

6.2 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

Figure 6.2.1. Clear Lake Basin from What Is Now Called Soda Bay.



Source: Photo by Laurie Monserrat

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 ([Figure 6.2.1](#) and [Figure 6.2.2](#)). 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.



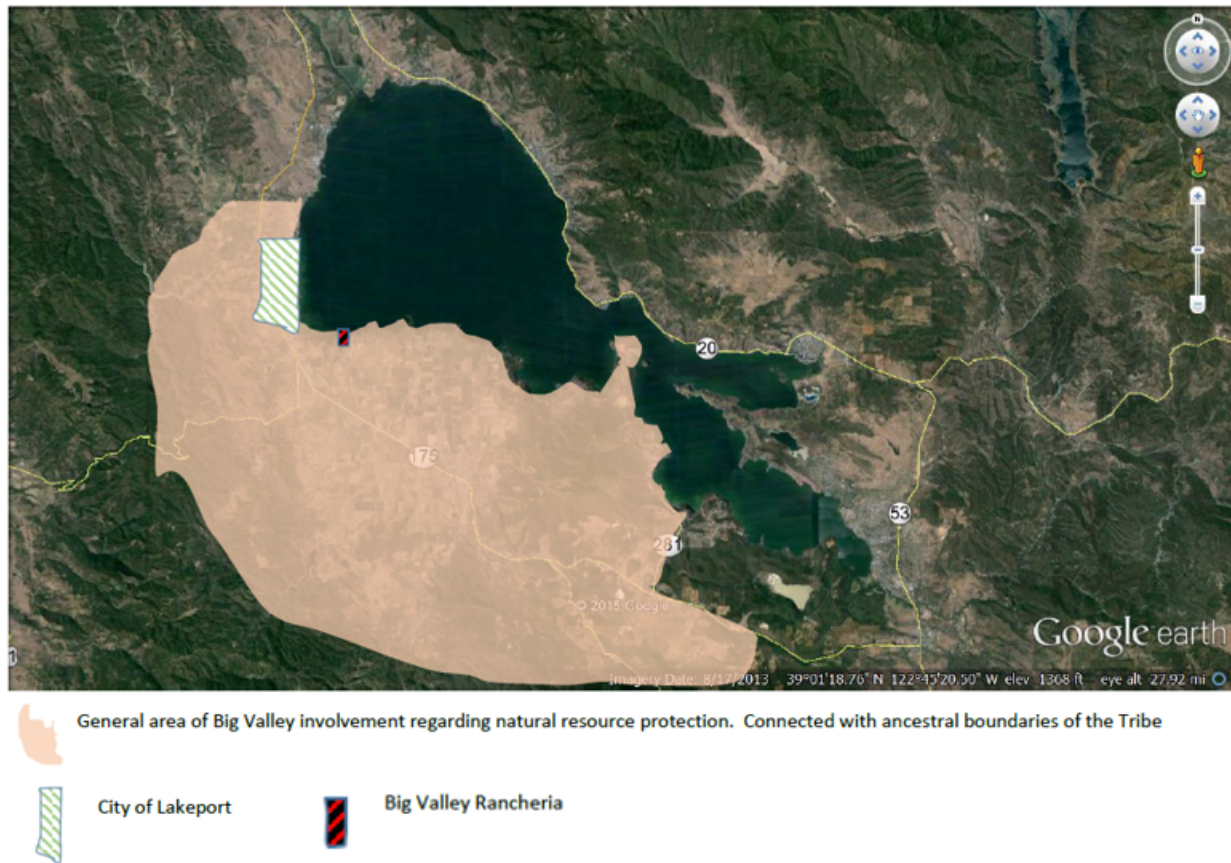
Konocti. However, the U.S. Senate refused to ratify this treaty and 17 others on July 8, 1852. The U.S. Senate placed the treaties under an injunction of secrecy which was not removed for over 50 years (Flushman and Barbier, 1986). Instead, Congress passed the Land Claims Act of 1851 requiring claims 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 U.S. Government took Indian homelands, they gave loans to settlers to buy Indian land (Montez, 2022).

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. They recently created housing for more than 70 Tribal members through the purchase of a 15-unit apartment property in Lakeport, the construction of five tiny homes for unhoused Tribal members, and through securing eight homes for Elders.

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 6.2.2**, below, 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.



Figure 6.2.2. Big Valley Natural Resource Protection Areas.



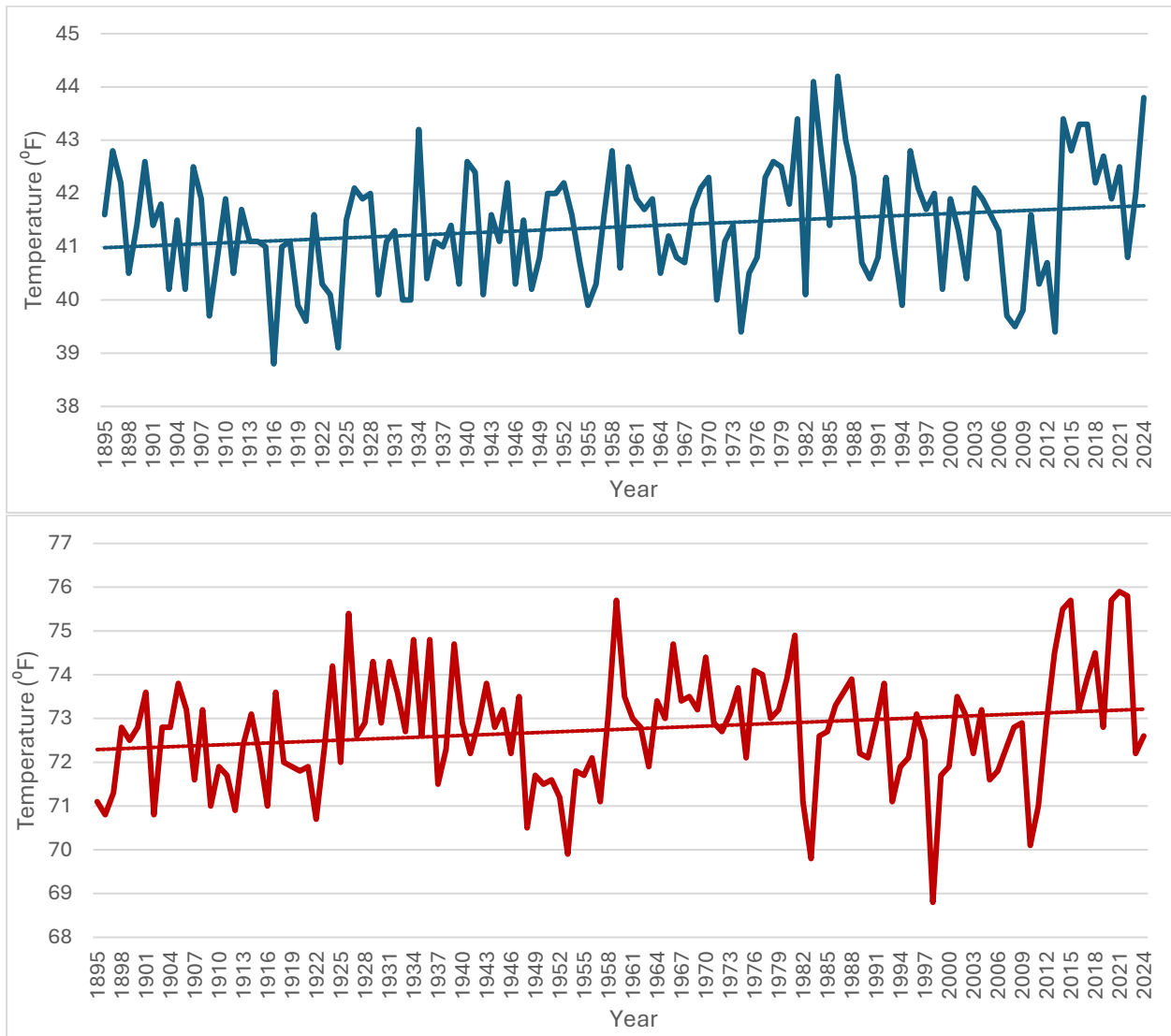
Map showing location of Big Valley Rancheria (red-striped area), the City of Lakeport (green-striped area), and the general area in which the Tribe engages in natural resource protection (tan area). The tan area is also closely tied to the Tribe's ancestral boundaries. Source: BV EPA (2014)

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 6.2.3. Nighttime (Top) and Daytime (Bottom) Temperatures at Big Valley Rancheria, 1895 to 2024.



The annual average minimum or nighttime temperatures (top) and annual average maximum or daytime temperatures (bottom) are shown as solid lines. Linear trends over the entire period are shown as dotted lines. Source: PRISM Climate Group (2025)

Over the past 129 years, annual average minimum temperatures (nighttime) and annual average maximum temperatures (daytime) have increased at the Big Valley Rancheria.

Figure 6.2.3, above, shows that nighttime temperatures are increasing at an average



rate of 0.06 degrees Fahrenheit (°F) or 0.03 degrees Celsius (°C) per decade, and that daytime temperatures are increasing at an average rate of 0.07°F (0.04°C) per decade.

In July 2024, Big Valley Rancheria experienced 15 days of temperatures above 100°F (37.8°C). During this heat wave, the Tribe experienced the hottest week, two-week, and month-long period on record (Abatzoglou et al., 2025).

Warming daytime and nighttime 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 (US EPA, 2021).

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).

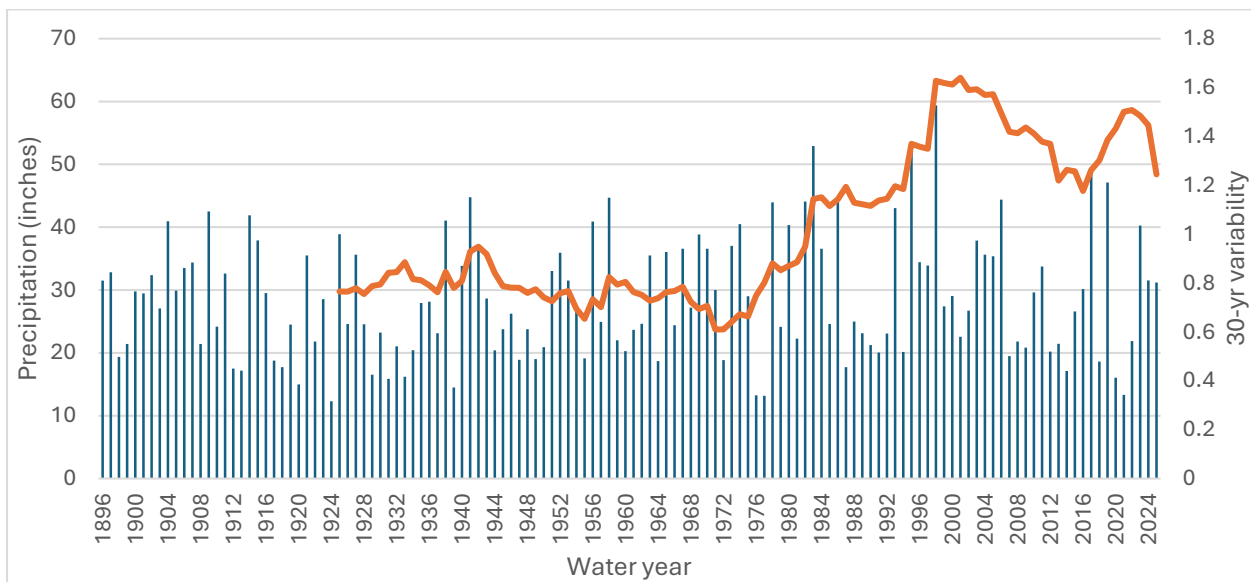
Precipitation

As shown in [Figure 6.2.4](#), below, there is considerable year-to-year variability in the annual precipitation at the Big Valley Rancheria, particularly over the last 30 years. Average annual precipitation dropped to its lowest around 2013 and 2014 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 result in a sharp increase in 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 promote the development of HABs.

