Clear Lake Cyanotoxins Monitoring Program: Toxins and Tribal Beneficial Uses

Sarah Ryan, Environmental Director, Big Valley Band of Pomo Indians

U.S. EPA March 22, 2022

Overview

- Tribal Water Programs
- Impacts to Beneficial Uses
- Clear Lake Cyanobacteria and Cyanotoxin Monitoring Program

California Native American Tribes

- 109 federally recognized in 34 counties in California
- 78 petitioning for recognition
- Federal treaties from the 1860's were signed but never ratified by Congress, leaving Tribes unprotected.
- Some are now "landless" because of a series of policies that allowed the land to be sold from under them.
- Because of a legal relationship with the federal government, Tribes are recognized to be self governing with inherent sovereignty over their members and territories.
- Tribal lands are located in some of the Waterboard regions; but there are Tribal interests in all of the regions.


California Indian
Pre-contact
Tribal
Territories
Tolowa
Yurok
Chilula
Wiyot
Whilkut
Chimariko
Mattole
Nongatl
Lassik
Wailaki
Sinkiyone
Kato
Coast Yuki
Huchnom
Lake Miwok
Wappo
Coast
Miwok
Esselen
Kitanemuk
Tataviam
Gabrieleño
Karok
Hupa
Shasta
Modoc
Achomawi
Wintu
Atsugewi
Yana
Maidu
Nomlaki
Konkow
Yuki
Pomo
Patwin
Nisenan
Northern
Paiute
Washo
Mono Lake
Northern Paiute
Sierra
Miwok
Owens Valley
Paiute-Shoshone
Western
Shoshone
Northern
Valley
Yokuts
Costanoan
Foothill
Yokuts
Monache
Tabtulabal
Southern
Valley
Yokuts
Salinan
Kawaiisu
Southern
Paiutes
Chumash
Serrano
Mojave
Chemehuevi
Gabrieleño
Cahuilla
Halchidhoma
Luiseño
Quechan
Ipai
Tipai
California Indian Library Collections

Tribal Water Monitoring Programs

- Using approved QAPPS
- Annual assessment reports required
- 56 Tribes in California have data in the federal WQX (Water Quality Exchange) database.
- Funding sources: USEPA CWA 106, USEPA NPS 319, BIA Water Resources, BOR and other state or local sources.
- Tribes have site specific and time specific uses of water – more than 'recreation' it's traditional usage that defines lifeways.

Tribes as Water Quality Data Partners

- Tribes are monitoring waterbodies throughout California to protect their uses and resources
- Their data is legally defendable and available
- Tribal programs should be partnered with to enhance cyanotoxin monitoring throughout the state
- Tribal data sovereignty should be discussed

