tribe. The community is actively working to understand, adapt to, and mitigate the effects of climate change. With the Tribe's goal of being consistent, transparent, and honorable, the North Fork Band of Mono Indians continue to manage and protect their lands and limit the impact of climate change on the North Fork Tribe'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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PALA BAND OF MISSION INDIANS

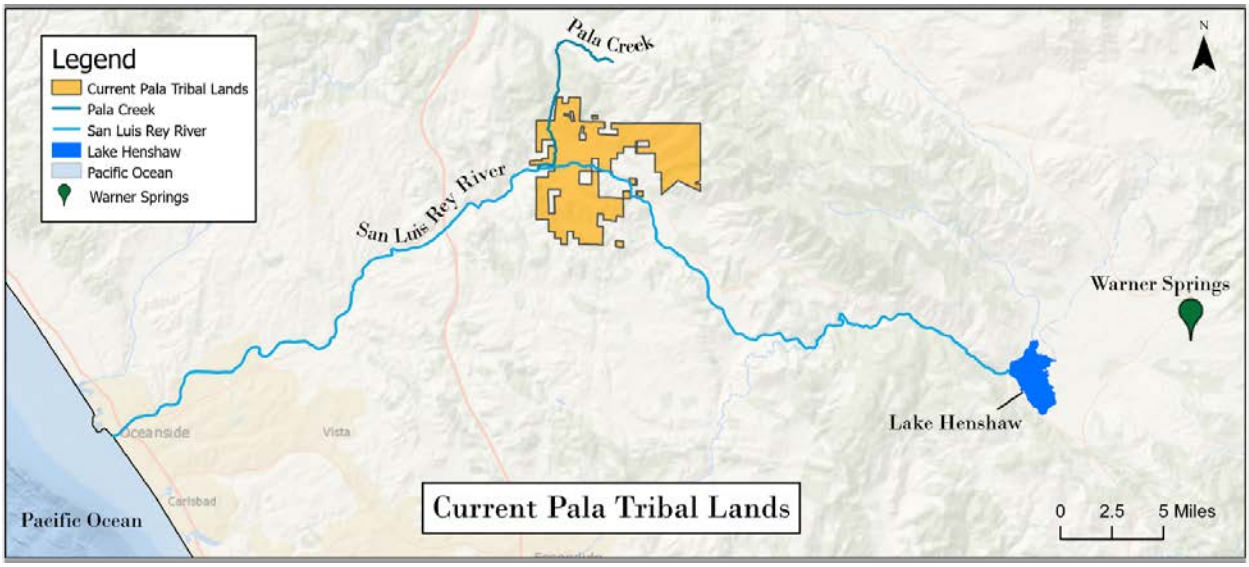
IMPACTS OF CLIMATE CHANGE ON THE PALA BAND OF MISSION INDIANS

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



Source: Pala Environmental Department

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.

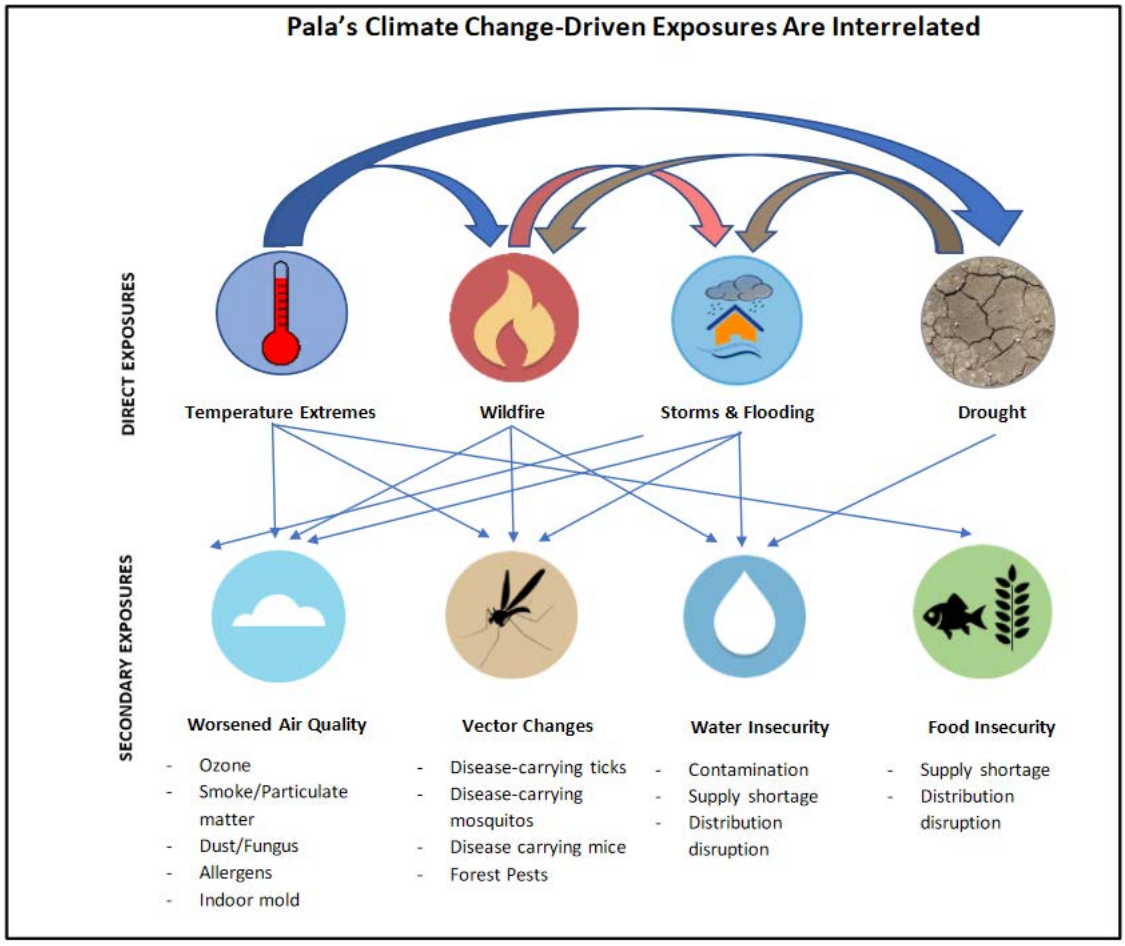
Climate change and the Pala Tribe

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).

Figure 2. Interrelated Climate Change Exposures



Source: Pala Environmental Department

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.

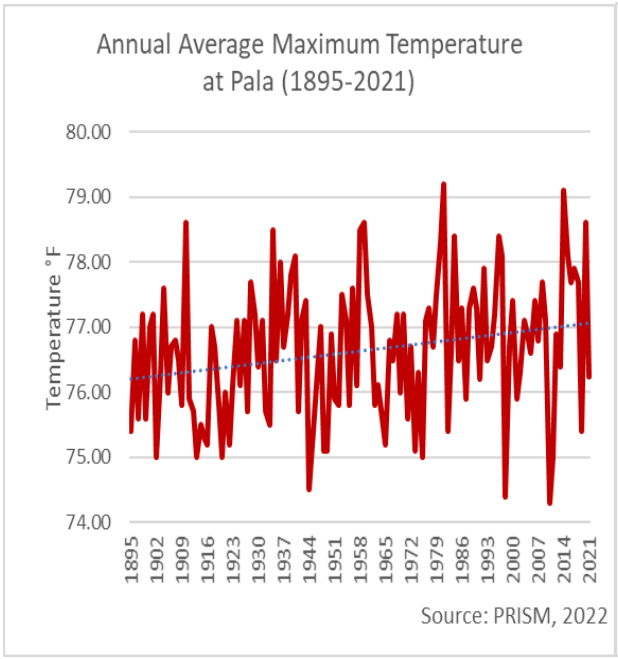
Elevated Temperatures

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).