Figure 6.2.4. Water Year Precipitation and Variability at Big Valley Rancheria from 1896 to 2025.



Blue bars represent precipitation totals for each water year (October 1st of the previous year through September 30th of the year). The orange line shows variability: a ratio of 30-year variance divided by the total record variance. Values higher than 1 represent more fluctuation in rainfall totals, while values less than 1 represent more consistency. Source: PRISM Climate Group (2025)

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. Several members have

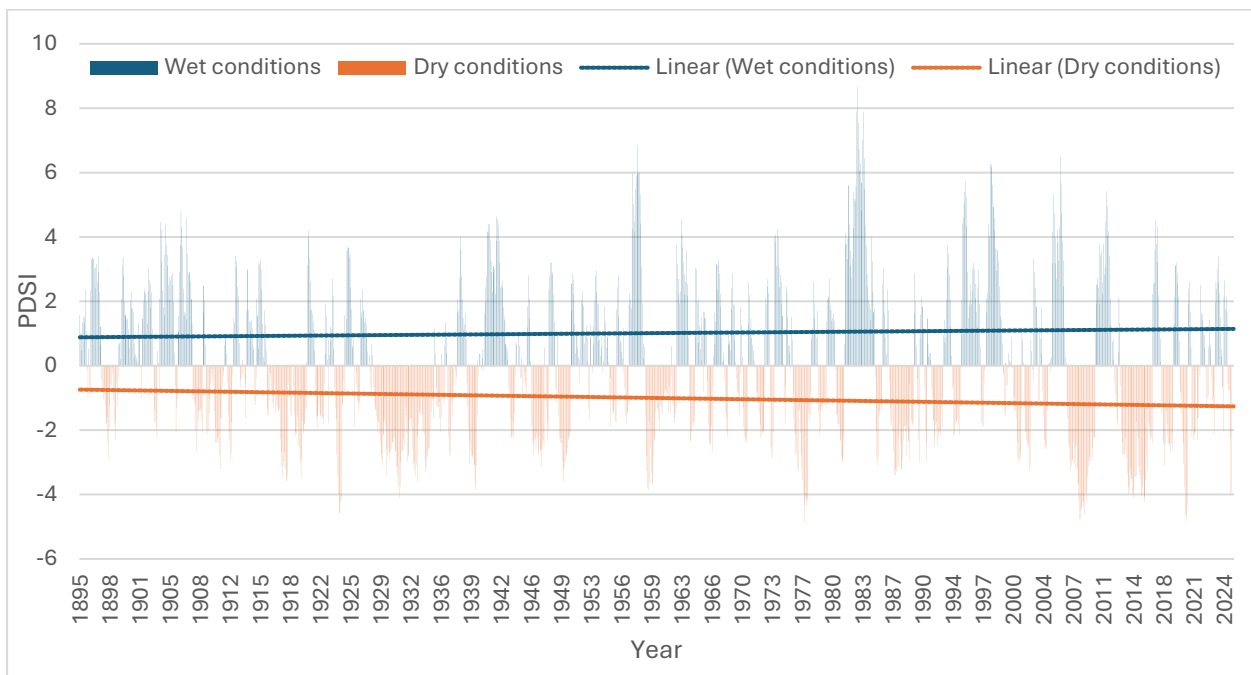


had to build their own weirs to access their homes during high rainfall. The Tribe has identified increased mold growth in Tribal members' homes after heavy rain events as an impact of climate change (BVBPI and MRPI, 2021). The marina at the Rancheria has been replanted with vegetation previously lost 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 rainfall in recent past and the Tribe is working to protect its facilities from future impacts (BV ISWMP, 2023).

Drought

Figure 6.2.5. Monthly PDSI for Big Valley Rancheria, 1895 to 2025.



Source: Abatzoglou et al. (2025)

Figure 6.2.5 shows the monthly Palmer Drought Severity Index (PDSI) for Big Valley Rancheria from 1895 to 2025. PDSI is a commonly used measure of drought that



integrates temperature, precipitation and soil moisture data to provide a measure of relative dryness (drought) on a scale from -10 (dry) to 10 (wet). A PDSI of negative four (-4) or less indicates extreme drought, while a PDSI of four (4) or more represents very wet conditions. Drought conditions at Big Valley have gotten more severe over this time period.

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 and oak trees, making them more susceptible to pests such as the pine bark beetle and Mediterranean oak borer, respectively. Dead trees and other vegetation increase fuel for wildfires.

Water scarcity also 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 [Impacts on Creeks](#) section). Investigations by California Water Boards and Big Valley have found that 90% of groundwater in the Big Valley basin is used for agriculture (SWRCB, 2023). The PDSI metric does not account for the role that increased groundwater pumping from subsurface creek flow plays during droughts and extreme heat events, causing much more severe impacts than might be expected based on PDSI alone. Many streams and creeks surrounding Clear Lake have dried up during periods of drought (BVBPI and MRPI, 2025).

During periods of drought, decreased stream flows into Clear Lake reduce dilution, resulting in higher concentrations of pollutants, and increases in microbes and pathogens in the lake, which in turn affects public health. Additionally, drinking water sources are impaired and with 17 water purveyors pulling water from the lake, the increased cost is passed to the consumer. Partnering with Tracking California, which compiles and analyzes data about public health and the environment, Big Valley tested self-supplied drinking water systems on Clear Lake for cyanotoxins, nitrates, coliform bacteria and herbicides, all contaminants of concern for self-supplied drinking water systems (BV EPA, 2017b). During the most recent testing between June and October



2021, 20 of the 36 homes tested had detectable cyanotoxins and 13 were above the US Environmental Protection Agency (US EPA) health advisory level of 0.3 micrograms per liter ($\mu\text{g/L}$). The highest resulting concentration was 3.85 $\mu\text{g/L}$. In November 2021, 41 homes were tested and cyanotoxins were found in 22 samples; of those 10 were above the US EPA health advisory level (Cal-WATCH, 2022). Since 2021, the Tribe has been implementing a program to measure groundwater elevation in local wells. Increased withdrawals during drought have been correlated with reduced tributary flows into Clear Lake and poorer lacustrine water quality. The Tribe seeks better understanding of the variations in groundwater storage to ensure long-term sustainability of surface and subsurface water.

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).

Impacts on creeks

As drought and extreme heat increase demand from other water users, such as agriculture, the Tribe has observed decreasing creek water levels earlier in the year and a corresponding reduction in suitable fish spawning and rearing habitat. The Chi or Clear Lake Hitch is a species of high cultural and dietary importance that is being particularly impacted. Hitch are also discussed in the [Culturally Important Species](#) section, below. Hitch depend on adequate freshwater flows and habitat in creeks through the summer to connect tributary spawning grounds and the Lake, and to maintain proper depth, water temperature, dissolved oxygen (DO) levels, and other conditions necessary to the survival of their young. When flows drop, Hitch can be stranded in shallow pools where they face certain death without intervention.

Many of the freshwater bodies most critical to the survival of the Hitch face multiple stressors that contribute to habitat decline, although temperatures and drought are most notable. In 2025, of the 23 creek sites that are monitored by the Tribe, 19 had dissolved oxygen below the attainment threshold, 20 had pH outside of the acceptable range, and



22 exceeded temperature standards (BV EPA, 2025). Clear Lake, McGaugh Slough, Rodman Slough, Manning Creek, Kelsey Creek, and Forbes Creek were also designated as impaired waterways in 2024 for not meeting other cold freshwater habitat requirements (US EPA, 2025a). Several of these waterbodies were first listed as impaired in 2022. Clear Lake was first listed in 2018.

In 2022, Big Valley and other entities began monitoring Hitch-bearing creek levels, noting where and when creeks become disconnected and rescuing stranded Hitch and other native fish species when possible (**Figure 6.2.6**, below).

Figure 6.2.6. Rescuing Hitch.



The pool in this photo was once part of the flowing creek. As creeks dry, they leave behind pools where Hitch become stranded and die unless they are rescued. Source: BV EPA (2025)



Due to drought conditions in 2022, low flows, disconnected pools and even dry creek beds were observed as early as January. Following precipitation events in 2023, low flows, creek disconnection and drying began a few months later than in 2022, and 26,090 stranded Hitch, mostly fry, were rescued. In 2024, drying conditions began slightly later than in 2023, and 24,541 Hitch, all fry, were rescued. However, in 2025 Big Valley again observed low flows as early as January, with disconnected pools and dry beds occurring in March and May, respectively. They rescued 28,125 stranded Hitch, predominantly juveniles, from unsuitable creek habitat in the Big Valley area alone in 2025 (BV EPA, 2025). Collectively, these data illustrate that drying is occurring during critical Hitch spawning and rearing windows and, without intervention, will strand and kill large numbers of Hitch.

In 2023, Governor Newsom issued an executive order (N-5-23) which highlighted the ongoing impacts of severe drought on the Clear Lake and Klamath River watersheds (State of California, 2023). He directed the State Water Board and California Department of Fish and Wildlife (CDFW) to study the minimum flow requirement in all Hitch-bearing streams and consider necessary regulations (SWRCB, 2025). This resulted in an emergency information order of all water users in the watershed.

The Water Boards shared preliminary results of this investigation with the Tribe in 2023. They estimate that there may be two to three times more unpermitted agricultural wells (850–1800 wells) than permitted agricultural wells (600 wells) in the Big Valley water basin, and their pumping rates are mostly unknown (SWRCB, 2023). Of the 225 water rights holders along Hitch-bearing creeks, 50% did not report diversion and use statements in 2022. The 50% of diversion and use statements that were reported were of poor quality. Of the 100 water rights holders that were subject to measurement requirements, 90% were out of compliance. Additionally, 200 reservoirs that did not have water rights were found near creeks. Getting a better understanding of water use in Big Valley basin is essential for the Tribe and state agencies to better address the problem of insufficient flows for fish.

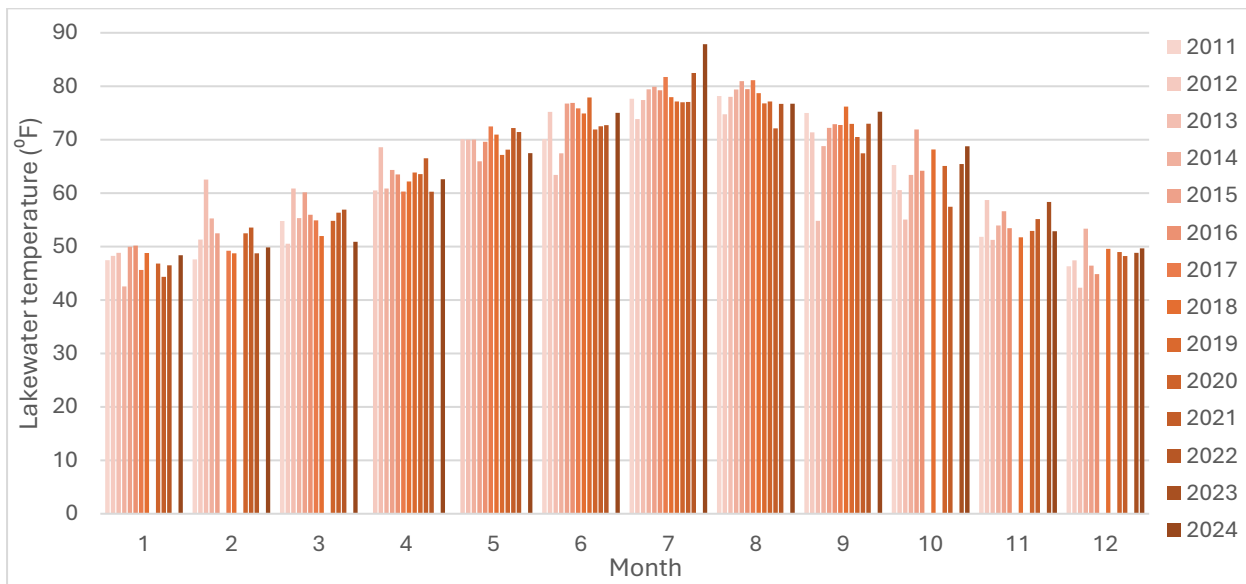


Lake water conditions

Lake water temperature

Figure 6.2.7, below, presents lake surface water temperature measured monthly between 2011 and 2024 at sampling site BVCL6, an area of Clear Lake of particular importance to the Tribe. This site has seen monthly average water temperatures that are highly variable across years, marked by exceptionally warm temperatures in certain years. Notably warm temperatures were observed from February to April in 2013, in December 2014, in October 2015, and through the second half of 2024. The highest temperatures on record were observed during the July 2024 heatwave.