Tribal Beneficial Uses - Definitions

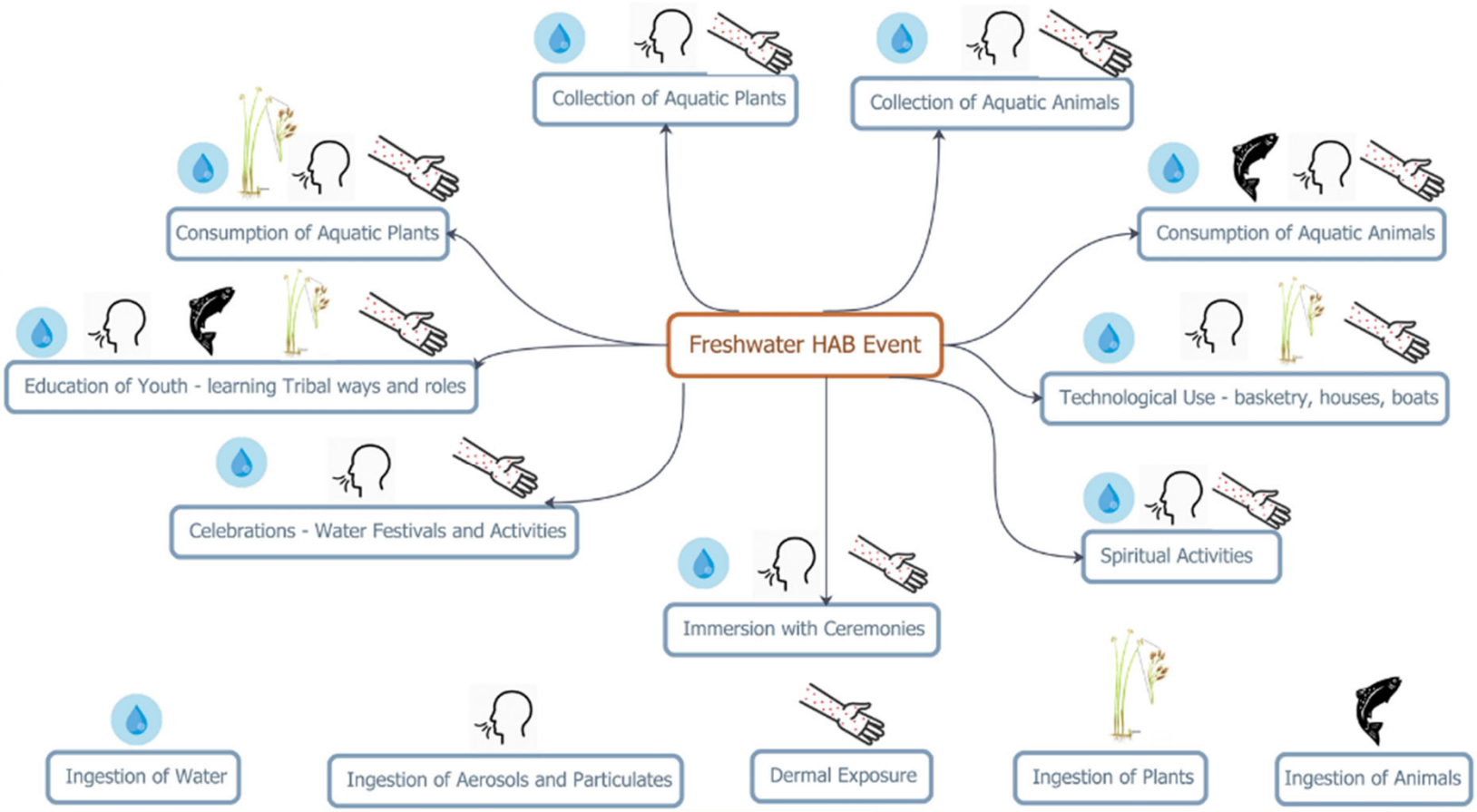
- **Tribal Tradition and Culture (CUL):** Uses of water that support the cultural, spiritual, ceremonial, or traditional rights or LIFEWAYS of CALIFORNIA NATIVE AMERICAN TRIBES, including, but not limited to: navigation, ceremonies, or fishing, gathering, or consumption of natural aquatic resources, including fish, shellfish, vegetation, and materials.

- **Tribal Subsistence Fishing (T-SUB):** Uses of water involving the non-commercial catching or gathering of natural aquatic resources, including fish and shellfish, for consumption by individuals, households, or communities of California Native American Tribes to meet needs for sustenance.

Adopted by the State Water Resources Control Board in May 2017
https://www.waterboards.ca.gov/about_us/public_participation/tribal_affairs/beneficial_uses.html

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

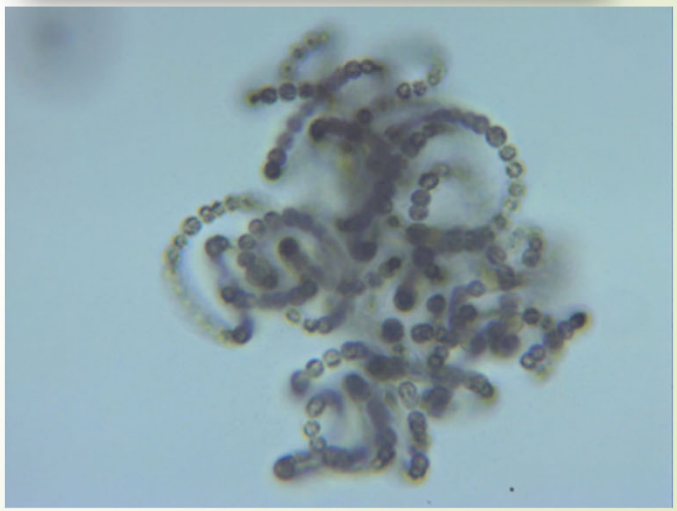
Native peoples were given their land by Creator and honor Creator and their Ancestors by maintaining traditions and cultural landscapes. This is the connection between the land and the people. Uses can be repetitive, gender assigned and long term. Exposures can occur second hand through the use and trade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



Amending Basin Plans to Protect Tribal Beneficial Uses

- Tribes in California are now engaging with Regional Waterboards to take the next steps of the Clean Water Act - inserting Water Quality Objectives related to Tribal Beneficial Uses in these Basin Plans
- All NPDES permits and TMDL clean ups are linked to stated beneficial uses and water quality objectives
- The Clean Water Act requires period review of water quality data against water quality objectives. Tribal data can be used during these 305b evaluations.

