CLEAR LAKE WATER QUALITY, TRIBES, AND CYANOTOXINS

BIG VALLEY RANCHERIA

Big Valley Band of Pomo Indians

Layout: M. Marrufo 2022

Tribal Cyanobacteria Monitoring Program

The Clear Lake Cyanotoxin Monitoring Program which was begun by Big Valley and Elem Indian Colony in 2014 continued its biweekly sampling for summer 2021. Most likely due to drought and other factors, we began seeing Anatoxin-a, a potent neurotoxin, in multiple locations on the lake. Big Valley Band of Pomo Indians and Elem Indian Colony already had established water monitoring programs and QAPPs to conduct this testing.

In 2021, our monitoring program became an extremely useful tool which identified more than 400 at risk private/individual drinking water systems on Clear Lake. Because of the unprecedented Microcystin and Anatoxin-a toxin levels on Clear Lake, Lake County Public Health issued a Health Advisory on September 16, 2021 of Do Not Drink the tap water for those private systems that draw their drinking water from Clear Lake. Alternate sources of tap water were set up for these homes.

Tribal Cyanobacteria Monitoring Program

2014

- Formed Clear Lake Cyanobacteria Task Force, has continued to meet quarterly
- Focused on Microcystin levels at 8 shoreline sites– lab analysis and field Algal Toxin strips

2015

- 18 shoreline sites
- Cyanobacteria cell identification
- Lab analysis for Microcystin, Anatoxin-a, Cylindrospermopsin, Saxitoxin

2016

- Monitoring toxins in drinking water systems
- Chlorophyll-a and phycocyanin for TMDL
- Microcystin analysis at every site and every sampling event

2017

- Expanded sites to a few creeks and other waterbodies in Lake County
- Began sending samples for qPCR analysis (quantifying toxin producing genes)

2018

- Analysis of fish and shellfish for Microcystin
- Began collaboration with CA DWR to get water samples from interior of lake

2019

- Development of graphics and language about HABs and Tribal Beneficial Uses: Tribal conceptual FHAB Pathway

Tribal Centric Program

- Include locations that are Tribally important
- Monitoring to coincide with important dates of Tribal uses of the water
- Communicate with Tribes and the public about the results

2022

- Program development for creek cyanotoxin monitoring using grab samples and SPATT bags
- Program development for cyanotoxin analysis of other traditional foods: waterfowl (mudhens) and tules

2020

- Development of signage tracker for Lake County and other agencies to monitor the changing toxin levels and communication signage throughout the sampling season

2021

- Analysis of private (self supplied) drinking water taps for cyanotoxins
- Work with local Public Health Officer to alert on cyanotoxins in private drinking water systems

Supporting Tribal Beneficial Uses

What are Tribal Beneficial Uses?

California Native American Tribes use California's surface waters in a manner unique to tribal culture, tradition, ceremonies, and lifeways. The term Tribal Beneficial Uses gives us a way to say "protect uses of water that directly relate to Native American cultures." In some cases, the pollution allowed in California waters or existing water quality standards may not protect Tribal Beneficial Uses. To protect our cultural use water, in 2017, the State Water Board identified and described beneficial uses unique to California Native American Tribes. The beneficial uses definitions established are the following:

- **Tribal Tradition and Culture:** Uses of water that support the cultural, spiritual, ceremonial, or traditional rights or lifeways of California Native American Tribes, including, but not limited to: navigation (boating/canoeing), ceremonies, or fishing, gathering, or consumption of natural aquatic resources, including fish, shellfish, vegetation, and materials.
- **Tribal Subsistence Fishing:** Uses of water involving the non-commercial catching or gathering of natural aquatic resources, including fish and shellfish, for consumption by individuals or communities of California Native American Tribes to meet needs for sustenance.

Why Protect Tribal Beneficial Use Water from Pollution?