Figure 6.2.7. Monthly Clear Lake Surface Water Temperature from 2011 to 2024.



Source: National Water Quality Monitoring Council (2025)

Even seemingly small increases in water temperature can significantly affect key physical and biological processes in lakes. Lake impacts have also affected 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.

Big Valley's understanding, based on their communication with the Central Valley Regional Water Board, is that the maximum temperature for surface water in the Clear Lake watershed should be 69.8°F (21°C). **Figure 6.2.7** above shows that Clear Lake surface water temperatures were regularly above 69.8°F from May to September of 2011 to 2024.

Figure 6.2.8. Map Showing Key Big Valley Freshwater Concerns.



Source: BV EPA (2014)

Changing lake temperatures affects the habitat and distribution of fish. **Figure 6.2.8**, below, 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., 2019a). In 2014 Hitch were only observed spawning in these two streams.

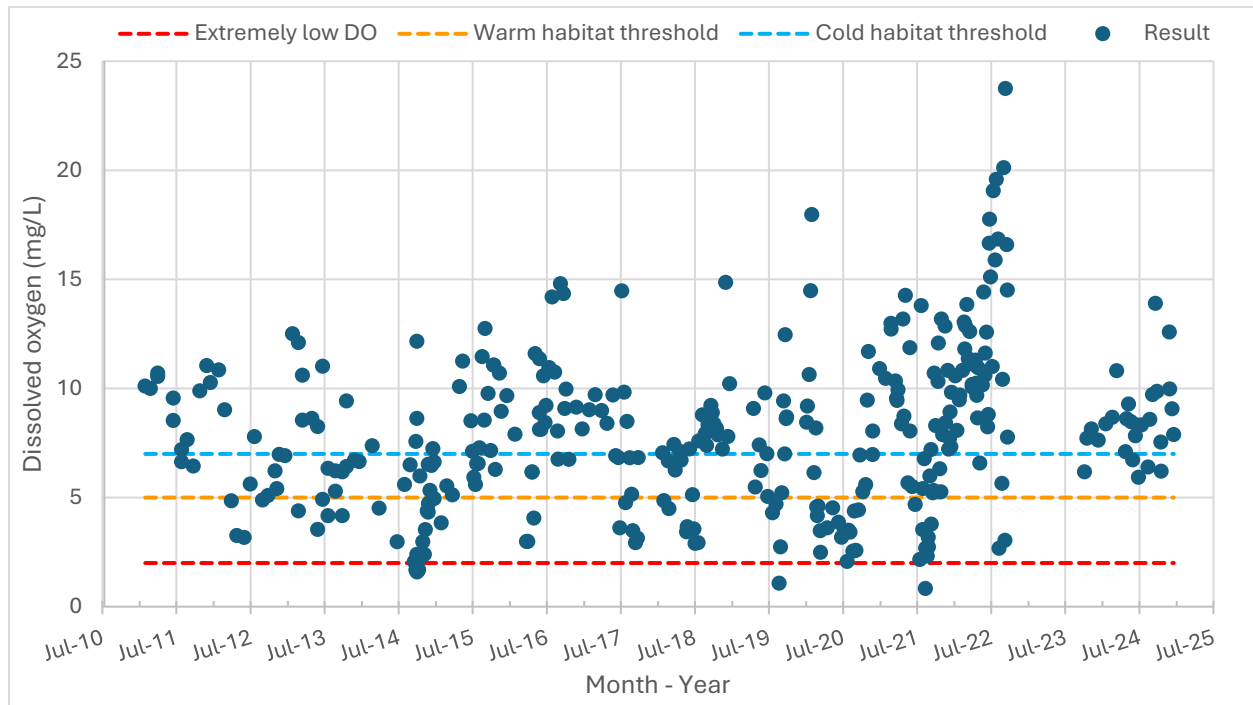
Dissolved oxygen in Clear Lake

Dissolved oxygen (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 material into Clear Lake leading to a reduction in DO. Low levels of precipitation reduce surface flow into Clear Lake and can both increase water temperature and reduce DO.

Big Valley Rancheria uses Central Valley Regional Water Quality Control Board objectives for DO that outline 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 milligrams per liter (mg/L) for warm habitat and 7.0 mg/L for both cold habitat and warm spawning habitat. **Figure 6.2.9**, below, shows DO levels at site BVCL6 over the past 14 years. During that time DO dropped to extremely low levels (below 2.0 mg/L) six (6) times, below 5.0 mg/L 73 times, and below 7.0 mg/L 140 times.



Figure 6.2.9. Dissolved Oxygen Concentrations at a Clear Lake Monitoring Site from 2010 to 2025.



Source: National Water Quality Monitoring Council (2025)

Data collected by multiple agencies over the last several years on Clear Lake show extended periods of time where DO was suppressed throughout the lake, leading to fish kills that have been investigated by CDFW 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 hypoxic conditions since 2000 (UCD, 2010).

Low DO in Clear Lake can both be caused by and contribute to blooms, or rapid growth, of cyanobacteria. Big Valley Environmental Protection Department (BV EPA) monitoring data showed a lake-wide cyanobacteria (*Synechocystis* spp.) bloom in September 2025 that coincided with a drop in DO observed by CDFW biologists, and a fish kill numbering in the millions observed by Clear Lake tribes and communities (BV EPA, 2025). These data provide strong evidence that cyanobacteria die-offs are driving low DO. In turn, oxygen-depleted conditions have been shown to trigger the release of



phosphorous from sediments at the bottom of Clear Lake. This phosphorous becomes bio-available and fuels the rapid growth of cyanobacteria.

To help mitigate the cycle of cyanobacterial blooms, low DO, and fish kills in Clear Lake, multiple projects are being developed to interrupt the life cycle of cyanobacteria in different ways. These initiatives are funded by the Blue Ribbon Committee for the Rehabilitation of Clear Lake (BRC, 2026). One such project is the Hypolimnetic Oxygenation Pilot Project that the UC Davis Tahoe Environmental Research Center recently began in the Oaks Arm. Simultaneously, a web-based clearinghouse is being launched to host and share data and documents having to do with Clear Lake (BVR, 2026).

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 their 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).

Asian clams

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.

Clear Lake Hitch

Figure 6.2.10. Clear Lake Hitch.



Source: Photos by Richard Macedo, CA Department of Fish and Game

One native species of concern is the Clear Lake Hitch (*Lavinia exilicauda chi*). Hitch are large minnows, 14–16 inches long found only in Clear Lake and its tributaries. Hitch typically live six to seven years. Unlike salmon that die after spawning, Hitch normally return to Clear Lake at the end of their spawning season. They 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, 2013; Feyrer, 2022).

Clear Lake Hitch were formally listed as a threatened species under California's state Endangered Species Act (ESA) in 2014 due to significant decline in numbers of Hitch, and the fish's disappearance from most former spawning streams. In January 2025, the U.S. Fish and Wildlife Service (USFWS) proposed to list Hitch as threatened under the Federal ESA as well (USFS, 2025). However, USFWS missed the January 2026 deadline for issuing a decision. In response, the Center of Biological Diversity sued USFWS in April 2026, arguing that by failing to issue Federal protection, the agency is



increasing the chances that Hitch will go extinct (Center for Biological Diversity, 2026).

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 six weeks and now the spawning season seems to be about three weeks.

“The chi are vital to our people, our heritage and our future. We cannot afford to lose them. That is why we strongly support federal endangered species protections and every available tool to safeguard their survival. We must act now to ensure that future generations can continue to have a relationship with this important species.”

~ Tribal Chairman Flaman McCloud Jr., of the Big Valley Band of Pomo Indians

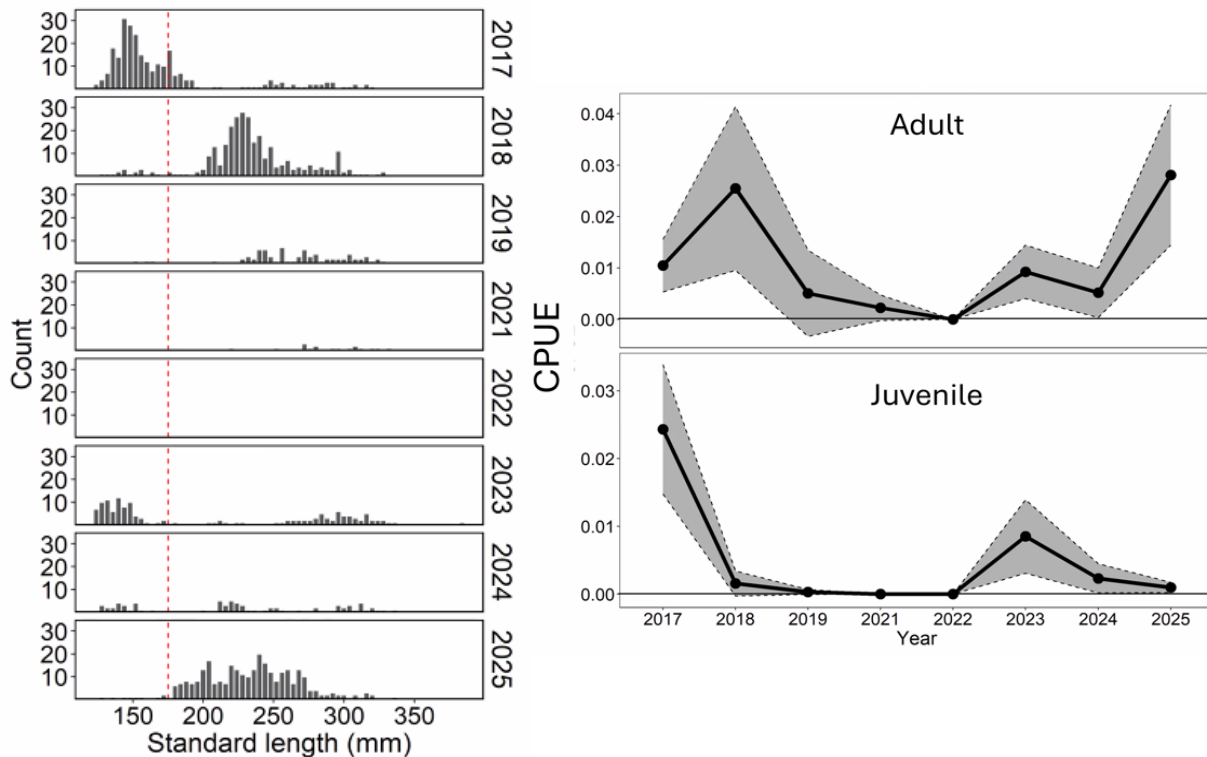
The Clear Lake Hitch are a culturally and biologically important fish. Another Elder explained that the Hitch were dried and kept for use throughout the winter and was a valuable trade item with Coastal Pomo tribes for resources such as seaweed, clam shells and abalone. Hitch were also a major food source for ceremonies (BVR, 2013). The 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.

Lake and stream surveys of Hitch

Monitoring of the Hitch in Clear Lake (**Figure 6.2.11**, below) shows a troubling pattern. There are fewer juvenile Hitch; and the overall numbers are drastically lower than the historic levels on which Big Valley relied for hundreds if not thousands of years.



Figure 6.2.11. Results of Clear Lake Hitch Gill Net Monitoring.