Clear Lake Cyanotoxin Monitoring Program

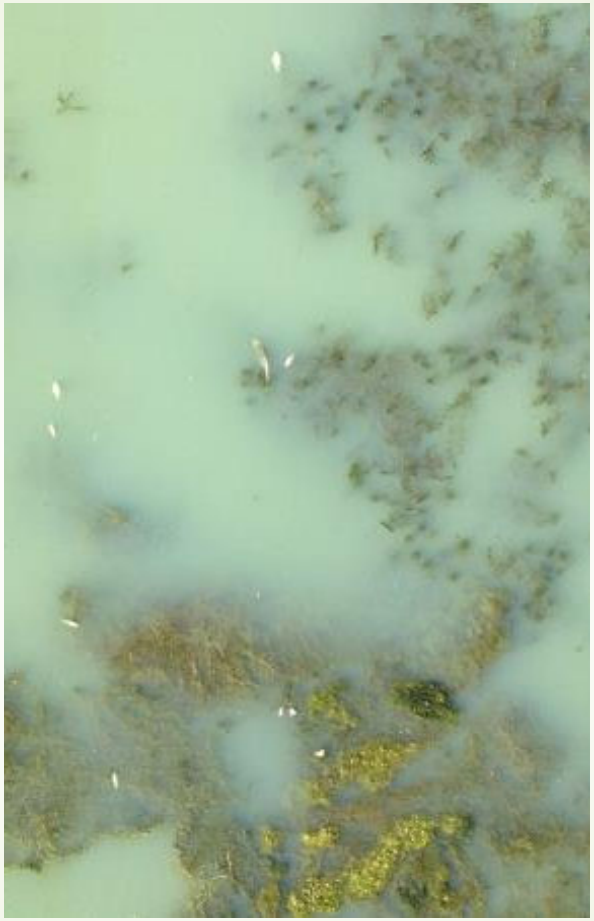


- Established by Big Valley Band of Pomo Indians and Elem Indian Colony, 2014.

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 drinking water systems

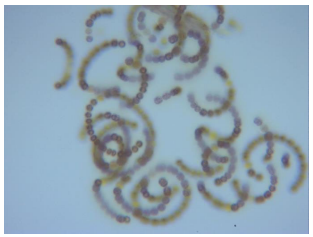
Clear Lake Cyanobacteria Bloom and Fish Kill, September 2014