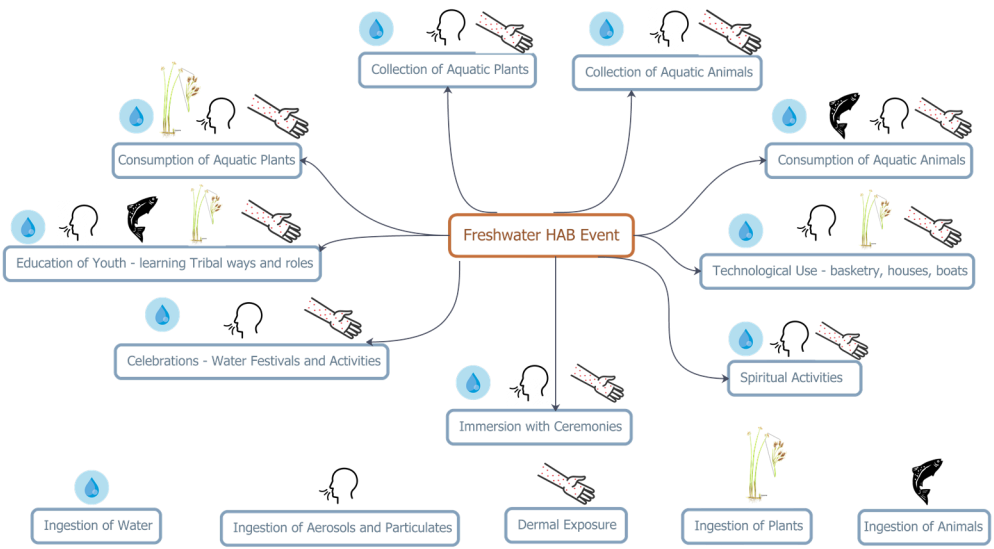
Clean water is fundamental to life, but many of our people have never had an opportunity to experience this basic and essential service, one that is taken for granted in most American communities. Our Tribes protect the water against pollution so that we can continue to gather and use the water. Some forms of water pollution are the following:

Pesticides -Pesticides include insecticides that are sprayed on crops to kill bugs and herbicides that are sprayed to kill weeds. These strong chemicals can get into the water through runoff of rain storms. They can also contaminate rivers and lakes through accidental spills.

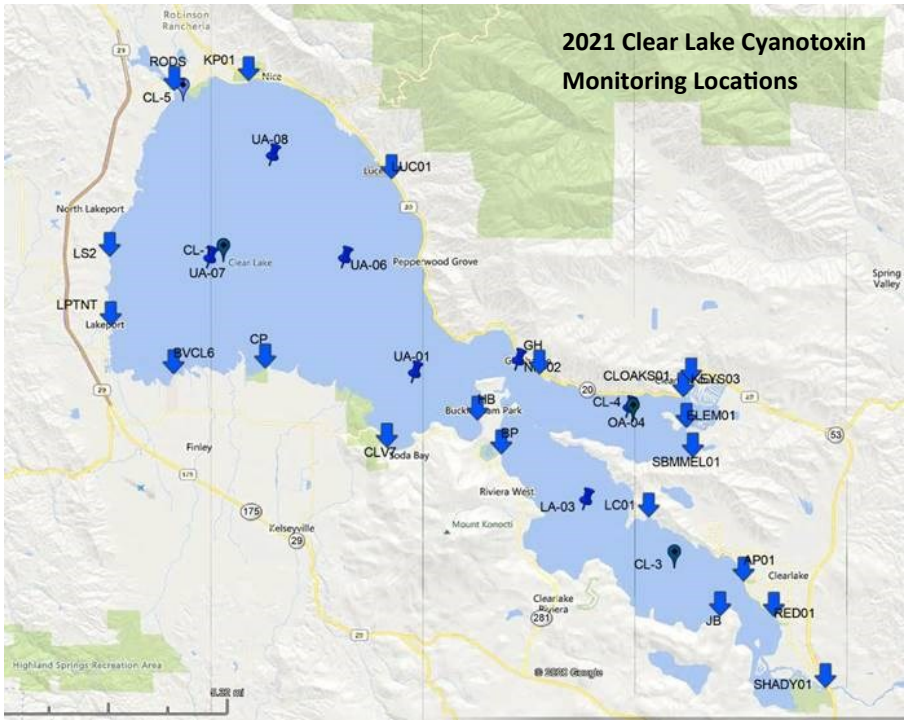
Construction, floods, and storms - Silt from construction, earthquakes, floods, and storms can lower the oxygen content in the water and suffocate fish.