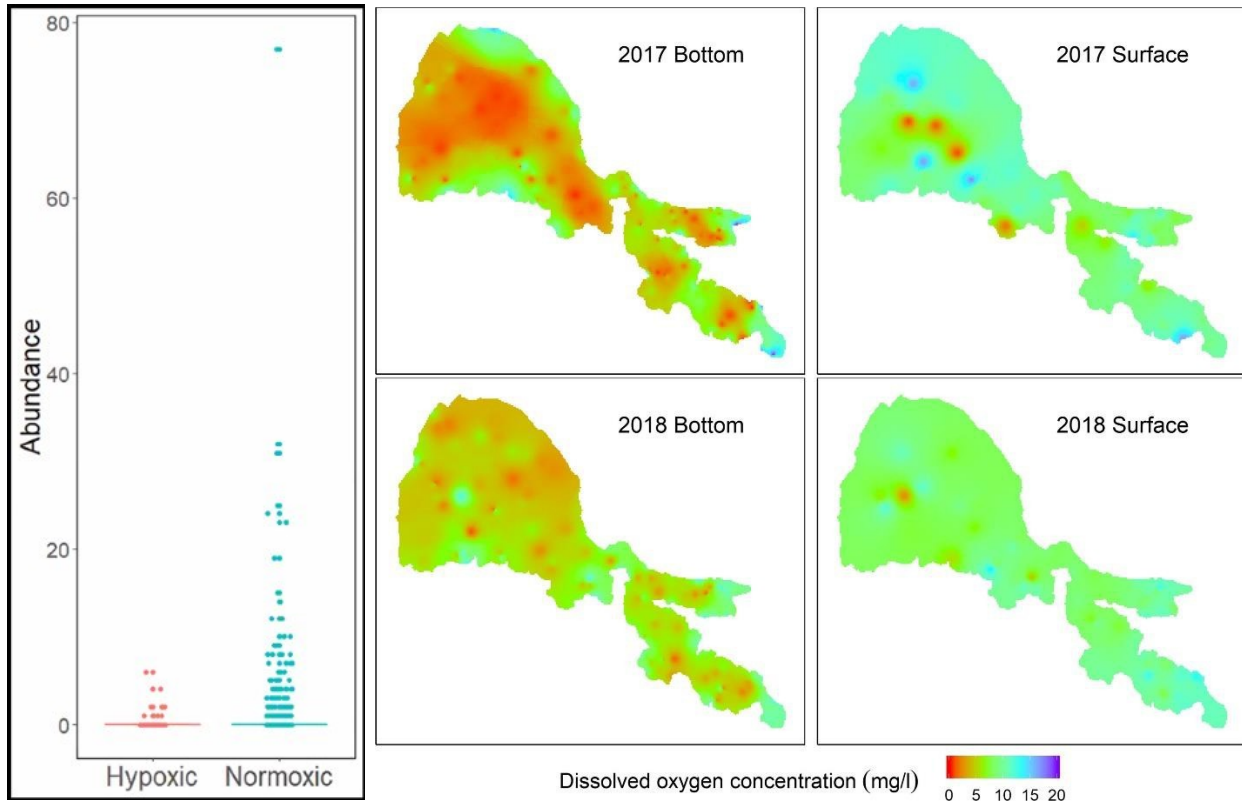


The graphs on the left show number of fish (y-axis) of different sizes (x-axis) caught each year. The graphs on the right show catch per unit effort (CPUE) or abundance of adults and juveniles. Source: Feyrer et al. (2025)

Along with showing changes in population structure, surveys also show that Hitch avoid areas with low levels of DO. Surveys done by the USGS from 2017 to 2025 identified abundance-habitat relationships for juvenile and adult Hitch. They observed that DO concentration was the most important habitat predictor for hitch abundance (Feyrer et al., 2019b; Feyrer et al., 2025). The graphics on the right side of [Figure 6.2.12](#), below, show DO concentrations in different areas of Clear Lake in 2017 and 2018. The abundance graph on the left shows the relationship between the number of Hitch detected and dissolved oxygen conditions in Clear Lake. Hypoxic areas are those with a DO concentration of less than 2 milligrams per liter ($\text{DO} < 2 \text{ mg/L}$); normoxic areas have a DO concentration of 2 or more milligrams per liter ($\text{DO} \geq 2 \text{ mg/L}$).



Figure 6.2.12. Association Between Hitch Abundance and DO Concentrations in Clear Lake.



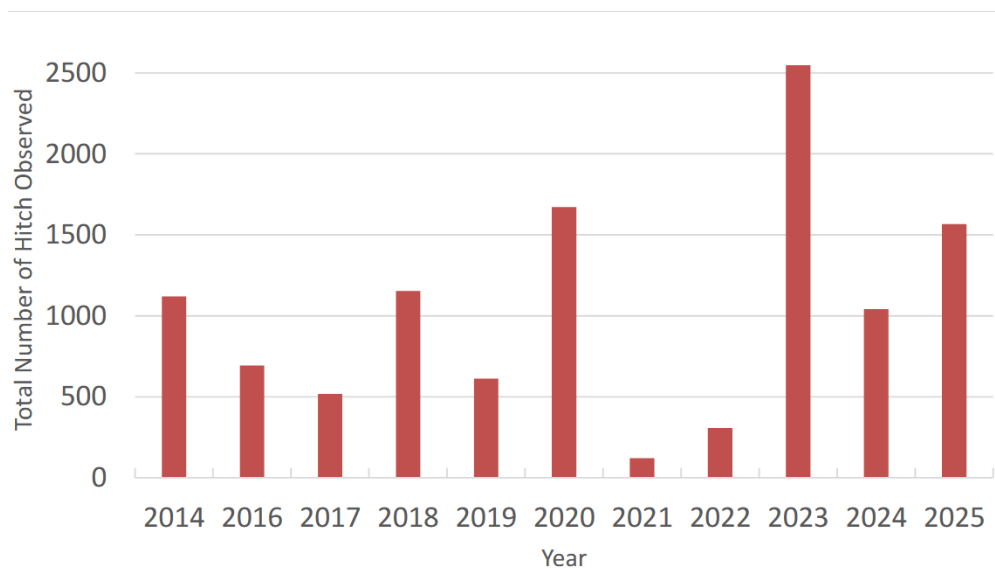
Source: Feyrer et al. (2019b)

Clear Lake Hitch also face challenges in their spawning tributaries. They 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 because of drought, agricultural irrigation, and the use of pumped water for frost protection. Low water levels impact 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 6.2.13. Results of CDFW Visual Creek Surveys, 2014 to 2025.



Red bars are the total number of Hitch observed across seven tributary creeks. Source: Ewing (2025)

Visual surveys ([Figure 6.2.13](#), above) of Hitch in tributary creeks from 2014–2025 reflect the severity of the impact of the 2020–2022 drought on their population, with a record low of 120 Hitch observed in just one creek, Kelsey, in 2021 (Ewing, 2021). After record winter rainfall in 2023, 2,548 Hitch were observed across five tributaries, demonstrating their ability to take advantage of adequate creek flow (Ewing, 2023). Based on the 2023 spawning season, surveyors expected a higher return of adults in 2025, however they counted only 1,567 Hitch (Ewing, 2025). Flow and habitat conditions, along with other factors, may have contributed to lower returns. In 2025, Big Valley Environmental Protection Department staff began observing low flows and disconnected pools in two of the spawning tributaries, Thompson and Manning Creeks,



several months earlier than in 2023. The hydrologic research underway in the subbasin will help elucidate influential factors.

There are many ongoing efforts to study and protect the Clear Lake Hitch. Big Valley and nearby Robinson Rancheria and Habematolel Pomo of Upper Lake have been working together for the protection of the Hitch since 2005. In 2022, CDFW formed the Clear Lake Hitch Task Force, which includes Big Valley Band of Pomo Indians, Robinson Rancheria, Habematolel Pomo of Upper Lake, Scotts Valley Band of Pomo Indians, Middletown Rancheria, state agencies, county agencies, and USGS. The Task Force is funded by CDFW and other sources. Since 2023, Big Valley has received grants from both CDFW and the Resources Legacy Fund to conduct fish observations and rescues and install groundwater monitoring wells on the Tribe's land to better understand the factors impacting their habitat and survival, including groundwater pumping.

Clear Lake area tribes are hopeful that their collaborations with non-Tribal agencies will bring about more effective regulations to support the Hitch. Enforcement of penalties for violations of Fish and Game codes, illegal water diversions, and illegal cannabis cultivation has improved. They are optimistic about the Clear Lake Watershed Co-Management Memorandum of Understanding, which is being developed to provide a framework for increased collaboration and goal setting to restore habitat and Hitch populations.

Fish for consumption

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

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, and 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, 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.

"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

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.

Other culturally important plant species

The use of plants such as Tule, sedge, dogbane, and willow benefits not only 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; grooming also 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 insect pests

Drought, wildfire, and other stressors on trees create more favorable conditions for secondary insect pests. Pine bark beetles are secondary pests that continue to contribute to largescale mortality of already-stressed pine stands in Lake and other California counties. While most of the mortality has occurred in ponderosa pines infected by Western pine beetle, *Ips* spp. pine bark beetles have also killed large areas of Pinyon pine trees which are a food source for the Tribe.

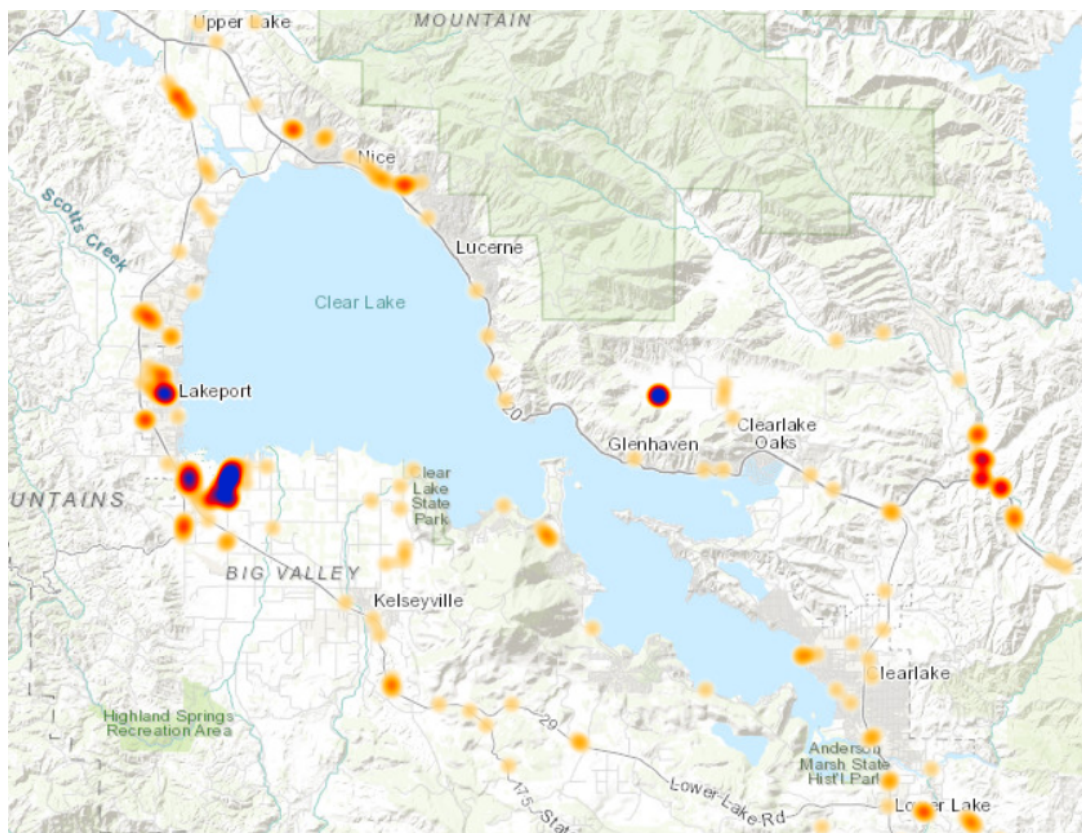
Big Valley has also seen a recent and dramatic increase in the presence of the Mediterranean oak borer (MOB), an insect which infests and kills oak trees. MOB is a small ambrosia beetle originally from Europe that creates tunnels in oak wood to cultivate the fungi that it feeds on, and that can harm or eventually kill the host tree.