Figure 3. Annual average temperatures at Pala



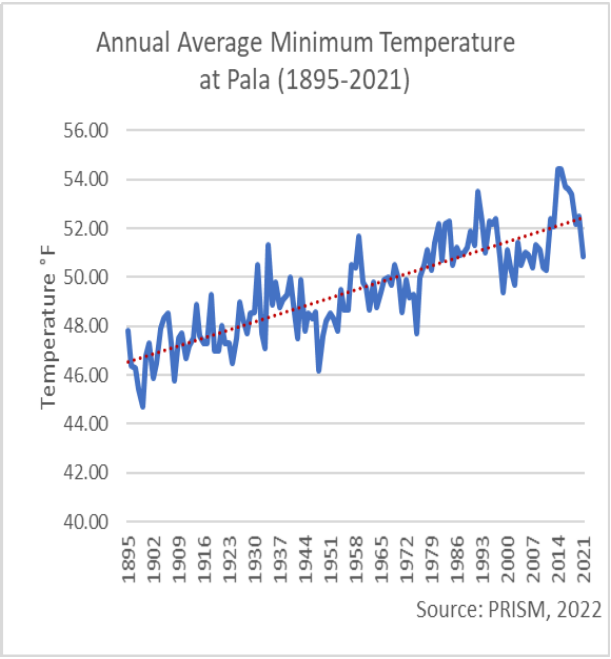


Table 1. Change in Day and Nighttime Average Annual Temperatures Over Time at Pala

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

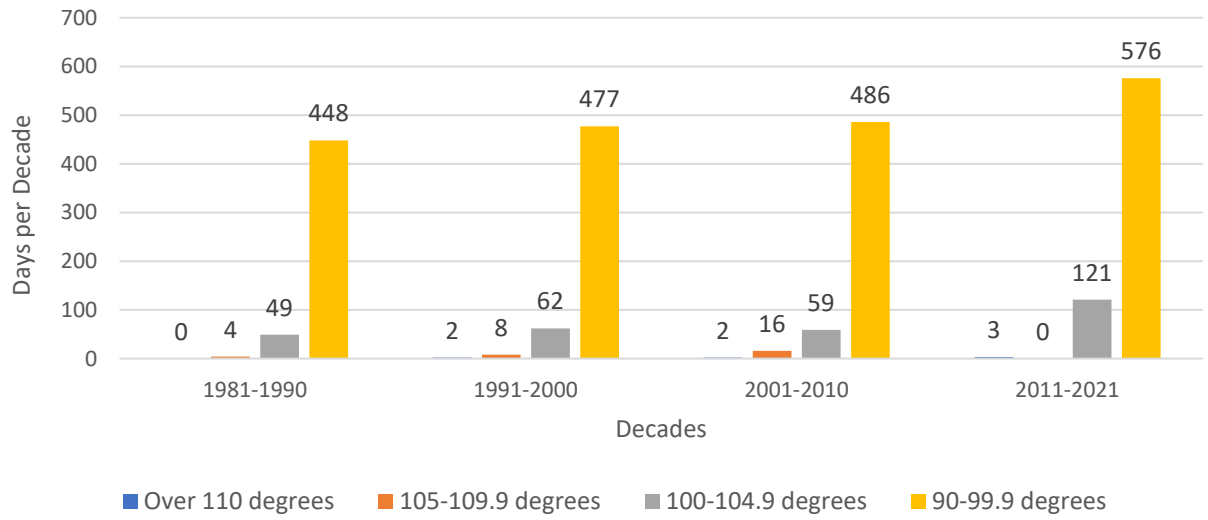
Table 1 shows the averages of the annual minimum (nighttime) temperatures (Tmin) and the annual maximum (daytime) temperatures (Tmax) during 30-year periods from 1895-2021. The Tmin has risen 5.8°F and the Tmax 1.2°F over the last 125 years.

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.

Figure 4. Extreme Heat at Pala



Source: PRISM, 2022

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).

> *"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*

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).

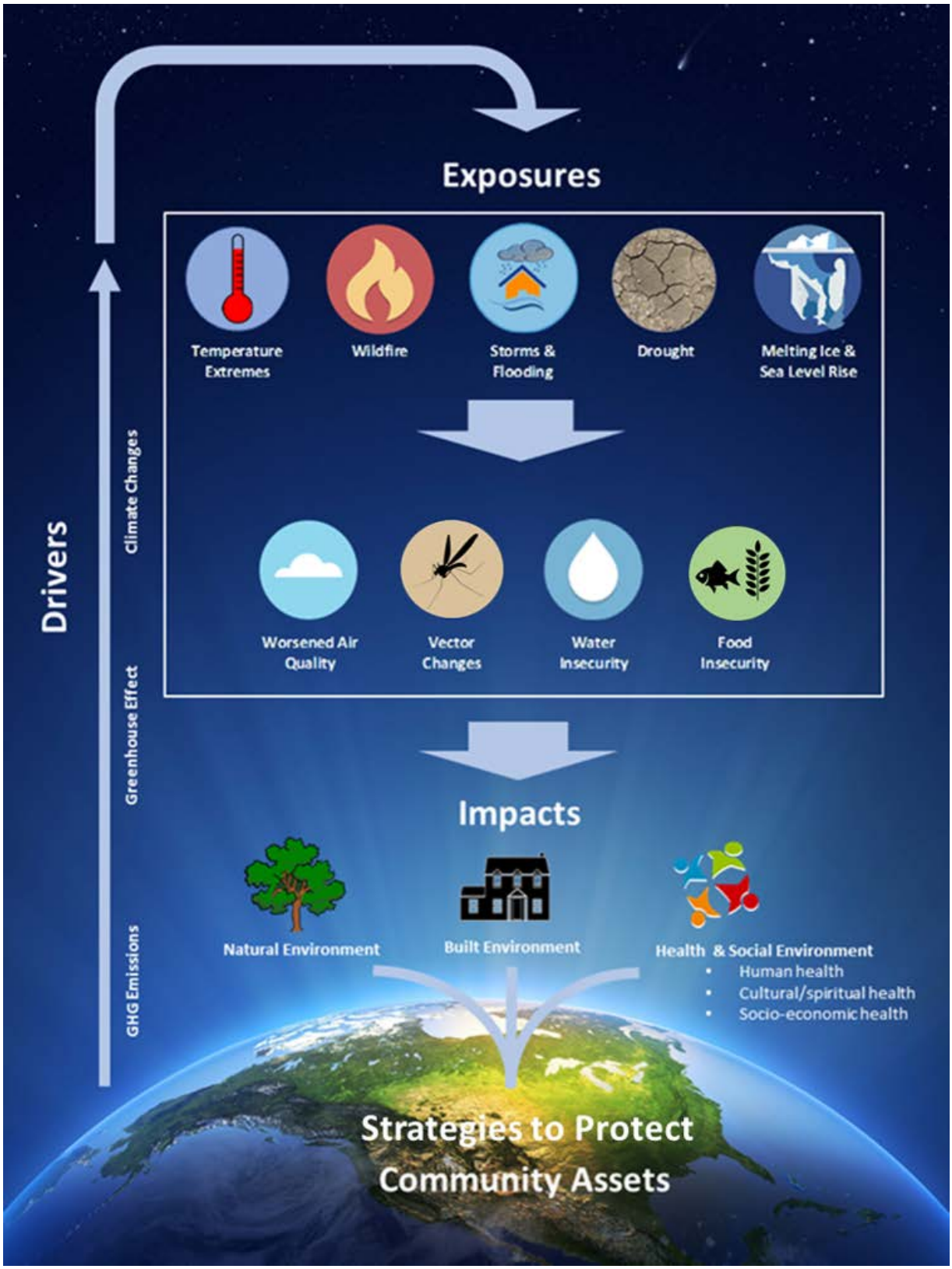
Increasing temperatures and earlier spring warming can also trigger extensive and prolonged algal blooms. These temperature shifts can also impact the breeding cycles of aquatic species that are triggered by warming temperatures, like the federally endangered arroyo toad (*Anaxyrus californicus*). Algal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