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 Moyo Mamufo and Dr. Jeanine Pfeiffer 2019.

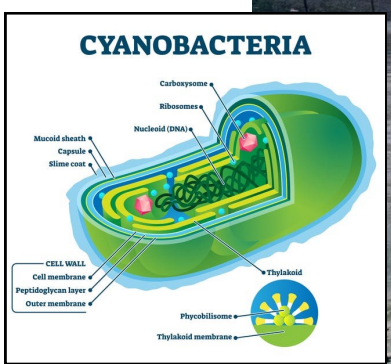


Year	Maximum Microcystin Value (µg/L)	Location
2021	160378	RED01
2020	1146	LUC01
2019	150	LC01
2018	4800	SBMMEL01
2017	46	CLOAKS01
2016	0.67	SBMMEL01
2015	10162	AP01
2014	16920	CLOAKS01

What are Cyanobacteria?

Cyanobacteria is a phylum comprised of photosynthetic bacteria that live in aquatic habitats and moist soils. Cyanobacteria are found to play a role in producing gaseous oxygen as a byproduct of photosynthesis.

- "Blue Green Algae"
- In marine or freshwater.
- Bacteria, not algae.
- Why our atmosphere has oxygen in it.
- Thrives with excess nutrient loads including Phosphorus and Nitrogen.
- Toxin producing– skin, liver and nerve
- "Harmful Algal Blooms"



Cyanobacteria Impacts

- Bloom proliferation —> reduced sunlight in water column, impacting plant growth
- Dying blooms —> oxygen depletion —> fish kills
- Questions about water safety
- Strong odor, visually unpleasing
- Increased filtration and treatment costs for

Lyngbya Cyanobacteria Bloom

Fish Kill During Cyanobacteria Bloom, Clear Lake
Photo: Big Valley EPA

Action levels for selected scenarios

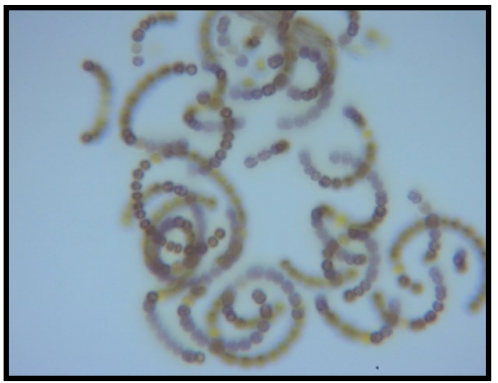
	Microcystins[1]	Anatoxin-a	Cylindro-spermopsin	Media (units)
Human recreational uses[2]	0.8	90	4	Water (µg/L)
Human fish consumption	10	5000	70	Fish (ng/g) ww[3]
Subchronic water intake, dog[4]	2	100	10	Water (µg/L)
Subchronic crust and mat intake, dog	0.01	0.3	0.04	Crusts and Mats (mg/kg) dw[5]
Acute water intake, dog[6]	100	100	200	Water (µg/L)
Acute crust and mat intake, dog	0.5	0.3	0.5	Crusts and Mats (mg/kg) dw[5]
Subchronic water intake, cattle[7]	0.9	40	5	Water (µg/L)
Subchronic crust and mat intake, cattle[7]	0.1	3	0.4	Crusts and Mats (mg/kg) dw[5]
Acute water intake, cattle[7]	50	40	60	Water (µg/L)
Acute crust and mat intake, cattle[7]	5	3	5	Crusts and Mats (mg/kg) dw[5]

[1] Microcystins LA, LR, RR, and YR all had the same RfD so the action levels are the same.
[2] The most highly exposed of all the recreational users were 7- to-10-year-old swimmers. Boaters and water-skiers are less exposed and therefore protected by these action levels. This level should not be used to judge the acceptability of drinking water concentrations.
[3] Wet weight or fresh weight.
[4] Subchronic refers to exposures over multiple days.
[5] Based on sample dry weight (dw).
[6] Acute refers to exposures in a single day.
[7] Based on small breed dairy cows because their potential exposure to cyanotoxins is greatest. See Section VI for action levels in beef cattle.