MOB tends to infect trees which are already weakened from other stressors such as drought, fire, or other diseases and pests. It affects 12 species of oak in California, mostly valley and blue oak. It was first detected in Big Valley in 2024, although it is suspected to have been in Northern California since 2012 or earlier.

Clear Lake Environmental Research (CLERC) has been tracking reports of MOB around Clear Lake since June 2023. **Figure 6.2.14**, below, shows a map of Clear Lake with the number of reports of MOB on oak trees from June 2023 to November 2025 represented as spots of color that range from pale orange (as few as one report in that area) to dark purple (as many as 113 reports in that area).

Figure 6.2.14. Number of MOB Reports Around Clear Lake.



Source: CLERC (2025)

Valley oaks are the main oak species in the Big Valley area, and the Tribe is concerned about the potential impact of MOB. In the past year, the Tribe has mapped at least 15



infected trees on the Rancheria and additional infections nearby (**Figure 6.2.15**, below). Valley oaks are not only central to the Big Valley Band of Pomo Indians' culture as the primary source of acorns, but also to the ecosystem, providing food and habitat for other species.

Figure 6.2.15. MOB-infected Oaks On and Near Big Valley Rancheria.



Source: BV EPA (2025)

Government policies that have prevented traditional cultural burning have also led to an increase in large-scale wildfires and 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.



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, 2026). 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. A recent study of conditions from 1950 to 2019 suggests that more rapid warming of the Lake in the spring, driven by higher seasonal air temperatures, may be contributing to cyanobacteria dominance (Smith et al., 2023).

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. **Figure 6.2.16**, below, illustrates the potential routes of exposure to HABs based on tribal uses and practices involving Clear Lake.

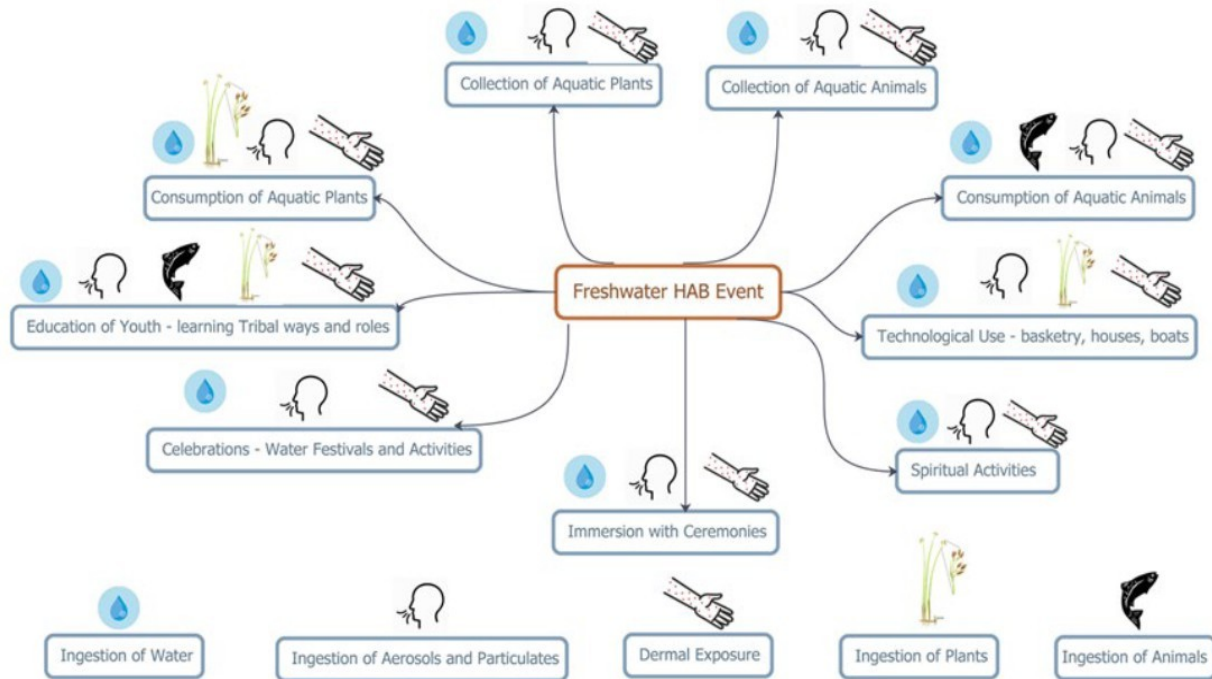
The California Cyanobacteria Harmful Algal Bloom (CCHAB) Network has adopted tiered cyanotoxin trigger levels for posting recreational waters (CWQMC, 2025). For microcystin these advisory levels are 0.8 µg/L (Caution - keep away from visible algae), 6 µg/L (Warning – no swimming) and 20 µg/L (Danger – 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.



Figure 6.2.16. Potential HAB Exposure Routes Through Cultural Use.

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

Native peoples were given their land by Creator and honor Creator and their Ancestors by maintaining traditions and cultural landscapes. This is the connection between the land and the people. Uses can be repetitive, gender assigned and long term. Exposures can occur second hand through the use and trade of plants and animals that have been in contact with HABs.



Developed by Big Valley Band of Pomo Indians and Karuk Tribe with assistance from Mayo Mamulo and Dr. Jeanine Pfeiffer 2019.

Source: Big Valley Band of Pomo Indians (2019)

HABs on Clear Lake produce very high levels of microcystin and the Lake is often posted with recreational advisories from April through October. The Big Valley Band of Pomo Indians and the Elem Indian Colony have been actively involved in sampling and monitoring their waters. **Table 6.2.1**, below, shows monitoring results for 2014–2025.



Table 6.2.1. Concentrations of Microcystin in Clear Lake Water Samples from 2014 to 2025.

Arm of Clear Lake	Highest Level of Microcystins (µg/L)											
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Upper Arm	878***	Trace	0.3	4*	13**	0.3	1,146***	5,910***	70.3***	13.8**	28.1***	N/A
Oaks Arm	16,920***	278***	0.7	46***	4,800***	0.9*	79***	1,449***	790***	562***	2,261***	1,377***
Lower Arm	769***	10,162***	0.3	5,554***	230***	150***	902***	160,378***	489.3***	16,821***	16,025***	13**

*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.

****Caution issued for Upper Arm in 2025 due to visual signs of HAB following CCHAB decision tree. BV EPA identified potentially toxic cyanobacteria through microscopy but did not send water sample to lab for microcystin analysis.

Source: BV EPA (2026b)



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 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).

Cyanobacteria blooms can also cause harm to habitats such as Clear Lake through means other than cyanotoxin production. For example, the fish kill of 2025 (see the [Dissolved oxygen in Clear Lake](#) section) was attributed to a bloom and die-off of *Synechocystis* spp., cyanobacteria which were dominant from August through September. This bloom did not end up producing high levels of microcystin. Rather, it took up the ecological niche otherwise held by *Microcystis* spp., potentially preventing other HABs from growing. In this case it was the reduction of lake DO associated with the decomposition of cyanobacteria which killed millions of fish in Clear Lake.

Climate change may increase the frequency of HABs in drinking water sources. Big Valley Band of Pomo Indians has partnered with Tracking California to carry out the California Water: Assessment of Toxins for Community Health Project, or Cal-WATCH since 2019. The project found microcystins in the tap water of 71% of homes tested with lake water intakes, and microcystins at or above the US EPA drinking water health advisory concentration of 0.3 µg/L in 53% of homes with lake water intakes (Solomon et al., 2022; Tracking California, 2026). These results led the local health officer to issue an emergency “Do Not Drink” advisory for private lake water drinking systems in early fall 2021. Information and recommendations were shared with residents utilizing lake water to help reduce their exposure risk, and alternative drinking water sources were provided for those impacted.

HABs create sludge that clogs drinking water intakes in Clear Lake ([Figure 6.2.17](#), below). 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 6.2.17. Shoreline Sludge from HABs on Clear Lake.



Source: Justin Sullivan, Getty Images

The occurrence of HABs causes great economic losses in the Clear Lake region. Clear Lake is a destination for large-mouth bass fishing and other water activities, such as water skiing, jet skiing, and swimming. An early 1990's study estimated that HABs resulted in \$7–10 million in lost tourist revenue annually in Lake County (Goldstein and Tolsdorf, 1994). Economic losses 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, 2026a).

Cyanotoxins in fish

Cyanotoxins, such as microcystin, can end up in aquatic species that are traditional foods for Tribal members (and others) and pose threats to human health. The Action Level for fish consumption recommended by CalEPA's Office of Environmental Health Hazard Assessment (OEHHA) based on total microcystin concentrations in fish and shellfish is 10 nanograms per gram (ng/g) and is calculated for a 70 kilogram person assuming a sport fish and shellfish consumption rate of one 8-ounce meal per week (Butler et al., 2012). However, many Tribal members eat fish and shellfish at a higher weekly consumption rate. Based on a subsistence consumption rate of five fish meals per week and a similar risk level, the recommended maximum total microcystin concentration in fish for tribal members is 2 ng/g (BV EPA, 2026b).

Fish and shellfish from ten species were collected from 2010 to 2018 and analyzed for microcystin using funds from a CalEPA Environmental Justice grant. Analysis of 91 fish tissue and 32 fish liver samples found detectable amounts of microcystin in all but one sample. Of these, all but one result were above the recommended threshold of 2 ng/g for tribal or subsistence consumption. Summaries of the average microcystin toxin levels per fish species in this study are shown in the second and third columns of [Table 6.2.2](#), below (BV EPA, 2025).

Big Valley conducted a second round of microcystin analysis on 79 specimens comprised of nine fish species and one shellfish caught between 2017 and 2023. Only fish or shellfish tissue was tested; livers were not. They included some species that were not previously tested, such as goldfish and Sacramento sucker, and did not re-test largemouth bass, Tule perch, or mussel. Microcystin concentrations were considerably lower in the second round of analysis than the first, with only four results that were above the recommended level for tribal subsistence consumption. The highest detection was in a Sacramento blackfish caught in the Upper Arm, with a tissue microcystin concentration of 7.19 ng/g. Summaries of the average microcystin toxin levels per fish species in the second study are shown in the fourth column of [Table 6.2.2](#), below (BV EPA, 2025).



Table 6.2.2. Concentrations of Microcystins (MC) in Clear Lake Fish.

Species	Tissue (2010-2018) MC ng/g average (count)	Liver (2010-2018) MC ng/g average (count)	Tissue (2017-2023) MC ng/g average (count)
Black crappie	4 (8)	*19 (5)	0.54 (6)
Blue gill	ND (2)	7 (2)	1.01 (2)
Carp	*14 (2)	*34 (2)	0.55 (8)
Catfish	2 (6)	*10 (6)	1.44 (8)
Goldfish	--	--	1.84 (14)
Hitch	*10 (8)	*16 (7)	3.7 (30)
Largemouth bass	2 (7)	6 (2)	--
Redear sunfish	--	--	ND (2)
Sacramento blackfish	7 (1)	*83 (1)	4.46 (5)
Sacramento sucker	--	--	3.17 (3)
Tule perch	6 (10)	*35 (8)	
Crayfish	4 (23)	--	6.8 (1)
Mussel	*10 (26)	--	--

Average MC concentrations for each species are given in nanograms per gram (ng/g). The number of fish of each species tested is in parentheses.

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

Source: BV EPA (2025)

Mining impacts

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 (US EPA, 2025b). OEHHHA has established fish advisories for Clear Lake based on high levels of mercury in fish (OEHHHA, 2018).

In 2015, Big Valley's Environmental Protection Department measured total mercury



concentrations in several species of fish in different locations around the lake. Mercury concentrations in certain fish were found to exceed fish tissue goals established by the CA State Water Resources Control Board (SWRCB, 2015). More recent fish tissue results can be found in [Figure 6.2.A-3](#) (page 73).