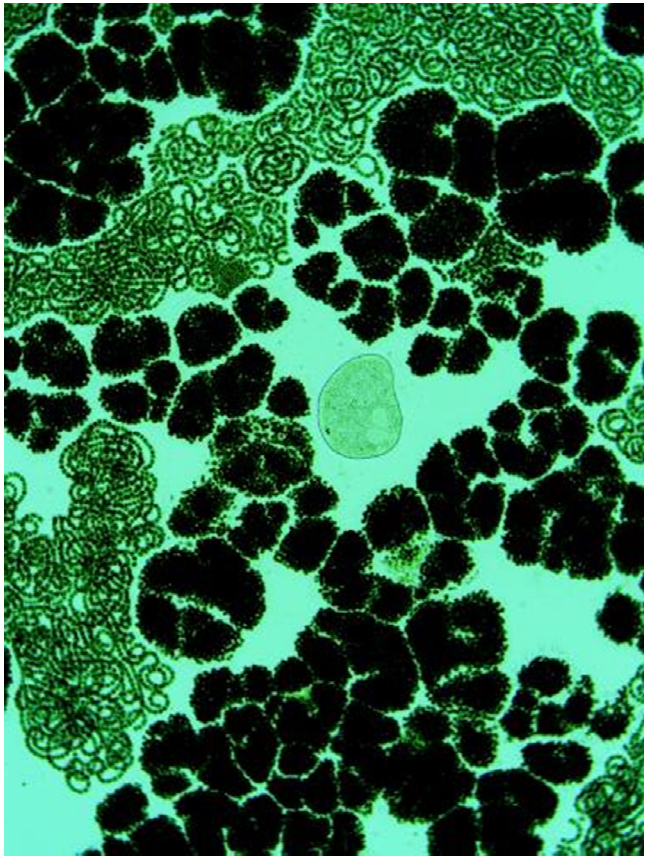


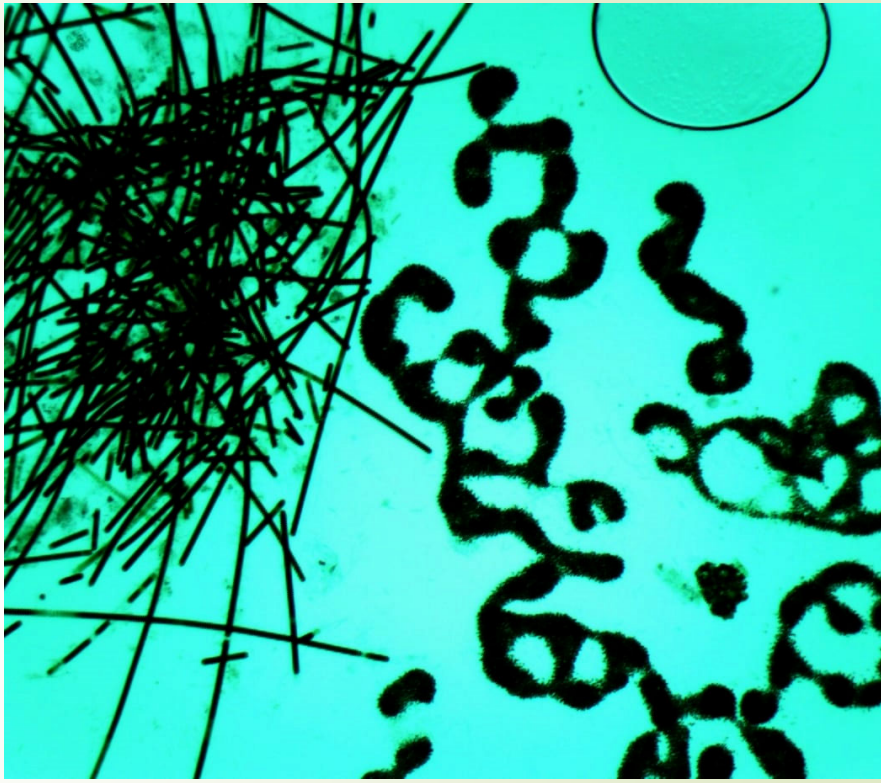
2021 Blooms

Some of Our In-House Microscopy

- We use this analysis to determine what toxin analysis to request, as well as identify trends.
- Nitrogen fixers dominated after heavy fires in 2015, for several years.







Microcystis and Lyngbya bloom, Clear Lake, August 2021

California Cyanotoxin Guidelines

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]

'Suggested Action Levels and Six Cyanotoxins', CA OEHHA, 2012

https://oehha.ca.gov/risk-assessment/document/toxicological-summary-and-suggested-action-levels-reduce-potential-adverse

Freshwater cyanotoxin producers chart

California State Water Boards Freshwater Harmful Algal Bloom Program | mywaterquality.ca.gov/habs

Toxin types[a]	
Liver toxins	microcystin (MC), nodularin (NOD), cylindrospermopsin[b] (CYN)
Neurotoxins	anatoxins (ATX; including homoanatoxin and derivatives), saxitoxins (STX), guanitoxin[c] (GTX)
Skin toxins[a]	lyngbyatoxin (LTX), debromoaplysiatoxin (DAT), aplysiatoxin (AT)

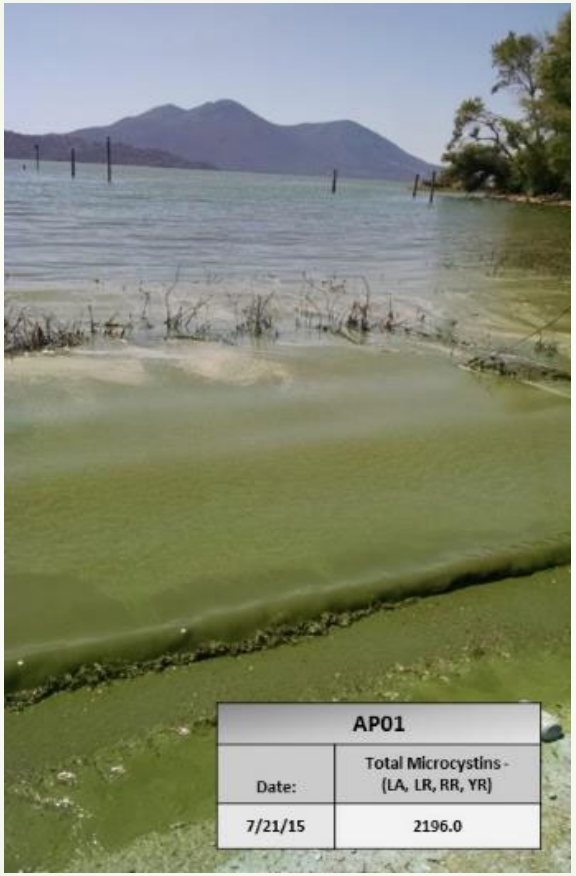
[a] In addition to the toxins listed, all cyanobacterial cell membranes contain lipopolysaccharides, which can irritate the skin and gastrointestinal tract[1]
[b] Cylindrospermopsin also impacts the kidney[2]
[c] Previously anatoxin-a(s)[3].