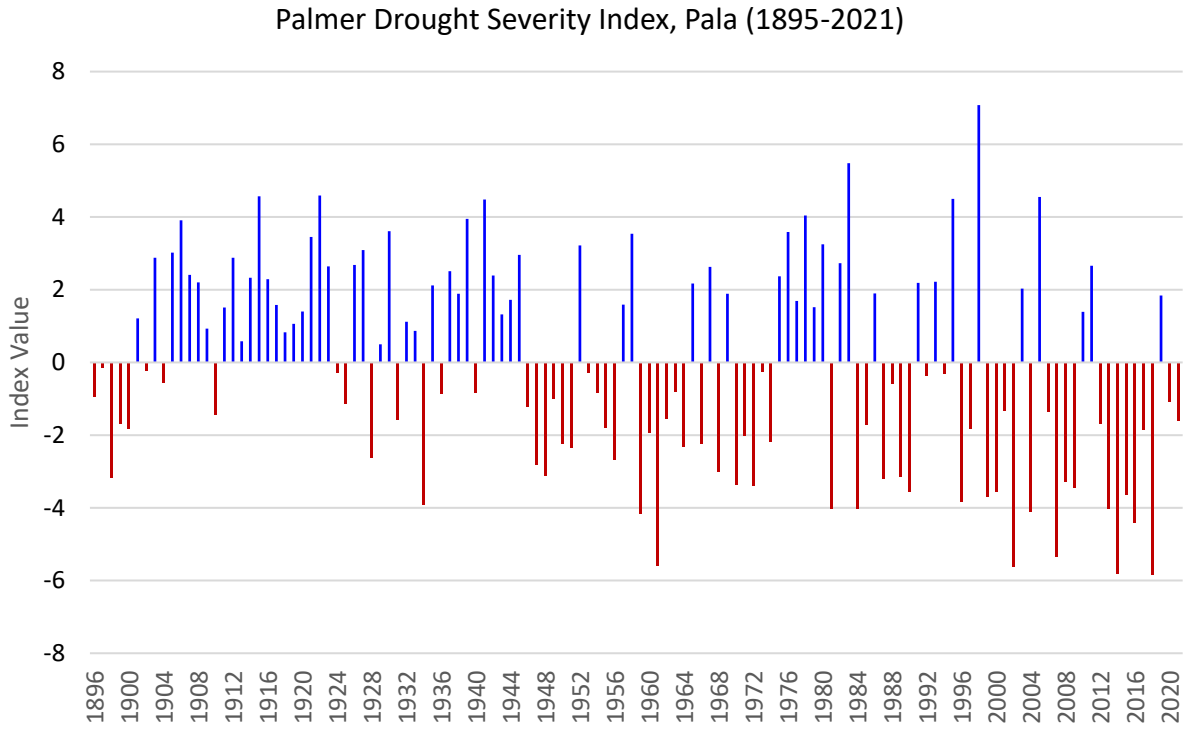
Increased heat intensifies photochemical reactions that produce ground level ozone, a key component of smog associated with motor vehicles, wildfires, and power generation. Levels of ozone at Pala are higher than in 71 percent of the census tracts in California (OEHHA, 2021).

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).

Figure 6. Drought at Pala



Source: 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 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, A*rundo*, and tamarisk. These species can degrade habitat quality for native wildlife and contribute to increased wildfire frequencies.

Figure 7. Southwestern willow flycatcher

Source: USFWS

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).

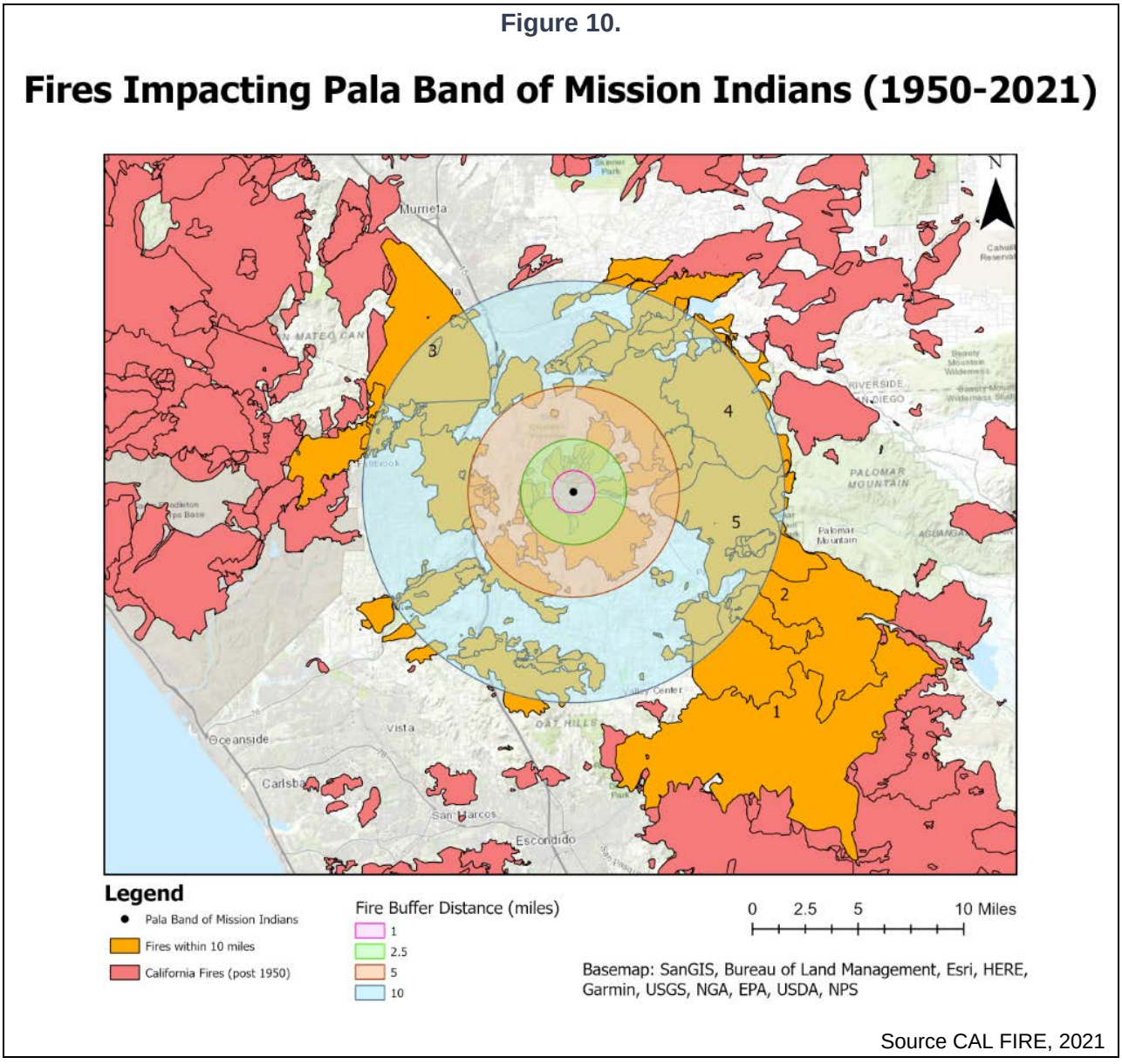
Wildfire

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.



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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IMPACTS OF CLIMATE CHANGE ON THE SANTA YNEZ BAND OF CHUMASH INDIANS

Sea level rise, flooding, erosion, drought, air quality and changes in flora and fauna are threatening the physical, cultural, and spiritual health of the Tribe, its habitats and ecosystems, and its built environment.

Background

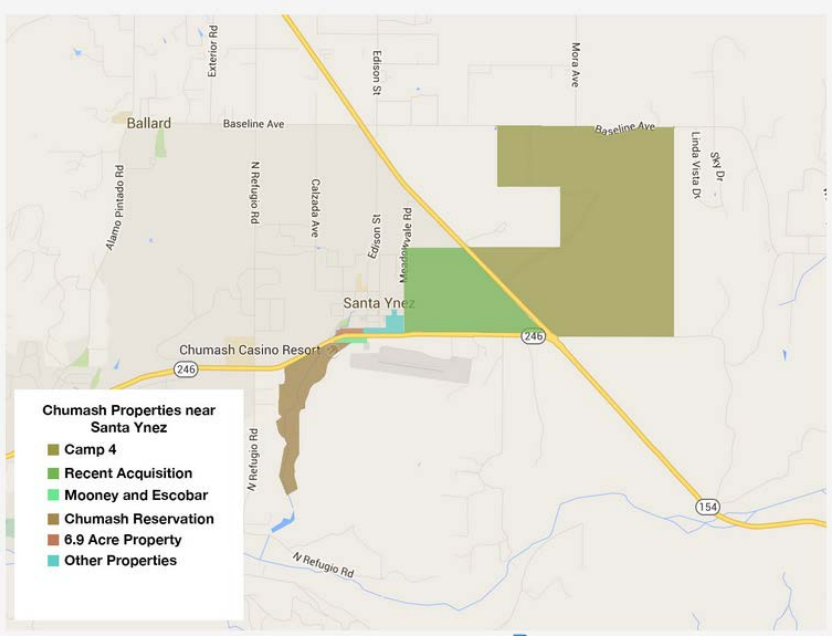
The Santa Ynez Band of Chumash Indians is a sovereign nation located in Santa Barbara County. They are currently the only federally recognized band of Chumash Indians. Santa Ynez is leading a coordinated effort of 11 of the 14 (SYBCI, 2020b) bands of Chumash Indians to document the impacts of climate change on the traditional Chumash territory (SYBCI, 2020a).