In September 2024, the US EPA began the main cleanup project, which will be broken 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 (US EPA, 2025b). The program manager for the cleanup verbally reported to the Tribe that it will take roughly 100 years for mercury levels in fish from Clear Lake to return to safe levels for human consumption.

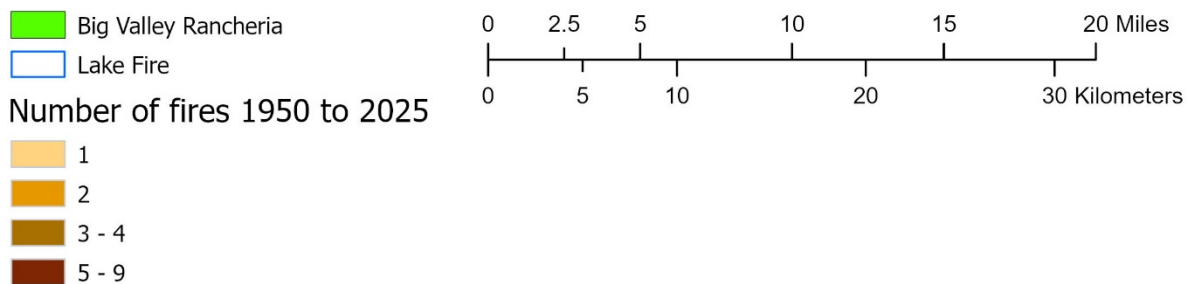
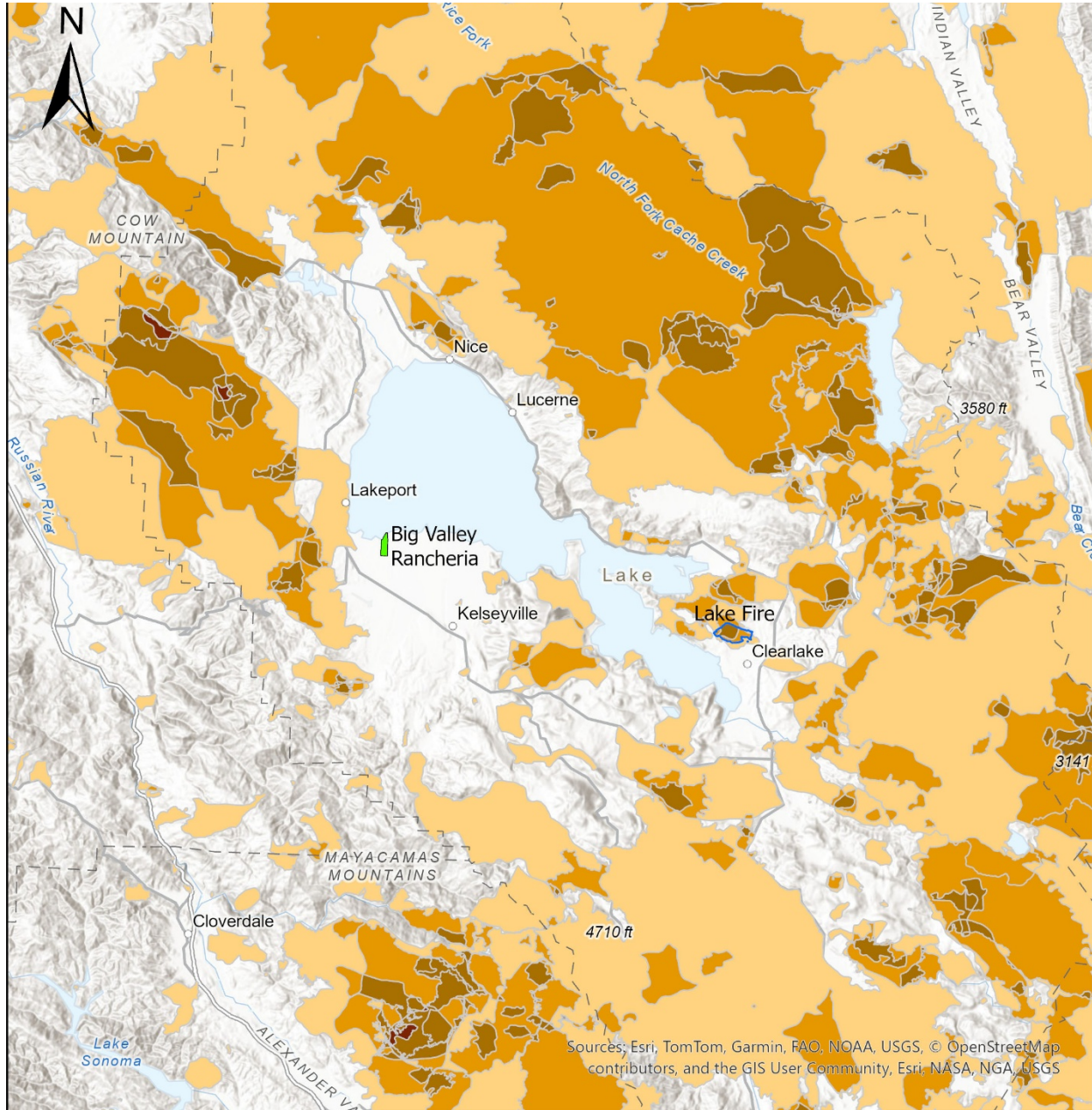
Wildfires

Big Valley Rancheria (BVR) and surrounding ancestral lands are severely impacted by both wildfires and smoke. [Figure 6.2.18](#), below, shows the number of times that parcels of land around Big Valley have burned between 1950 and 2024. A third of Lake County is considered very high wildfire risk area, which is more than four times the state average (CCHViz, 2025). The county has lost more than 1,800 homes to wildfire since 2015. The number of fires occurring each year within a 50-mile radius of BVR has increased over the last half century by a factor of four ([Figure 6.2.A-1](#), page 72). The corresponding burned area has increased exponentially in just the last 10 years ([Figure 6.2.A-2](#), page 72).

In 2025, the Lake fire forced 3,386 people to evacuate and burned 401 acres just north of the town of Clearlake, roughly 13 miles across the lake from BVR (CAL FIRE, 2025). In 2024, the Glenhaven fire, roughly 10 miles across the Lake from BVR, threatened over 2,500 structures and forced over 3,400 people to evacuate (Tracking California, 2025). In 2020 alone, more than half of the unhoused population in Lake County said that a wildfire made them homeless that year.



Figure 6.2.18. Fires Within 30 Miles of BVR from 1950 to 2025.

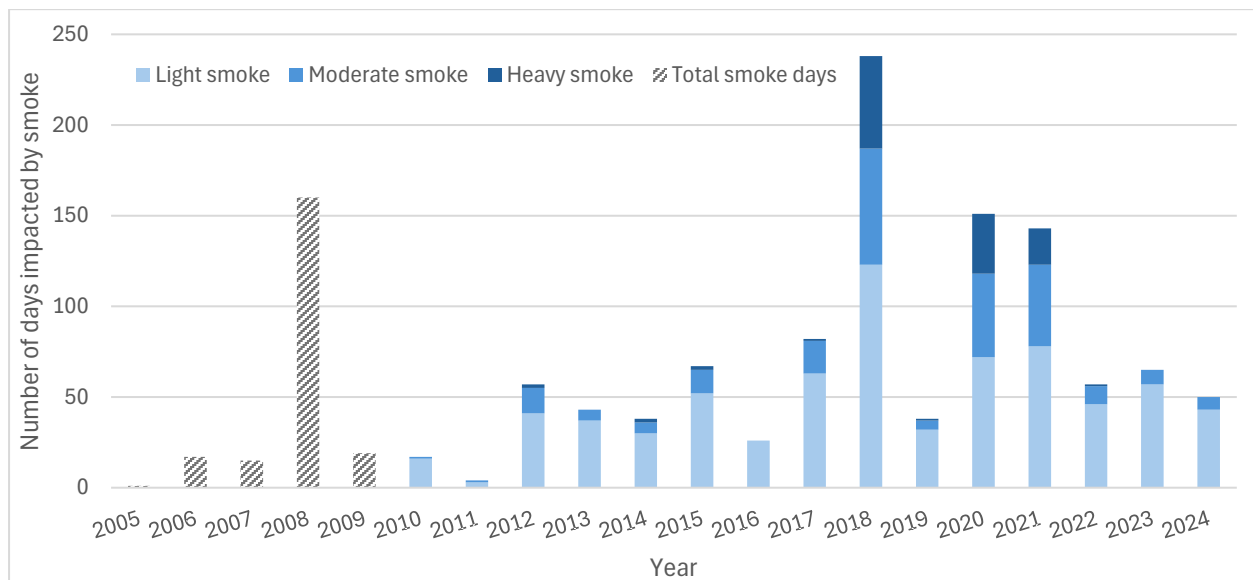


Source: Fire perimeter data from CAL FIRE (2026)



Along with threatening lives and structures, wildfires are increasingly impacting air quality for the Tribe. 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, California's largest wildfire on record at the time. The Big Valley Environmental 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."*

Figure 6.2.19. Smoke-impacted Days Per Year for BVR, 2005 to 2024.



Source: CDPH (2025); NOAA (2025)

Figure 6.2.19, above, shows the number of days each year between 2005 and 2024 when the zip code containing BVR (95453) was impacted by wildfire smoke. Hatched bars from 2005 to 2009 represent any smoke-impacted days. From 2010 to 2024, stacked bars display the number of days impacted by light (pale blue), medium (medium blue), and heavy (dark blue) smoke.

BVR was impacted by smoke for 238 days in 2018, or for just over 65% of the year, making 2018 the most smoke-impacted year in a 20-year record available from the



National Oceanic and Atmospheric Administration (NOAA). During this time, there were 51 days of heavy smoke when there were likely to be exceptionally high levels of particulate matter of 2.5 micrometers or less in diameter (PM_{2.5}) in the air. Exposure to PM_{2.5} poses the greatest health risk to health when inhaled (CARB, 2025). The Lower Arm of Clear Lake, just east of BVR, experienced smoke for 275 days in 2018, or roughly 75% of the year, with 64 days of heavy smoke. According to data from 2008-2018, BVR is an area with the highest likelihood of experiencing health impacts from smoke due to having high numbers of extreme smoke days and high socioeconomic vulnerability (UCLA, Tracking California and Howard University, 2026).

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.

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 lack an understanding of tribal customs and priorities.

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. As a result, droughts, fires, flooding, increases in HABs and other climate threats are impacting our Tribe.



Human Health

Figure 6.2.20. Mount Konocti in the Clouds.



Source: Photo by Laurie Monserrat

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 6.2.21**, below). Thus, potential exposures to HABs that produce cyanotoxins include unique pathways that do not apply to non-tribal individuals (**Figure 6.2.16**, page 54). 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.

The impact of extreme heat combined with poor air quality is of high concern for Big Valley Tribal members. Emergency room visits due to heat-related illness in Lake County and their incidence rate for heat-related illness has been among the highest in the state since 2007 (Tracking California, 2025a). Roughly 37% of homes in Lake County lack air conditioning, and 22% of residents live in mobile homes where indoor heat exposure deaths are more likely. One in four residents of Lake County are age 65 or older, and one in five residents have some sort of disability, which is almost double the statewide average (Tracking California, 2025b).