Genus	Liver toxins			Neurotoxins			Skin toxins		
	MC	NOD	CYN	ATX	STX	GTX	LTX	DAT	AT
Anabaena	X[4]		X[5]		X[6]				
Anabaenopsis	X[7]								
Anagnostidinema[8] (prev. *Geitlerinema*)	X[9]				X[6]				
Aphanizomenon			X[10]	X*[11,12]	X[13,14]				
Aphanocapsa	X[15]								
Chrysosporum			X[16]						
Coelosphaerium	O[17]								
Cuspidothrix[18] (prev. *Aphanizomenon*)				X[19]	X[20]				
Cylindrospermum				X[11]	X[6]				
Dolichospermum[21] (prev. *Anabaena*)	X[22]		X[5]	X[13]	X[23]	X[3]			
Fischerella	X[24]								
Geitlerinema	X[9]			X[9]	X[6]				
Gloeotrichia	X[25]								
Hapalosiphon	X[26]								
Iningainema		X[27]							
Kamptonema				X[28]					
Leptolyngbya	X[4]								
Limnospira[29] (prev. *Arthrospira*)	X[30]			X[30]					
Limnothrix	X[31]				X[32]				
Merisimopedia	X[33]								
Microseira wollei[34] (prev. *Lyngbya*)			X[35]		X[36,37]				