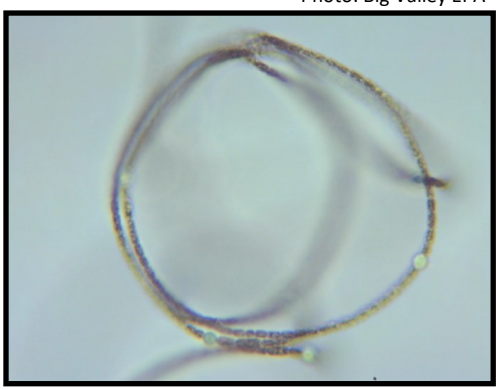
https://oehha.ca.gov/media/downloads/fish/document/cyanotoxins053112.pdf

Types of Cyanobacteria

Cyanobacteria: Anabaenopsis
Photo: Big Valley EPA



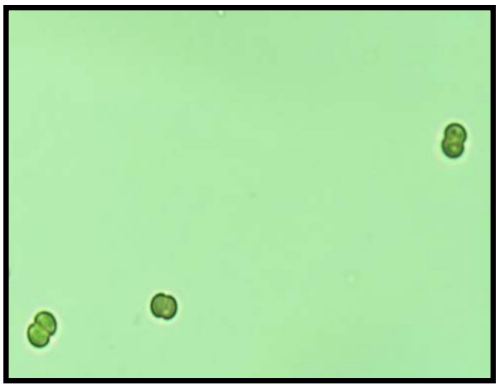
Cyanobacteria: Dolichospermum
Photo: Big Valley EPA



Cyanobacteria: Dolichospermum
Photo: Big Valley EPA

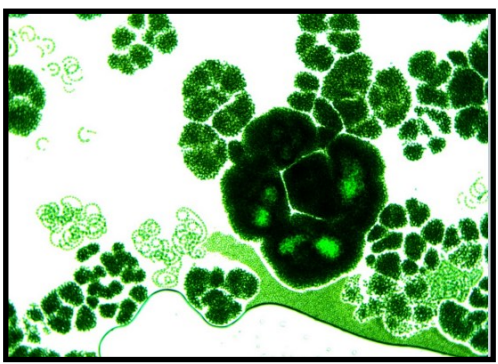
Cyanobacteria: Aphanizomenon
Photo: Big Valley EPA

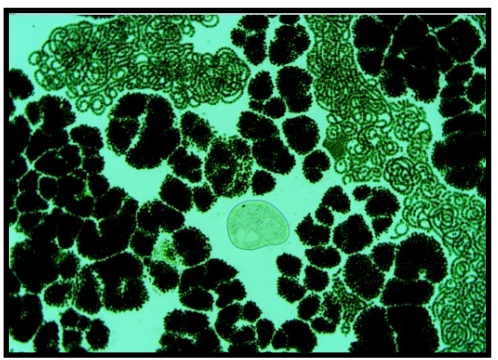
Types of Cyanobacteria



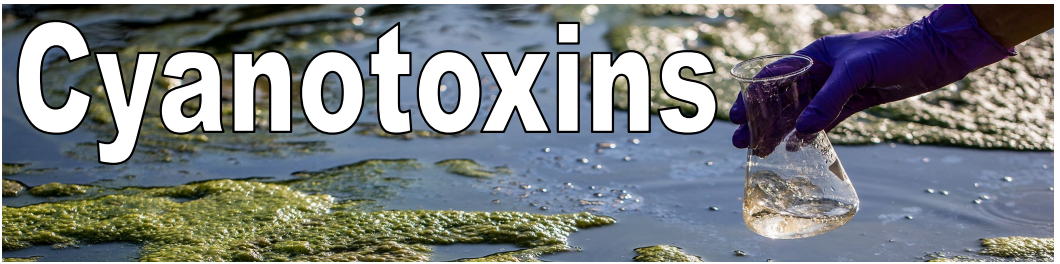
Cyanobacteria: Synechocystis
Photo: Big Valley EPA