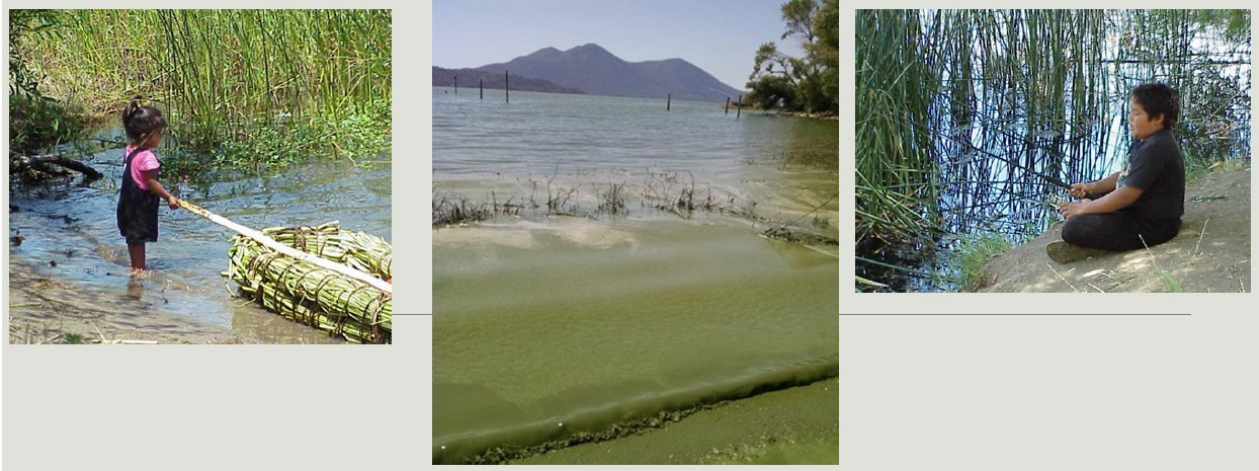
Lake County's incidence rate of emergency department visits due to asthma has been among the highest in the state for the last decade and has exceeded the state average for the last two decades (Tracking California, 2025b). The incidence rate of chronic obstructive pulmonary disease (COPD) is three to four times higher in Lake County than the state average and was the first or second highest rate in the state almost every year between 2013 and 2023. While these statistics are for all of Lake County, it is likely from anecdotal evidence that Tribal members would have similar if not greater vulnerability to heat- and air quality-related illnesses.

Big Valley used a Tracking California grant to install Purple Air air quality monitors in five Tribal households in 2024, allowing them to compare indoor and outdoor air concentrations of PM_{2.5}, and the composite metric of Air Quality Index (AQI).

Households report weekly activities such as cleaning, smoking, cooking, gathering, etc. The Tribe has observed that newer homes which are "tighter," or have less air exchange, have higher 5-month averages of PM_{2.5} and higher AQIs than older homes. This phenomenon was particularly noticeable during and after wildfires, when newer homes reached AQI's in the 800s (which is considered "Hazardous") and had poor air quality for weeks following outdoor wildfire smoke events. The Tribe continues to monitor air quality to protect Tribal health.



Figure 6.2.21. 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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Big Valley Band of Pomo Indians (2026). Impacts of Climate Change on the Big Valley Band of Pomo Indians. In: OEHHA 2026 Indicators of Climate Change in California.

References:

Abatzoglou JT, McEvoy DJ and Redmond KT (2025). [The West Wide Drought Tracker: Drought Monitoring at Fine Spatial Scales](#). In Press in the *Bulletin of the American Meteorological Society*. Retrieved December 5, 2025.

BRC (2026). Blue Ribbon Committee for the Rehabilitation of Clear Lake. [Landing page hosted by the California Natural Resources Agency](#). Retrieved May 13, 2026.

BVBPI and MRPI (2021). Big Valley Band of Pomo Indians and Middletown Rancheria of Pomo Indians. Summary of the Lake, Sonoma, and Mendocino County Tribal Listening Session (May 1819, 2021), hosted by the Big Valley Band of Pomo Indians, the Middletown Rancheria of Pomo Indians, and the Office of Environmental Health Hazard Assessment.

BV EPA (2014). Big Valley Environmental Protection Department. Points for Discussion on Climate Change and Impacts on Tribal Resources and Summary of questions from Tule Boat Festival 2014.

BV EPA (2017a). Big Valley Environmental Protection Department. Clear Lake Water Quality and Beneficial Use Objectives.

BV EPA (2017b). Big Valley Environmental Protection Department. Triennial Review Comments submitted September 2017.

BV EPA (2021). Big Valley Environmental Protection Department. Big Valley Rancheria Interim Report to the Bay Area Council California.

BV EPA (2022a). Big Valley Environmental Protection Department. Sarah Ryan, Big Valley Band of Pomo Indians of California Environmental Protection Agency, Director. Culturally important species impacted by climate change. Email communication with OEHHA.

BV EPA (2022b). Big Valley Environmental Protection Department. Clear Lake Water Quality Dashboard. Retrieved January 11, 2022.

BV EPA (2025). Big Valley Environmental Protection Department. Clear Lake Hitch Summit Presentation. December 12, 2025.

BV EPA (2026a). Big Valley Environmental Protection Department. [Clear Lake Water Quality Monitoring](#). Retrieved May 13, 2026.

BV EPA (2026b). Big Valley Environmental Protection Department. [Big Valley Environmental Protection Department](#). Retrieved May 13, 2026.

BV ISWMP (2023). Big Valley Integrated Solid Waste Management Plan. Integrated Solid Waste Management Plan for the Big Valley Rancheria.

BVR (2013). Big Valley Rancheria. Hitch Interview Notes. Shared with the permission of Big Valley Environmental Protection Department.

BVR (2022). Big Valley Rancheria. 'About Us'. Retrieved January 04, 2022.



Indicators of Climate Change in California (2026)

BVR (2026). Big Valley Rancheria. [Big Valley Rancheria Web Clearinghouse](#). Retrieved May 13, 2026.

BIA (2015). Bureau of Indian Affairs. Bureau of Indian Affairs 2015 Award Summary released September 28, 2015.

Butler N, Carlisle J and Linville R (2012). Toxicological summary and suggested action levels to reduce potential adverse health effects of six cyanotoxins. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento.

CAL FIRE (2026). [2026 Incident Archive](#). Retrieved May 14, 2026.

Cal-WATCH (2022). Cal-WATCH Drinking Water Testing for Cyanobacteria and Cyanotoxin. Presentation by Sarah Ryan, Big Valley Environmental Protection Agency and Susan Paulukonis, Tracking California, January 19, 2022.

CARB (2025). California Air Resources Board. [Inhalable Particulate Matter and Health \(PM2.5 and PM10\)](#). Retrieved December 29, 2025.

CCHViz (2025). [Climate Change and Health Vulnerability Indicators for California](#). California Department of Public Health.

CDFW (2014). California Department of Fish and Wildlife. Report to the Fish and Game Commission, A Status Review of Clear Lake Hitch (*Lavinia exilicauda chi*). May 2014.

CDPH (2025). California Department of Public Health. Environmental Health Investigations Branch. Email communication with OEHHHA.

Center for Biological Diversity (2013). [Vanishing Clear Lake Fish Becomes Candidate for California Endangered Species Act Protection \[Press release\]](#). Retrieved December 29, 2025.

Center for Biological Diversity (2021). [Lawsuit Seeks Protection for Northern California's Clear Lake Hitch \[Press release\]](#). Retrieved December 29, 2025.

Center for Biological Diversity (2026). [Lawsuit Seeks Endangered Species Protection for California's Clear Lake Hitch \[Press release\]](#). Retrieved May 12, 2026.

CLERC (2025). Clear Lake Environmental Research Center. [Mediterranean oak borer reports in Lake County, California](#). Retrieved December 4, 2025.

COST (2016). *Harmful Algal Blooms and California Fisheries, Developed in Response to the 2015-2016 Domoic Acid Event*. California Ocean Science Trust. Oakland, CA.

CWQMC (2025). State of California Water Quality Monitoring Council. [HABs Response Guidance](#). Retrieved December 29, 2025.

Ewing B (2021). [2021 Clear Lake Hitch \(Lavinia exilicauda chi\) Visual Surveys on Clear Lake Tributaries](#). Region 2 Fish Files. California Department of Fish and Wildlife.

Ewing B (2023). [2023 Clear Lake Hitch \(Lavinia exilicauda chi\) Visual Surveys on Clear Lake Tributaries](#). California Department of Fish and Wildlife.

Ewing B (2025). [2025 Clear Lake Hitch \(Lavinia exilicauda chi\) Visual Surveys on Clear Lake Tributaries](#). California Department of Fish and Wildlife.

Feyrer F (2019). Observations of the spawning ecology of the imperiled Clear Lake Hitch. *California Fish*



and Game **105**(4): 225-232.

Feyrer F, Young M, Whitman G and Johnson R (2019a). Strontium isotopes reveal ephemeral streams used for spawning and rearing by an imperiled potamodromous cyprinid Clear Lake Hitch. *Marine and Freshwater Research* **70**(12): 1689–1697.

Feyrer F, Young M, Patton O and Ayers D (2019b). Dissolved oxygen controls summer habitat of Clear Lake Hitch (*Lavinia exilicauda* chi), an imperiled potamodromous cyprinid. *Ecology of Freshwater Fish* **2019**(00): 1–9.

Feyrer F (2022). Presentation at Water Quality Wednesday, Lake County Water Resources Department. January 12, 2022. With permission of the author.

Feyrer F, Young MJ, Huntsman B, Violette V, Clause JK, et al. (2025). Gillnet sampling methods for monitoring status and trends of Clear Lake Hitch in Clear Lake, Lake County, California: U.S. Geological Survey Open-File Report 2025–1018, 26 p.

Flushman B and Barbieri J (1986). Aboriginal Title: The Special Case of California. *Mc George Law Review* **17**(2) Article 4.

Goldstein JJ and Tolsdorf TN (1994). An economic analysis of potential water quality improvement in Clear Lake: benefits and costs of sediment control, including a geological assessment of potential sediment control levels: Clear Lake Basin, Lake County, California. U.S. Department of Agriculture, Washington, DC.

Lake County (2021). Water Conservation. Retrieved January 04, 2022.

Lehman PW, Kurobe T, Lesmeister S, Baxa D and Teh SJ (2017). Impacts of the 2014 severe drought on the Microcystis bloom in San Francisco Estuary. *Harmful Algae* **63**: 94-108.

Miller RK, Field CB and Mach KJ (2020). Barriers and enablers for prescribed burns for wildfire management in California. *Nature Sustainability* **3**: 101–109.

Montez R (2022). Ron Montez, Tribal Historic Preservation Officer (THPO). Email communication between the Big Valley Band of Pomo Indians THPO and Laurie Monserrat, OEHHA, on the subject of Tribal history.

National Water Quality Monitoring Council (2025). [Water Quality Portal](#). Results for Lake County. Retrieved December 12, 2025.

OEHHA (2018). Office of Environmental Health Hazard Assessment. [Fish Advisory for Clear Lake](#). Retrieved December 29, 2025.

Patrick KC (2008). The Pomo of Lake County. ISBN 978-0-7385-5604-8. Arcadia Publishing, Charleston, South Carolina.

Pearce C (2021). Magical Manzanita. Workshop held at the Grace Hudson Museum, July 23, 2021.

Pearce C (2022). Keeping Native Habitats Healthy. Retrieved January 11, 2022.

Pierce JR, Feyrer F, Young M, Enos E, Clause J, et al. (2022). Mercury in fishes from Clear Lake, California, 2019 and 2020 (ver. 2.0, February 2022). U.S. Geological Survey data release.

Power ME, Bouma-Gregson K, Higgins P and Carlson S (2015). The Thirsty Eel: Summer and Winter Flow Thresholds that Tilt the Eel River of Northwestern California from Salmon-Supporting to



Cyanobacterially Degraded States. *Copeia* **103**(1): 200-211.

PRISM Climate Group (2025). [Parameter-elevation Regressions on Independent Slopes Model](#). Oregon State University, Corvallis. Retrieved December 8, 2025.

Smith J, Eggleston E, Howard MDA, Ryan S, Gichuki J, et al. (2023). Historic and recent trends of cyanobacterial harmful algal blooms and environmental conditions in Clear Lake, California: A 70-year perspective. *Elem Sci Anth* **11**: 1.

Solomon GM, Stanton B, Ryan S, Little A, Carpenter C and Paulukonis S (2022). Notes from the Field: Harmful Algal Bloom Affecting Private Drinking Water Intakes — Clear Lake, California, June–November 2021. *The Morbidity and Mortality Weekly Report* **71**(41):1306–1307.