https://drive.google.com/file/d/1jSK9zEW-POTlLXB0S60KQB7ksNEvc0nP/view

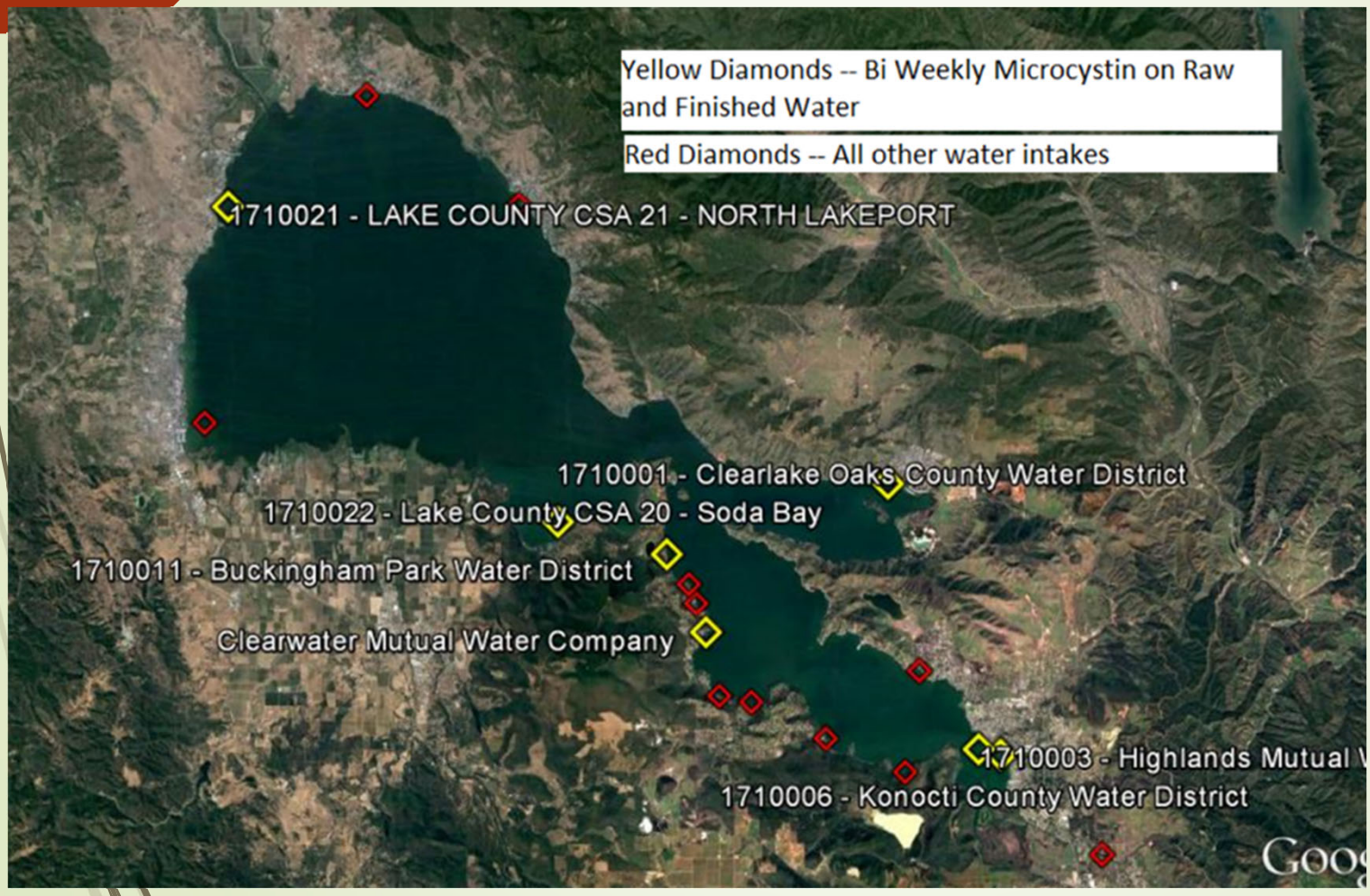
Cyanobacteria and Known Toxins

Cyanotoxins' Impacts on Beneficial Uses



HUMAN EXPOSURE

Cyanotoxins' Impacts on Beneficial Uses



DRINKING WATER

Clear Lake surface water serves approximately 60% of Lake County residents.

The Safe Drinking Water Act currently has guidelines on cyanotoxins

Cyanotoxins' Impacts on Beneficial Uses

FISH CONSUMPTION

INVENTORY NAME	SITE ID	DATE COLLECTED (see seasonal color chart at bottom of spreadsheet)	SPECIES NAME *species are categorized by different colors	Microcystin RESULT TISSUE (ng/g)	Microcystin RESULT LIVER (ng/g)
83	M4	4/21/2015	CRAYFISH	5.94	
84	609	4/22/2015	BLACK CRAPPIE	4	59.75
85	762	4/23/2015	TULE PERCH	3.02	6.18
86	609	4/22/2015	TULE PERCH	4.56	ND
87	AC1	3/25/2010	HITCH	13.34 ☆	52.42
88	AC1	3/25/2010	HITCH	16.5 ☆	10.89
89	AC1	3/25/2010	HITCH	9.08	1.65
90	AC1	MAY, 2010	HITCH	8.47	7.51
91	215	5/26/2015	LM BASS	1.94	8.04
93	BVCL6	12/12/2017	MUSSEL	28.6 ☆	
100	BVCL6	12/12/2017	MUSSEL	17.25 ☆	
101	BVCL6	12/12/2017	MUSSEL	15.21 ☆	
103	CP	12/14/2017	MUSSEL	12.73 ☆	
104	CP	12/14/2017	MUSSEL	19.53 ☆	
105	CP	12/14/2017	MUSSEL	22.95 ☆	

Table 12: Sport Fish and Shellfish Action Levels for Consumption (ng/g, ww[1])

	Microcystins	Anatoxin-a	Cylindrospermopsin
Sport fish tissue level	☆10	5000	70

Fish Cyanotoxin Study, 2016

- Big Valley EPA staff collected 10 fish and shellfish species and submitted them to a lab for microcystin cyanotoxin analysis.
- A total of 44 Clear Lake fish (tissue and liver samples) and 49 Clear Lake shellfish (crayfish and mussels), totaling 126 samples were submitted in February 2018.
  - Multiple species - Tribally important fish
  - All arms of the lake
  - All seasons
- Crappie, blackfish, bluegill, carp, catfish, crayfish, hitch, bass, mussel, tule perch
- Fish from 2010-2018