The culture of the Santa Ynez Band of Chumash Indians is deep within the souls of every tribal member and rests within our hearts. Throughout time, and in spite of challenges, the Tribe has maintained a connection to its ancestors and to a core identity of being Chumash. The Chumash have survived because of their strength as a Tribe and their spiritual connection to Chumash heritage and lands"

~Nakia Zavalla, Santa Ynez Chumash Cultural Director

For over 15,000 years the Chumash lived in a territory that encompassed approximately 7,000 square miles and ranged from the Channel Islands and Malibu to Paso Robles, then inland to the western edge of the San Joaquin Valley (Thornton, 2000). The Chumash population of approximately 25,000 people was decimated by disease and genocide, first by the Spanish starting in 1769, then by the

Figure 1. Chumash properties near Santa Ynez



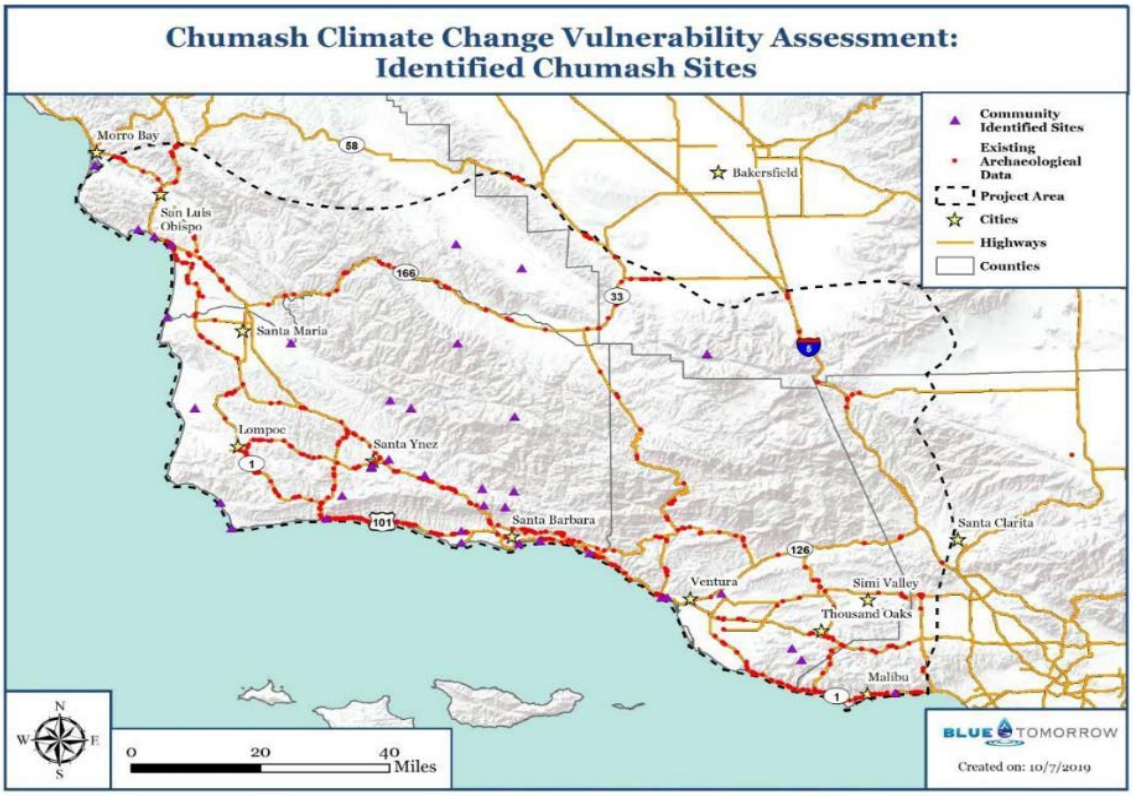
Source: County of Santa Barbara, 2021

Mission system and immigrant Americans colonizing the West (McWilliams, 1983). Today there are approximately 3,000 Chumash.

The Santa Ynez area is primarily rural, with vegetable and flower fields, cattle and horse ranches, vineyards, and wineries. As shown in Figure 1, access to the Santa Ynez reservation is via State Route 246, which connects on the west to Highway 101 and on the east to Highway 154. A creek bed separates the reservation into the Upper Reservation (west) and Lower Reservation (east). The original reservation covered 99 acres. In 2010, the tribe purchased 1,427 acres of land known as the Camp 4 property. The Camp 4 addition brought the size of the reservation to 1,526 acres (SYBCI, 2019). This addition also improved the overall lands of the Santa Ynez Chumash as the original reservation was intentionally placed along a floodplain (McCormick, 1996).

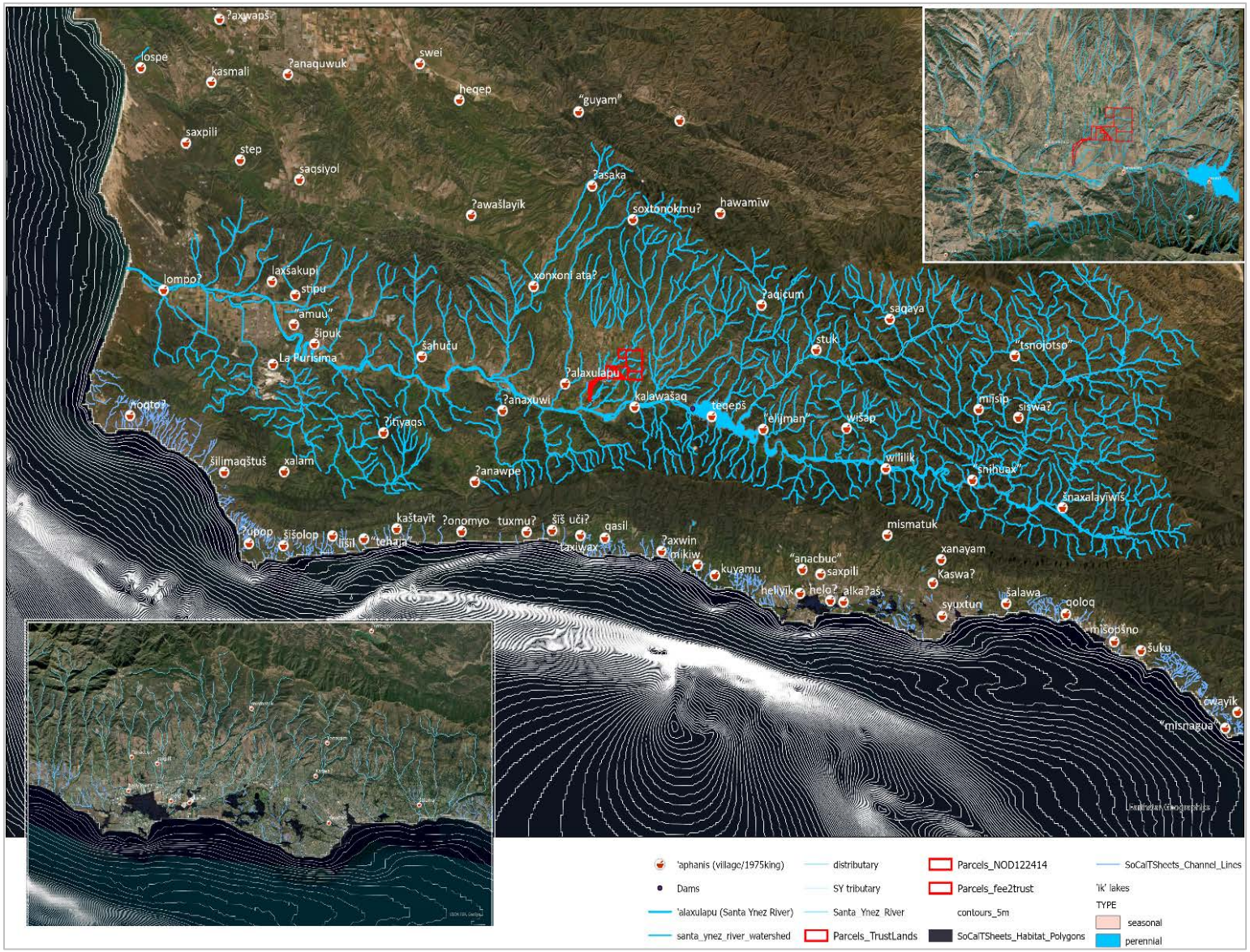
In assessing the impacts of climate change, the Chumash considered the approximate range of traditional Chumash tribal lands as those lands still hold important Chumash cultural sites (see map, Figure 2). Non-federally recognized Chumash bands and sacred and important Chumash cultural sites are located throughout this area (SYBCI, 2020a).