Cyanobacteria: Dolichospermum
Photo: Big Valley EPA



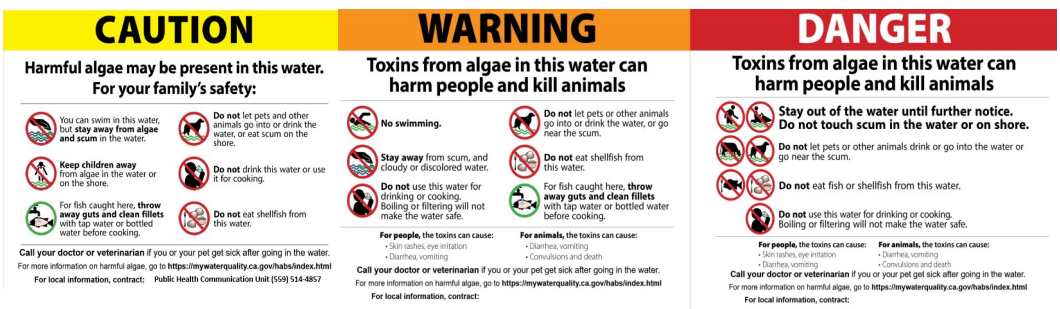


Cyanobacteria: Microcystis and Dolichospermum
Photo: Big Valley EPA



Cyanobacteria (also called blue-green algae) can grow quickly, or bloom, when the water is warm, slow-moving, and full of nutrients. Cyanobacterial blooms are most commonly found in fresh water such as lakes, rivers, and streams. Blooms can discolor the water and look like foam, scum, mats, or paint on the surface. These blooms sometimes produce toxins called cyanotoxins. Common cyanotoxins include Microcystin and Anatoxin-a.

People are most often exposed while swimming, boating, or doing other activities in or near water with a cyanobacterial bloom. During recreational water activities, humans can be exposed to contaminated water by dermal contact, inhalation, and also ingestion. People can also be exposed through contaminated tap water; seafood; dietary



supplements; or, infrequently, dialysis. Symptoms and signs depend on how people were exposed, how long they were exposed, and the types of toxins they were exposed to. Medical care is supportive. There are no known antidotes to cyanotoxins or specific treatments for illnesses caused by cyanobacteria and their toxins.

Pet illness may provide additional evidence that a patient could have an illness caused by a cyanobacterial bloom. Dogs and other animals might have more severe symptoms than people, including collapse and sudden death.

Trigger Levels for Human and Animal Health

Criteria*	No Advisory [a]	CAUTION (TIER 1)	WARNING (TIER 2)	DANGER (TIER 3)
Total Microcystins [b]	< 0.8 µg/L	0.8 µg/L	6 µg/L	20 µg/L
Anatoxin-a	Non-detect [c]	Detected [c]	20 µg/L	90 µg/L
Cylindrospermopsin	< 1 µg/L	1 µg/L	4 µg/L	17 µg/L
Cell Density of potential toxin producers	< 4,000 cells/mL	4,000 cells/mL	_____	_____
Site-specific indicator(s)	No site-specific indicators present	Discoloration, scum, algal mats, soupy or paint-like appearance. Suspected illness	_____	_____

* Action levels are met when one or more criteria are met.