Clear Lake Cyanotoxin Fish Tissue Testing Results

SEASON	AVERAGE MICROCYSTIN NG/G	COUNT
FALL	12.10	28
SPRING	6.88	35
SUMMER	2.84	15
WINTER	3.51	14

FISH	AVERAGE MICROCYSTIN IN TISSUE NG/G	COUNT
CRAPPIE	4.15	8
BLACKFISH	6.91	1
BLUEGILL	ND	2
CARP	13.60	2
CATFISH	2.02	6
CRAYFISH	4.19	23
HITCH	9.81	8
BASS	1.85	7
MUSSEL	10.33	26
TULE PERCH	2.99	9
all fish species	5.90	43
all shellfish species	7.26	49

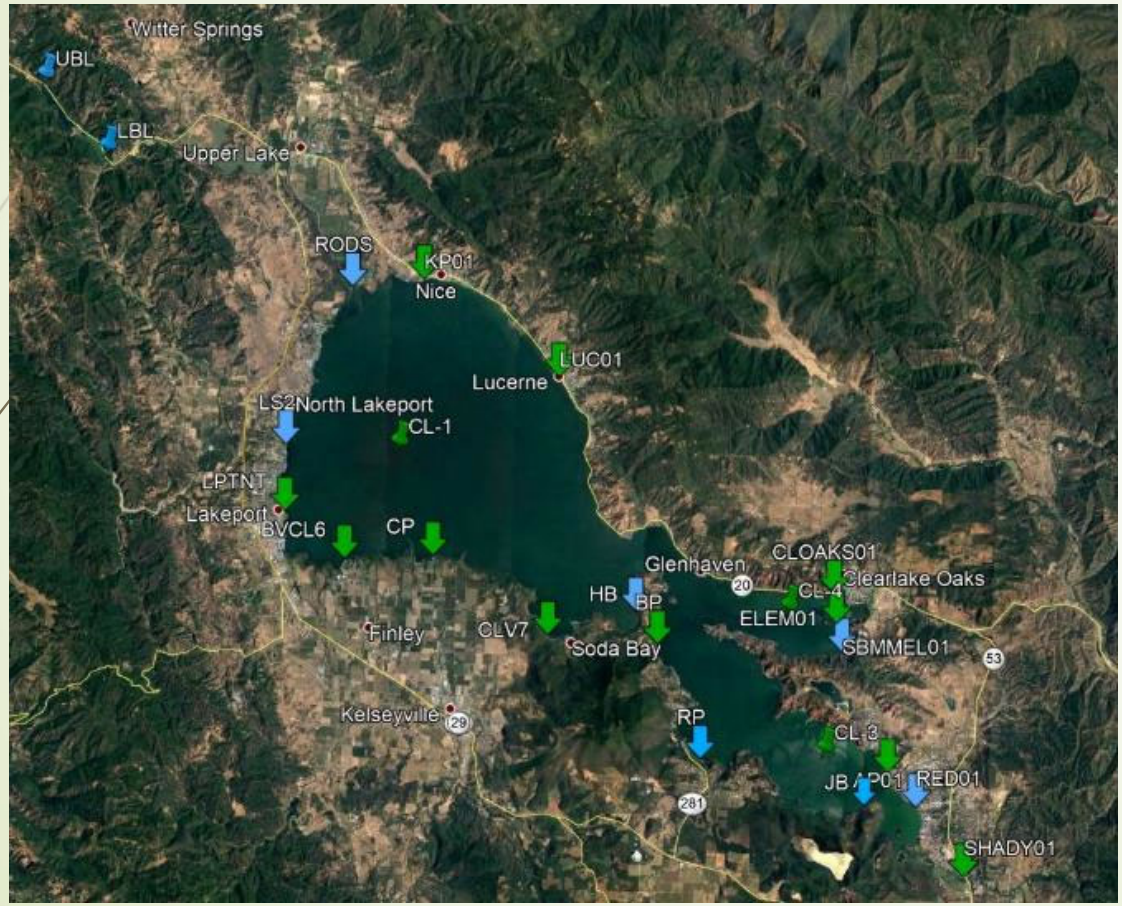
YEAR OF SAMPLE	AVERAGE MICROCYSTIN NG/G	COUNT
2010	11.85	4
2015	5.34	32
2017	10.69	42
2018	3.51	14

ARM OF LAKE	AVERAGE MICROCYSTIN NG/G	COUNT
LOWER	2.02	4
OAK	2.85	14
UPPER	8.21	74

Clear Lake Cyanobacteria Monitoring Program

- 2014: Tribes wanted more info on blooms, realized they had to start the program.
- Big Valley Band of Pomo Indians, Elem Indian Colony already had established water monitoring programs and QAPPs so added this element.
- Funding used: CalEPA EJ, BIA Water Resources, GAP, US Fish and Wildlife.