Figure 2. Chumash area considered in assessing the Tribe's vulnerability to climate change ("Project Area," dotted line), and sites of cultural significance to the Tribe



Source: SYBCI, 2020a

Figure 3. Watershed areas and creeks listed in Samala



Source: SYCEO, 2021a

Samala is the primary language traditionally spoken by the Santa Ynez Chumash people. Recent years have seen a renaissance of Chumash pride and identity, including efforts to continue to teach Samala and other Chumash languages (SYBCI, 2020a). For example, the watershed map in Figure 3 identifies creeks using their Samala names within the Chumash tribal area.

Climate change and the Santa Ynez Tribe

According to the Santa Ynez Chumash Environmental Office (SYCEO) Tribal Hazard Mitigation Plan, by 2100 the average temperatures are predicted to rise by over 7 degrees Fahrenheit (˚F), resulting in over six times as many extreme heat days. Average precipitation, currently about 16 inches per year (SB County, 2021), will increase by approximately 4 inches and hectares burned in wildfire will increase by over 20%.

Increasing temperatures, changing precipitation patterns, sea-level rise, wildfires, drought, and debris flows can all cause impacts to the Chumash by disturbing plants and animals, potentially leading to their local extinction. These disturbances in turn may impact traditional hunting and gathering practices, the timing of spiritual practices, and the loss of local food sources, traditional medicinal plants, and traditional materials used for jewelry, sculptures, ceremonial pieces, basketry, nets, and lodgings (SYBCI, 2020a).

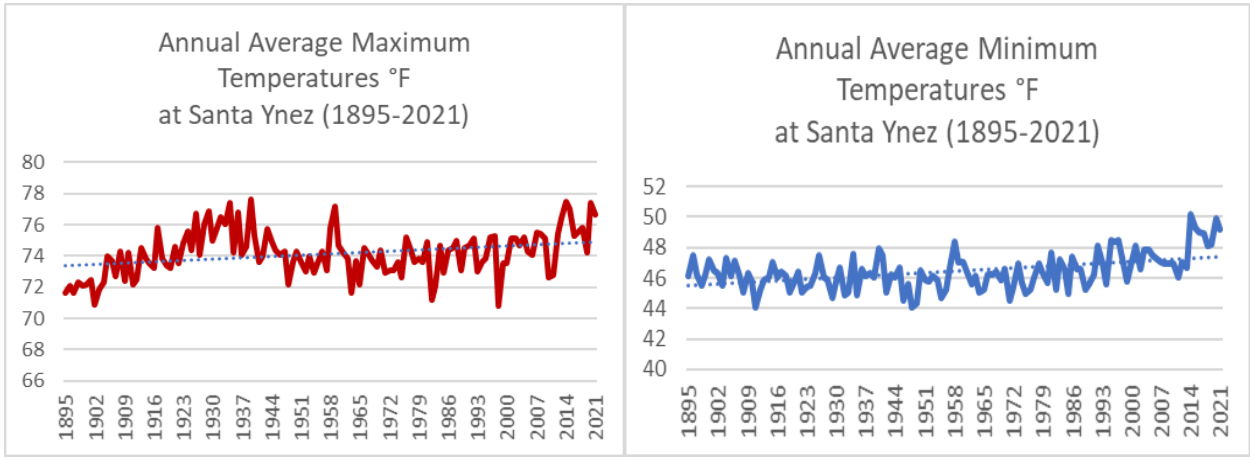
In a survey conducted by the SYCEO as part of a Climate Change Vulnerability Assessment, 90% of respondents stated that climate change and the resulting sea level rise, flooding, erosion, wildfires, reduction and extirpation of plants and animals, has already had an effect on access to cultural sites (Figure 2) and resources, including the availability of plant and animal resources (SYBCI, 2020a).

Elevated Temperatures

What does this Indicator show?

At Santa Ynez, both the nighttime temperatures and daytime temperatures are rising, with the nighttime temperatures rising more quickly. As shown in Figure 4, before 1950 the annual average minimum temperature varied between 41.5°F and 46.1°F and the annual average maximum temperature varied between 72.5°F and 77.5°F. Since 1950 the annual average minimum temperature has been between 42.2°F and 48.5°F and the annual average maximum temperatures has ranged from 71.6°F to 77.6°F (PRISM, 2022).

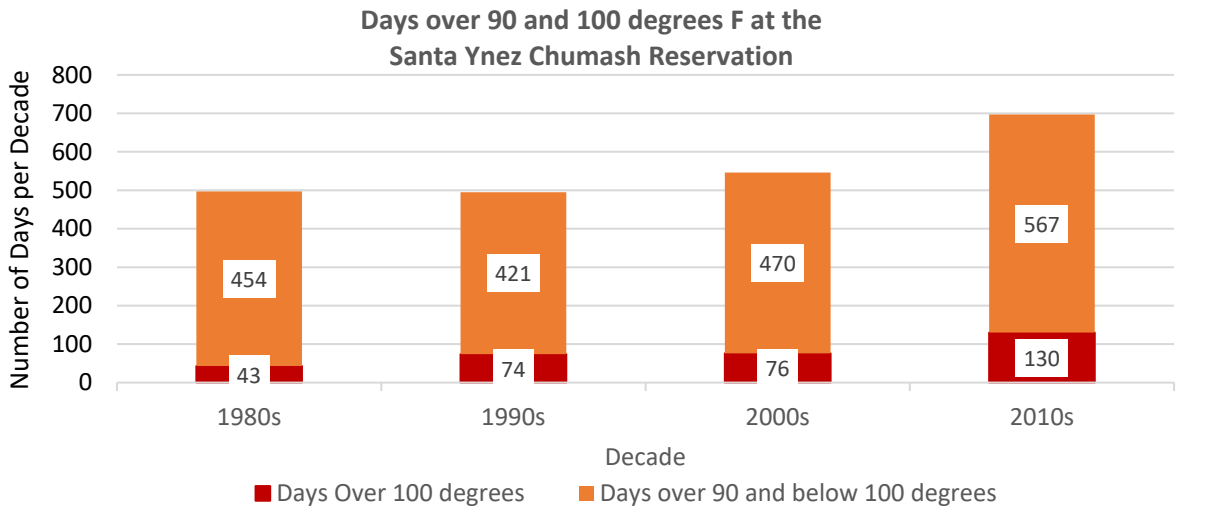
Figure 4. Annual average temperatures at Santa Ynez 1895-2021



Source: PRISM 2022

The number of extreme heat days has increased as well. As shown in Figure 5 the number of days with temperatures over 100°F has more than tripled since the 1980s (PRISM, 2022). In 2020 and 2021 the Tribe experienced 111 days over 90°F and 17 days with temperatures over 100°F.

Figure 5.



Source: PRISM, 2022

Why is this indicator important?

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 the Santa Ynez Chumash environment. Elders, children, outdoor workers, and those with existing medical conditions are particularly susceptible to these impacts.

With the increasing nighttime temperatures, people do not have the chance to cool down. In addition, in traditionally temperate areas such as Santa Ynez, people are not

physiologically acclimated to higher temperatures. The Tribe currently does not have enough cooling centers to help members in need during times of extreme heat.

Many indigenous cultural practices rely on natural or seasonal cycles associated with changes in weather patterns, plants, and animals. Increased temperatures, extreme heat, and heat waves affect the traditional timing of Chumash cultural practices due to climate's effect on the landscape. Warmer temperatures and changes to precipitation patterns may cause plants to fail to grow in one area and be able to grow in another. Some species may be able to expand their range, while others may experience a decrease in range. The Tribe has already seen traditional plants migrating to different areas and the off-season blooming and fruiting of many species (SYBCI, 2020a).