Sousa R, Antunes C and Guilhermino L (2008). Ecology of the invasive Asian clam *Corbicula fluminea* (Müller, 1774) in aquatic ecosystems: an overview. *International Journal of Limnology* **44**(2): 85-94.

State of California (2023). Executive Department: State of California. [Executive Order N-5-23](#).

SWRCB (2015). State Water Resources Control Board. Fish sampling results for Clear Lake.

SWRCB (2022). State Water Resources Control Board. California Environmental Data Exchange Network. Retrieved January 08, 2022.

SWRCB (2023). State Water Resources Control Board. “Clear Lake Hitch Emergency.” Presentation given March 7, 2023.

SWRCB (2025). State Water Resources Control Board. [Clear Lake Hitch](#). Retrieved December 4, 2025.

SWRCB (2026). State Water Resources Control Board. [Statewide Mercury Provisions](#). Retrieved February 25, 2026.

Tracking California (2025a). [Lake County – Vulnerable infrastructure, persistent smoke and wildfire threats](#). Retrieved December 18, 2025.

Tracking California (2025b). Public Health Institute. [Data Explorer](#). Retrieved December 18, 2025.

Tracking California (2026). [Issue Brief: Hidden Water Risks: Algal Blooms and Contaminants Found in Self-Supplied Drinking Water Systems](#). Retrieved July 30, 2026. USDA (1995). US Department of Agriculture. Effects of Sediment on the Aquatic Environment. Retrieved January 04, 2022

US EPA (2021). US Environmental Protection Agency. Health Effects of Ozone Pollution. Retrieved January 04, 2022.

US EPA (2025a). US Environmental Protection Agency. [How's My Waterway?](#) Retrieved December 18, 2025.

US EPA (2025b). US Environmental Protection Agency. [Sulphur Bank Mercury Mine Clearlake Oaks, CA Cleanup Activities](#). Retrieved December 18, 2025.

US EPA (2026). US Environmental Protection Agency. [Climate Change and Freshwater Harmful Algal Blooms](#). Retrieved July 28, 2026.

USFS (2025). US Forest Service. [Endangered and Threatened Wildlife and Plants; Threatened Species Status With Section 4\(d\) Rule for Clear Lake Hitch](#). Federal Register **90** FR 4916.



Indicators of Climate Change in California (2026)

UCD (2010). University of California at Davis. Clear Lake Historical Data Analysis.

UCDNAR (2022). University of California, Division of Agriculture and Natural Resources. Clear Lake Aquatic Website. Retrieved January 28, 2022

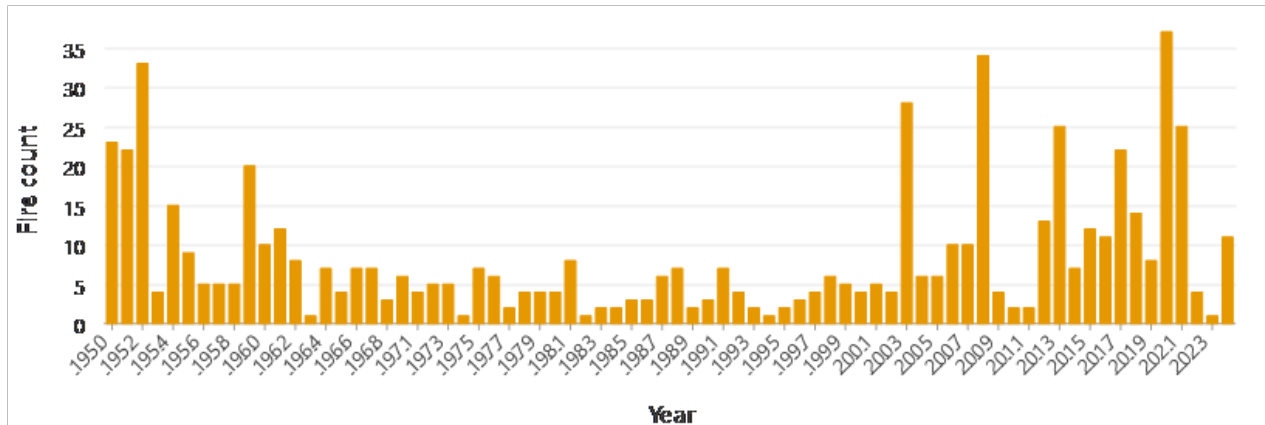
UCLA, Tracking California and Howard University (2026). University of California Los Angeles. [Hot & Smoky: Mapping California Communities Vulnerable to Climate Extremes](#). Funded by NASA's Equity and Environmental Justice Award No. 80NSSC22K1684

WHO (1999). World Health Organization. Toxic cyanobacteria in water: a guide to their public health consequences, monitoring and management. London and New York, Routledge.



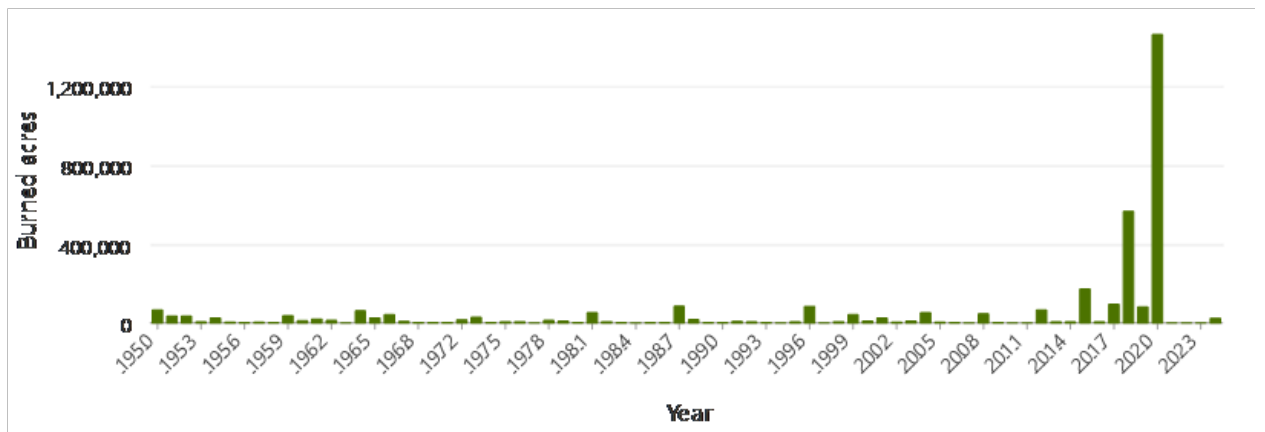
Appendix:

Figure 6.2.A-1. Number of Fires Within 50 Miles of Big Valley Rancheria from 1950 to 2024.



Source: CAL FIRE (2025)

Figure 6.2.A-2. Annual Acres Burned by Fires *Within 50 Miles of Big Valley Rancheria from 1950 to 2024.



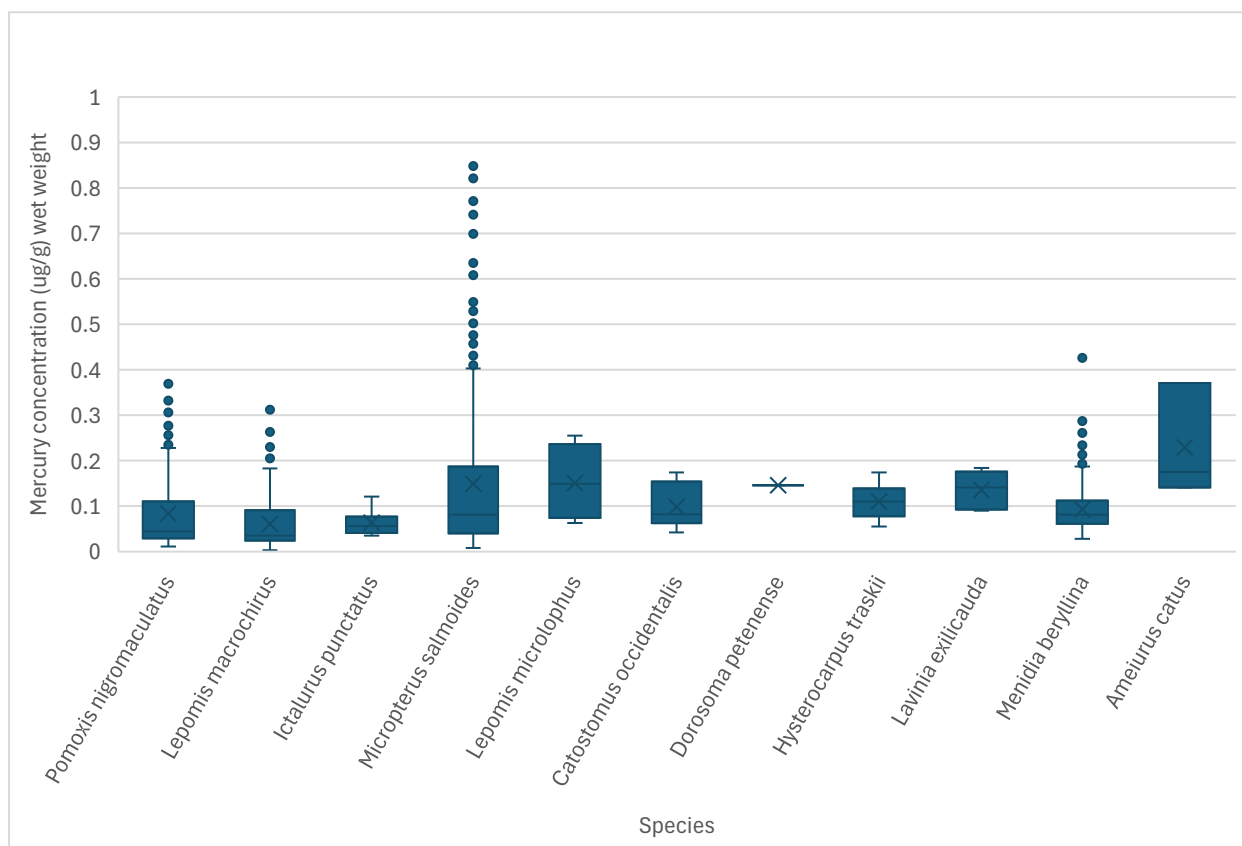
Acres burned were estimated using ArcGIS Pro, based on fire perimeter data from CAL FIRE.

*This includes *all* acres burned by fires which had any portion of their perimeter within 50 miles of the Big Valley Rancheria.

Source: CAL FIRE (2025)



Figure 6.2.A-3. Total Mercury Concentration in USGS Fish Tissue Samples from Clear Lake, 2019 to 2020.



Total mercury concentration is given in microgram per gram (ug/g, equivalent to mg/kg or ppm) wet weight fish tissue samples. The Tribal Subsistence Fishing Objective for mercury in fish tissue is 0.04 mg/kg (SWRCB, 2026). Common names, number of samples, and types of samples for each species are given in the table below.

Species	Common name	# Samples	Axial muscle	Whole body
<i>Pomoxis nigromaculatus</i>	Black crappie	128	32	96
<i>Lepomis macrochirus</i>	Bluegill	285	65	220
<i>Ictalurus punctatus</i>	Channel catfish	15	15	0
<i>Micropterus salmoides</i>	Largemouth bass	331	127	204
<i>Lepomis microlophus</i>	Redear sunfish	9	9	0
<i>Catostomus occidentalis</i>	Sacramento sucker	8	8	0
<i>Dorosoma petenense</i>	Threadfin shad	1	1	0
<i>Hysterocarpus traskii</i>	Tule perch	14	14	0
<i>Lavinia exilicauda</i>	Clear Lake Hitch	5	1	4
<i>Menidia beryllina</i>	Inland silverside	274	0	274
<i>Ameiurus catus</i>	White bullhead	3	3	0

Source: Plot and table created using data published by the USGS from Pierce et al. (2022)