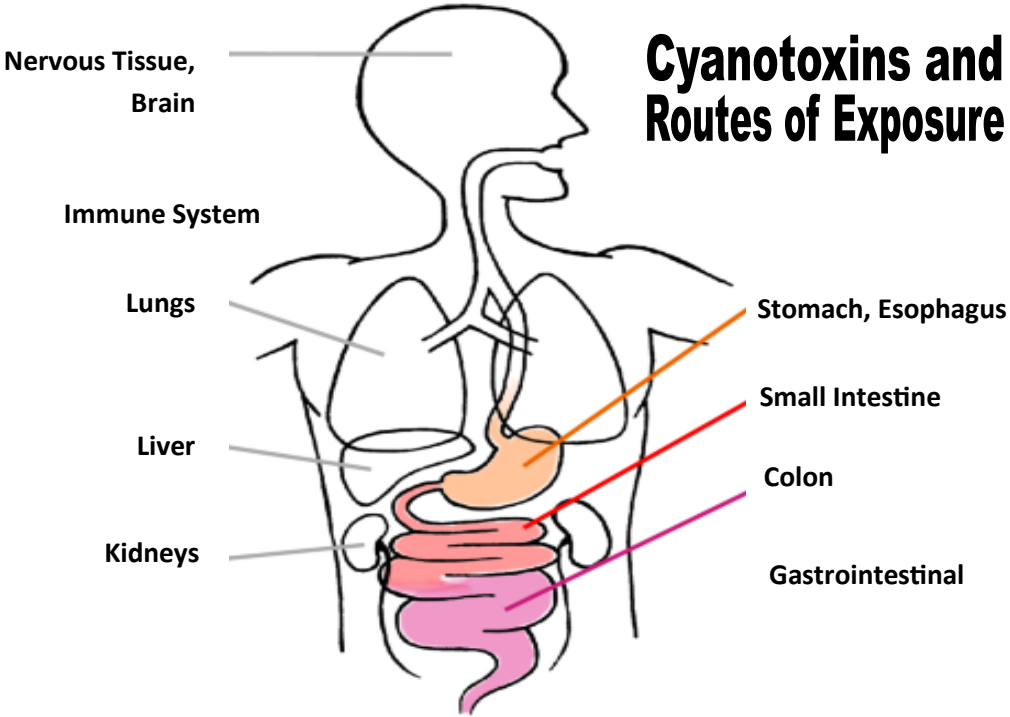
[a] For de-posting, all criteria for no advisory must be met for a minimum of 2 weeks. General awareness sign may remain posted and healthy water habits are still recommended.

[b] Microcystins refers to the sum of all measured Microcystin congeners.

[c] Must use an analytical method that detects ≤ 1µg/L Anatoxin-a.

https://mywaterquality.ca.gov/habs/resources/habs_response.html#advisory_signs_guidance

Cyanotoxins and Routes of Exposure



https://enveurope.springeropen.com/articles/10.1186/s12302-019-0212-2#Fig1

Ingestion	Direct Contact
Swallowing water contaminated with cyanobacteria or toxins	Skin contact with water that is contaminated with cyanobacteria or toxins
Eating contaminated fish or dietary supplements	Other exposure routes of Cyanotoxins are Inhalation and Dialysis

Freshwater Cyanotoxin Producers Chart

Cyanobacteria Genus	Liver Toxins			Neurotoxins			Skin Toxins		
	MC	NOD	CYN	ATX	STX	GTX	LTX	DAT	AT
Anabaena	X		X		X				
Anabaenopsis	X				X				
Anagnostidinema	X				X				
Aphanizomenon			X	X	X				
Aphanocapsa	X								
Chrysosporum			X						
Coelosphaerium	X								
Cuspidothrix				X	X				
Cylindrospermum				X	X				
Dolichospermum	X		X	X	X	X			
Fischerella	X								
Geitlerinema	X			X	X				
Gloeotrichia	X								
Hapalosiphon	X								
Iningainema		X							
Kamptonema				X					
Leptolyngbya	X								
Limnospira	X			X					
Limnothrix	X				X				
Merisimopedia	X								
Microseira wollei			X		X				

Cyanobacteria Genus	Liver Toxins			Neurotoxins			Skin Toxins		
	MC	NOD	CYN	ATX	STX	GTX	LTX	DAT	AT
Microcoleus	X		X	X	X				
Microcystis	X								
Nodularia		X							
Nostoc	X	X		X					
Oscillatoria	X		X	X			X		X
Planktothrix	X			X	X				
Pseudanabaena	X								
Radiocystis	X								
Raphidiopsis			X	X	X				
Rivularia	X								
Schizothrix								X	X
Scytonema	X				X				
Sphaerospermopsis	X								
Synechococcus	X			X					
Synechocystis	X								
Tolypothrix	X								
Trichormus	X								
Tychonema				X					
Umezakia			X						
Woronichinia	X								

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