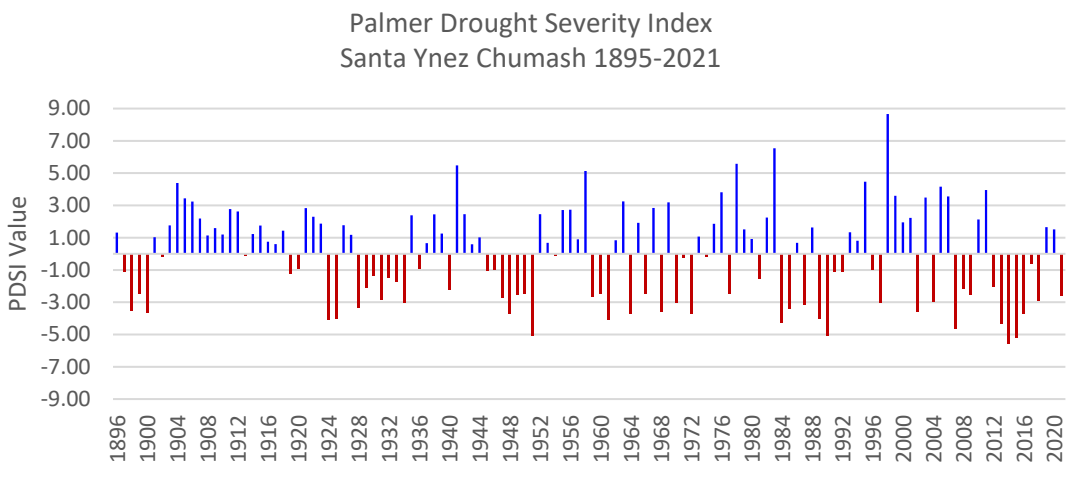
Drought

What does this indicator show?

Because of its geography, Santa Barbara County does not always experience drought at the same time as the rest of California. The county has been free of drought at times of state-declared drought emergencies, but also has experienced drought when there is no state-declared drought. For example, after the state lifted its declaration for the drought of 2014 – 2017, Santa Barbara County's local drought declaration remained in place. As a result, examining impacts at a local level reveals a more accurate picture of drought impacts (SYBCI, 2020a).

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, the Santa Ynez Chumash Tribe is having more, and more intense, dry years. Prior to 1950, dry years (with PDSI values below zero) occurred 26 times, three of which were classified as extreme drought (PDSI at or below -4). From 1951 to 2021 Santa Ynez experienced 35 dry years, including 7 years of extreme drought.

Figure 6. Drought at Santa Ynez



Source: Abatzoglou et al., 2022

Why is this indicator important?

The Tribe has observed that ground water levels on the Santa Ynez reservation have dropped during drought, and that plants are migrating to higher elevations or are not propagating due to a combination of drought and extreme heat.

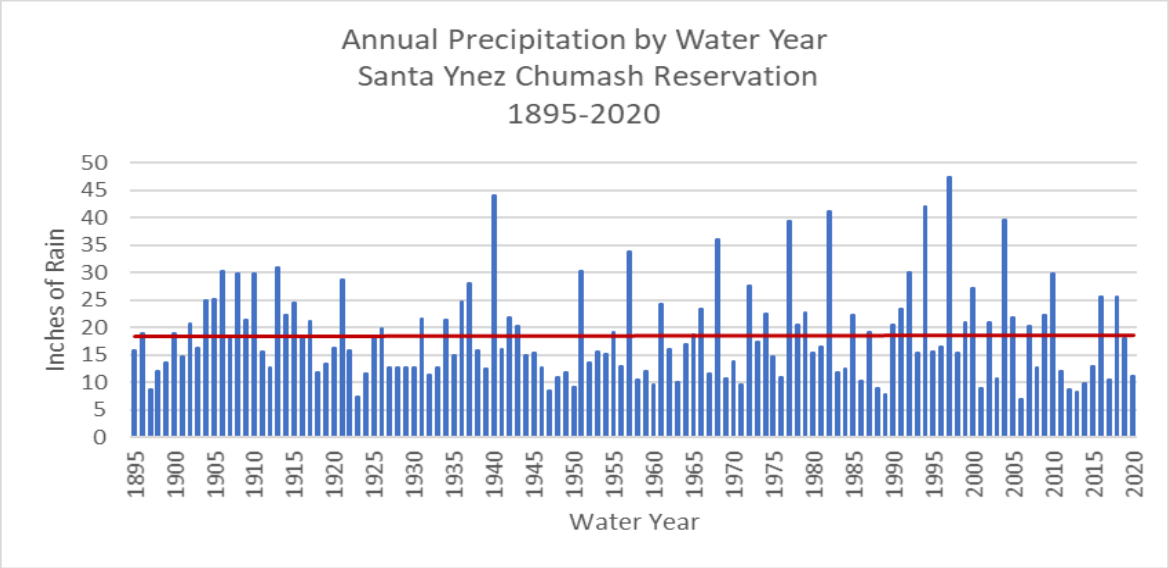
During interviews with the Chumash community, 74 plant species were identified that have traditionally been or currently are gathered. Approximately 76% of respondents (22 individuals) said that they have noticed changes in the availability of plant and animal resources in recent years, with 20 respondents experiencing a decrease in availability. For those respondents who experienced a decrease in plant and animal resource availability, the commonly reported reasons for the decline included: loss of access, overharvest, drought, lack of instream water availability, and development (SYBCI, 2020c).

Precipitation and Flooding

What does this indicator show?

As shown in Figure 7, while the total amount of rain over time has remained steady, the fluctuation in wet and dry years has grown greater over time. Looking at water years, which start in October and run through September the following year, between 1895 and 1958 the Santa Ynez Chumash experienced one year with rainfall over 35 inches. From 1959 to 2020 the Santa Ynez Chumash experienced six years with rainfall of over 35 inches per year. This high intensity rain is matched with high runoff and the Chumash have seen that groundwater is not being recharged as a result (PBMI and SYBCI, 2021).

Figure 7. Annual Precipitation at the Santa Ynez Chumash reservation

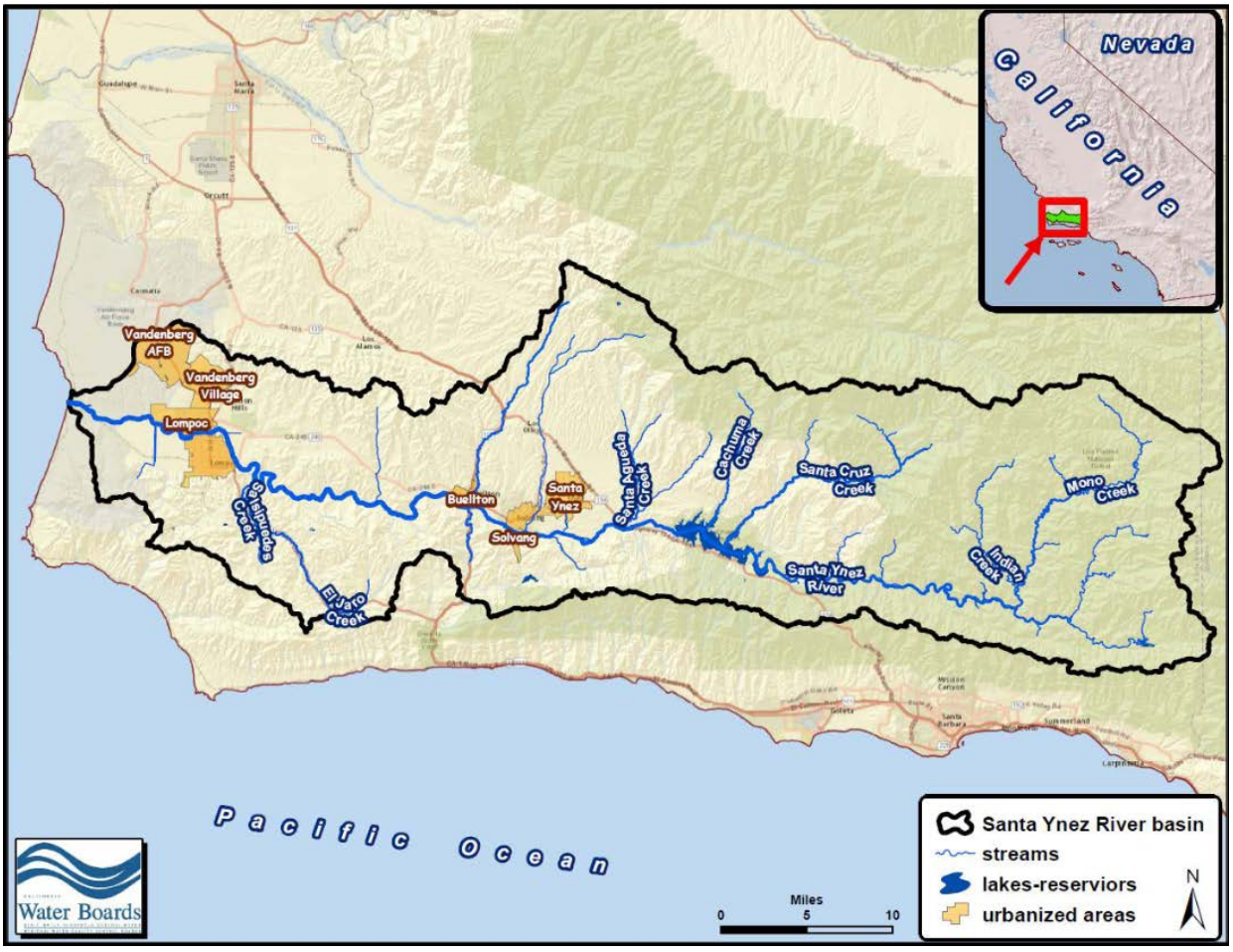


Source: PRISM 2022

Why is this indicator important?

The Santa Ynez Reservation lies within the Santa Ynez River Watershed (See Figure 8, Watershed subbasins). The Santa Ynez River borders the southerly edge of the Santa Ynez Valley, along the northern slopes of the Santa Ynez Mountains. One of the largest rivers on the Central Coast of California, the Santa Ynez River is 92 miles long, flowing east to west across the valley, through Solvang, Buellton, and Lompoc. The watershed encompasses 897 square miles. It drains from the Santa Ynez River's headwaters in the Santa Ynez Mountains west through the Santa Ynez Valley before emptying directly into the Pacific Ocean north of Surf Beach. Elevations range from 4 feet at the head of the estuary to 6,820 feet in the Santa Ynez Mountain headwaters.

Figure 8. Santa Ynez River watershed subbasins

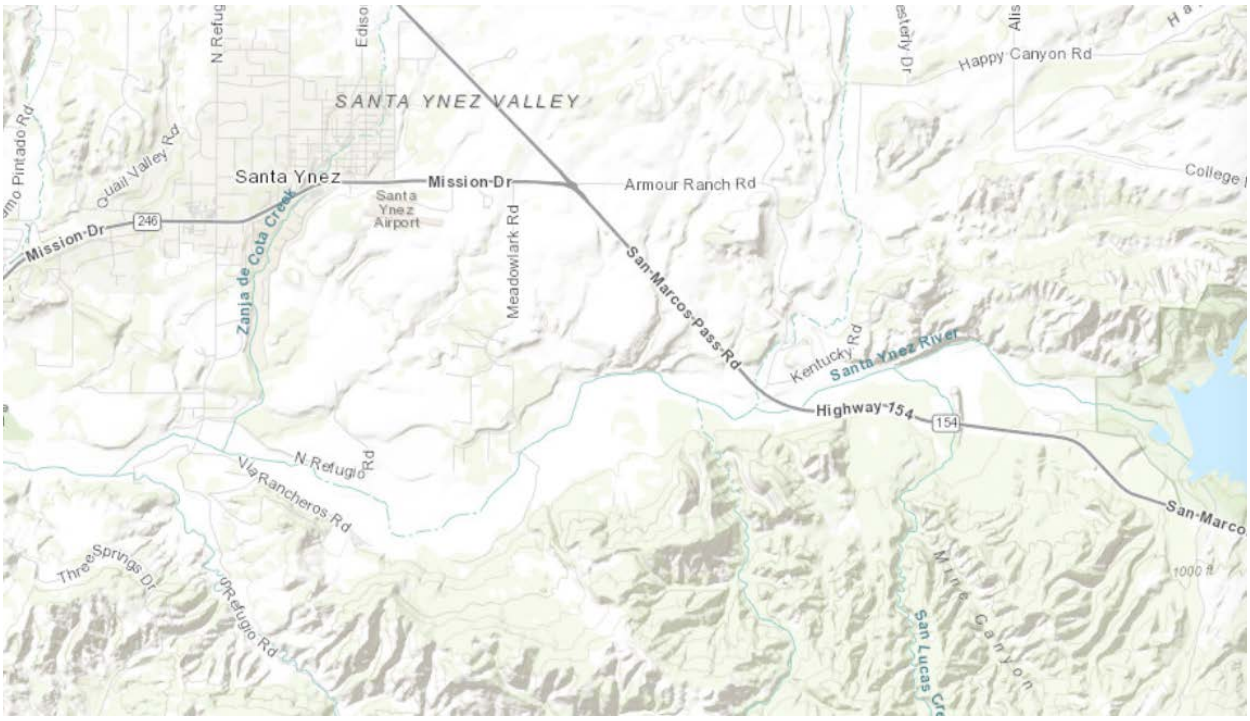


Source: Waterboards, 2016

The USGS designates the Santa Ynez River as a fourth-order river (medium sized) with 2,077 miles of total tributary stream length: 1,663 intermittent miles, 350 perennial miles, and 63 miles of man-made channels. Drainages exiting the hills and draining to the Santa Ynez River cross the valley northeast to southwest. The most significant

surface water for the Santa Ynez Tribe is the Zanja de Cota Creek (see Figure 9) which bisects the original Santa Ynez Chumash reservation lands.

Figure 9. Zanja de Cota Creek



Source: USGS, 2021

With increasingly variable precipitation, extreme rainfall events are projected to pose a risk of flooding. (Coastal Resilience, 2020). Santa Barbara County experienced 14 significant floods between 1862 and the 1998. Eight of these floods were declared state and federal disasters. The Santa Ynez Reservation has seen major flooding along Zanja de Cota Creek and the Santa Ynez River. In recent years, major flooding along the creek occurred in 1980, 1995 and 1997.

The 2019 Santa Ynez Band of Chumash Multi-Hazard Mitigation Plan (SYBCI, 2019) provides an account of flooding on the reservation along Zanja de Cota Creek and the Santa Ynez River. As is summarized below in the first 130 years of modern flood records the Santa Ynez Chumash endured four major floods; in the last 30 years the Santa Ynez Chumash have experienced five major floods.

Summary of major flood events

- 1862—Great Flood
- 1907—Flood flows on the Santa Ynez River engulfed the entire Lompoc Valley
- 1969—California declared Santa Barbara County a disaster area on January 25; major flooding along the Zanja de Cota; Santa Ynez River experienced the highest flows in almost 3,000 years; 16 inches of rain fell at Juncal Dam (Goleta)

in a 24-hour period; in the Upper Santa Ynez watershed, the flood was equivalent to a 100-year storm
- 1980—Major flooding along the Zanja de Cota; mudslides in some areas
- 1992–1993—Santa Ynez Valley received approximately 180 percent of normal rainfall
- 1995—Major flooding along the Zanja de Cota; part of widespread flooding throughout the County
- 1997–1998—Flooding along the Zanja de Cota; several record-breaking rainfalls with 50-year storm event intensities in February 1998
- 2011 (March) Santa Ynez River flooding
- 2018 Montecito debris flow. This debris flow impacted local Chumash cultural resources and caused damage to the reservation.

Sea level rise

What does this Indicator show?

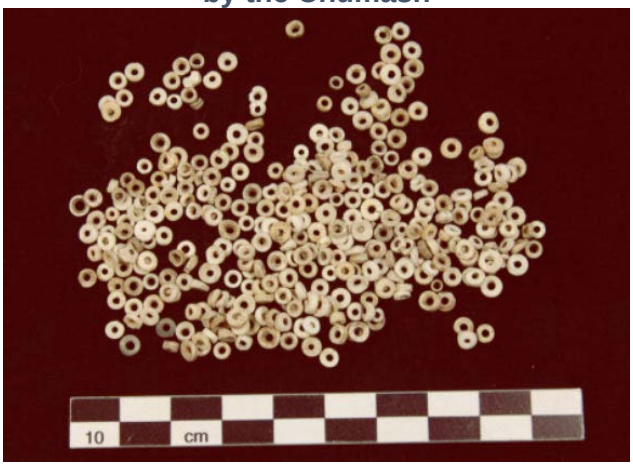
The Nation Oceanic and Atmospheric Administration (NOAA) reports that the mean sea level in Santa Barbara County has increased an average of 1.08 millimeter per year between 1973 and 2020 (NOAA, 2021).

Why is this indicator important?

Sea level rise and the resulting erosion are already impacting important Chumash cultural sites along the coast (PBMI and SYBMI, 2021). Like many cultures, the Santa Ynez Chumash youth are taught by parents or elders in the group. As sea levels rise, sites previously used for gathering are no longer accessible. In addition, the Tribe has seen damage to cultural sites due to erosion along the coast. Without access to these traditional sites, knowledge can be disrupted, and the weight of that loss is felt by generations of tribal members (PBMI and SYBMI, 2021).

Olivella shells (Figure 10), are gathered by the Tribe for use in shell money, jewelry, and regalia, are becoming more scarce and traditional areas for gathering are often no longer accessible (PBMI and SYBMI, 2021).

Figure 10. Olivella shells carved by the Chumash



Source: Science News, 2021

While sea water intrusion is not expected to impact the Santa Ynez reservation directly, its impact on other aquifers will likely increase dependency on the other groundwater basins between the Santa Ynez Mountains and the Pacific Ocean (Coastal Resilience, 2020).

Impacts on Plants and Animals

What does this indicator show?

The Santa Ynez Chumash have already seen a reduction or extirpation of species such as steelhead, red-legged frogs, kelp, sea grass and Olivella. Both Chia Sage (*Salvia columbariae*) and Chuchupate (*Ligusticum porter*) are no longer found in the area and grow only at higher elevations where temperatures are cooler, and more water is available.

Plant communities and animal habitats are anticipated to be further affected by changes to primary (temperature, precipitation, sea-level rise) and secondary (drought, wildfire, flooding, flooding, cliff erosion, debris flows, and wildfire) climate change impacts (SYBCI, 2020a).

Why is this indicator important?

The Chumash have always harvested from both the land and the sea. Changes in ocean temperature and ocean acidification have impacted species important to the tribe (PBMI and SYBMI, 2021). In 2013 sea stars, the main predator of purple urchin, were decimated by the sea star wasting disease virus; while the causes of the incident have not been established, it is hypothesized that elevated ocean water temperatures may have been an exacerbating factor (Miner et al., 2018). With sea stars gone, the urchin population grew unchecked.

2014 brought a marine heat wave, which was followed in 2015 by an El Niño causing the ocean waters to warm further. These warm waters contained fewer nutrients than the normally cold coastal California waters, which caused kelp to grow more slowly. Urchin and abalone both mainly eat kelp. The explosion in the urchin population and the reduction in kelp due to warming waters impacted two species important to the Chumash: kelp and abalone (UCD, 2021).

Many species which are important to the Santa Ynez Chumash are currently threatened by climate change such as: Belding's Savannah Sparrow, tidewater goby, steelhead, snowy plover, willow flycatcher, white-tailed kite, monarch butterfly, Coastal Range newt, Western Pond Turtle, and brown pelican. Waqaqʾ (red-legged frogs, Figure 11), in particular, used to thrive on the reservation, are no longer present.

Figure 11. Waqaq' (California red-legged frog)

Source: Los Padres Forest Watch

The Zanja de Cota Creek that flows through the reservation used to be the site of steelhead fishing derbies (Figure 12). Due to the drop in water in the creeks, and an increase in pesticide runoff, there are no steelhead remaining in the creeks.

Figure 12. Historic photo - steelhead caught along Zanja de Cota Creek (1912)

Source: Lompoc Historic Society

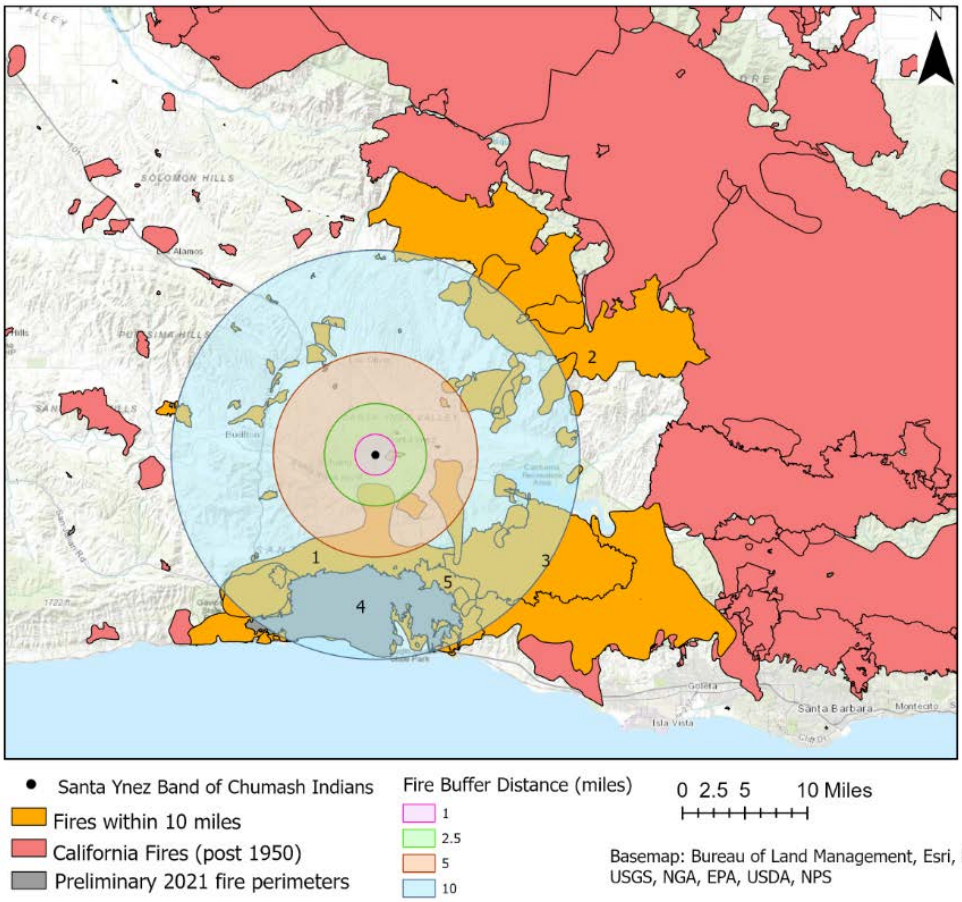
Wildfire

What does the 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, 2020). A study of microscopic charcoal from the Santa Barbara Channel indicates that over the past 560 years large wildfires (greater than 500 acres) occurred in the Santa Barbara County area an average of every 20 to 30 years (Mensing et al., 1999). Prior to the 1950s, the greater Santa Barbara area averaged one large fire per decade; however, the number of large fires within and adjacent to the County has increased substantially. There were 93 large fires within Santa Barbara County between 1955 and 2021 that burned over 1,475,042 acres. This equates to 1.4 significant fires every year (SB Fire Safe Council, 2021, CAL FIRE 2021). Figure 13 shows the fires that came from within one to ten miles of the Santa Ynez Chumash reservation between 1950 and 2021.

Figure 13.

Fires Impacting the Santa Ynez Band of Chumash Indians (1950-2021)



Source: CAL FIRE, 2021. Map generated using fire perimeter data from CAL FIRE

Why is this indicator important?

Wildfire is considered a high-risk exposure for the Santa Ynez Chumash tribe. Climate factors including Santa Barbara's Sundowner winds (Ryan et al., 1992), increasing temperatures, and severe drought conditions are increasing the wildfire risk at Santa Ynez.

Firefighting equipment can expose and destroy cultural sites. Burned areas that are then subjected to heavy rain will be subject to flooding, landslides and rockfalls. Cleanup of burned areas can expose cultural artifacts and destroy sites important to the Tribe. SYCEO has begun studying impacts in burn scar areas, including loss of trees and species that are returning to these areas. Some burn scar areas are not supporting the growth and reproduction of tree seedlings, likely due to warmer temperatures or insufficient moisture related to climate change, in addition to the wildfires.

Poor air quality, caused by wildfire smoke, is of great concern on the reservation; when wildfire smoke is present outdoor activities cannot occur, ceremonies and gathering

activities are cancelled. Smoke more heavily impacts Tribal members who have asthma, or other respiratory related health issues such as chronic obstructive pulmonary disease (COPD).

Summary

Warming temperatures, drought, increasingly variable rainfall – and ensuing floods – erosion resulting from sea level rise, and wildfires have impacted the people of the Santa Ynez Band of Chumash Indians and their environment. In addition to exposures to temperatures much warmer than they are acclimated to, these changes have altered and disrupted the ecosystems within and around Santa Ynez, impacting many species of cultural importance to the Tribe, and interfering with their ability to carry out traditional practices. The 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 of climate change on the Santa Ynez Chumash Tribe'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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