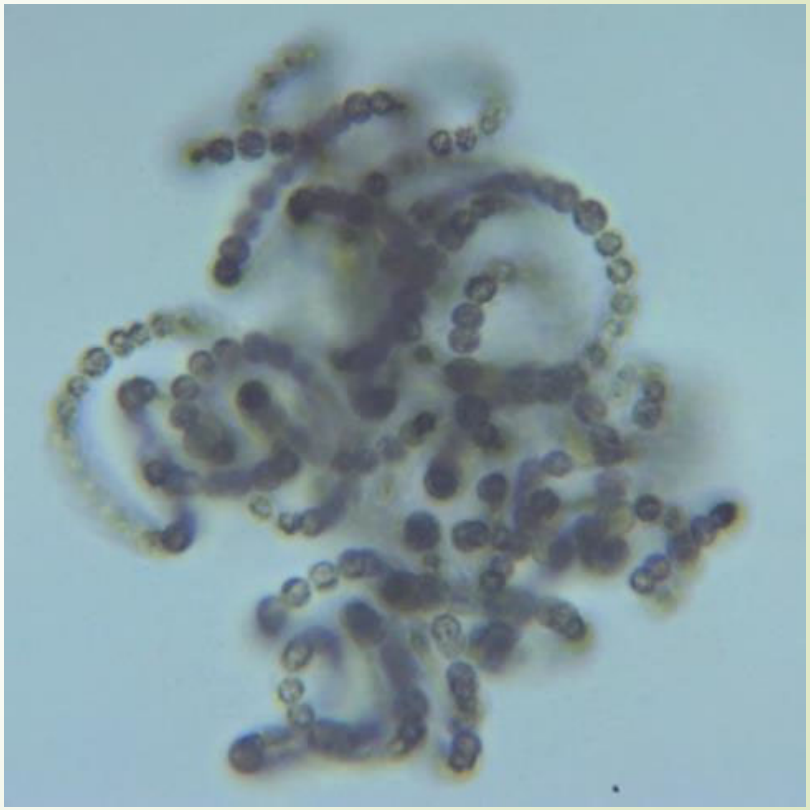
Clear Lake Cyanotoxin Monitoring Locations



- Included 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

Clear Lake Cyanobacteria Task Force

- Local Tribes
- County agencies
- City agencies
- Local elected officials
- US EPA
- CalEPA
- Central Valley Regional Water Quality Control Board
- California Dept of Public Health
- California State Parks, Clear Lake

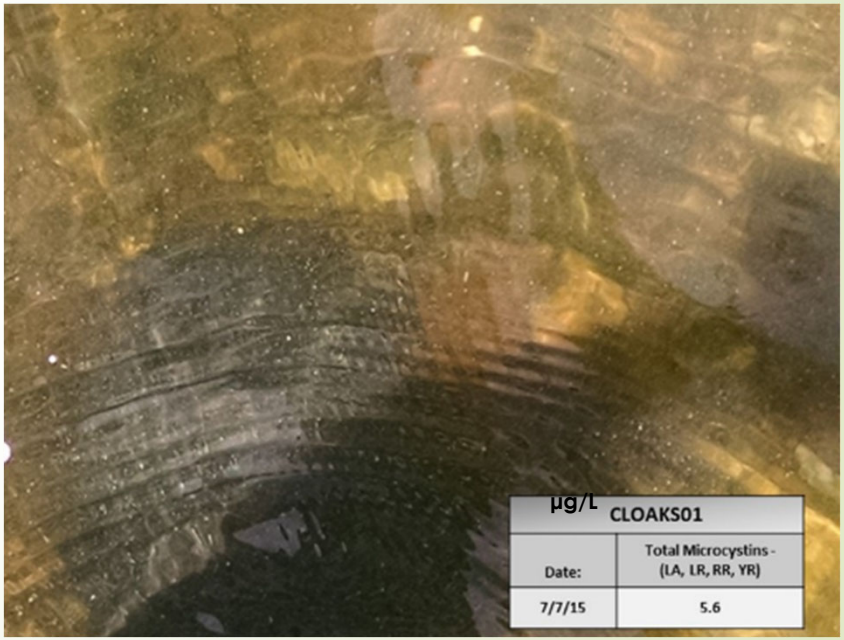


Educating the Public About Water Quality Conditions

Research from Tribal Work on Clear Lake

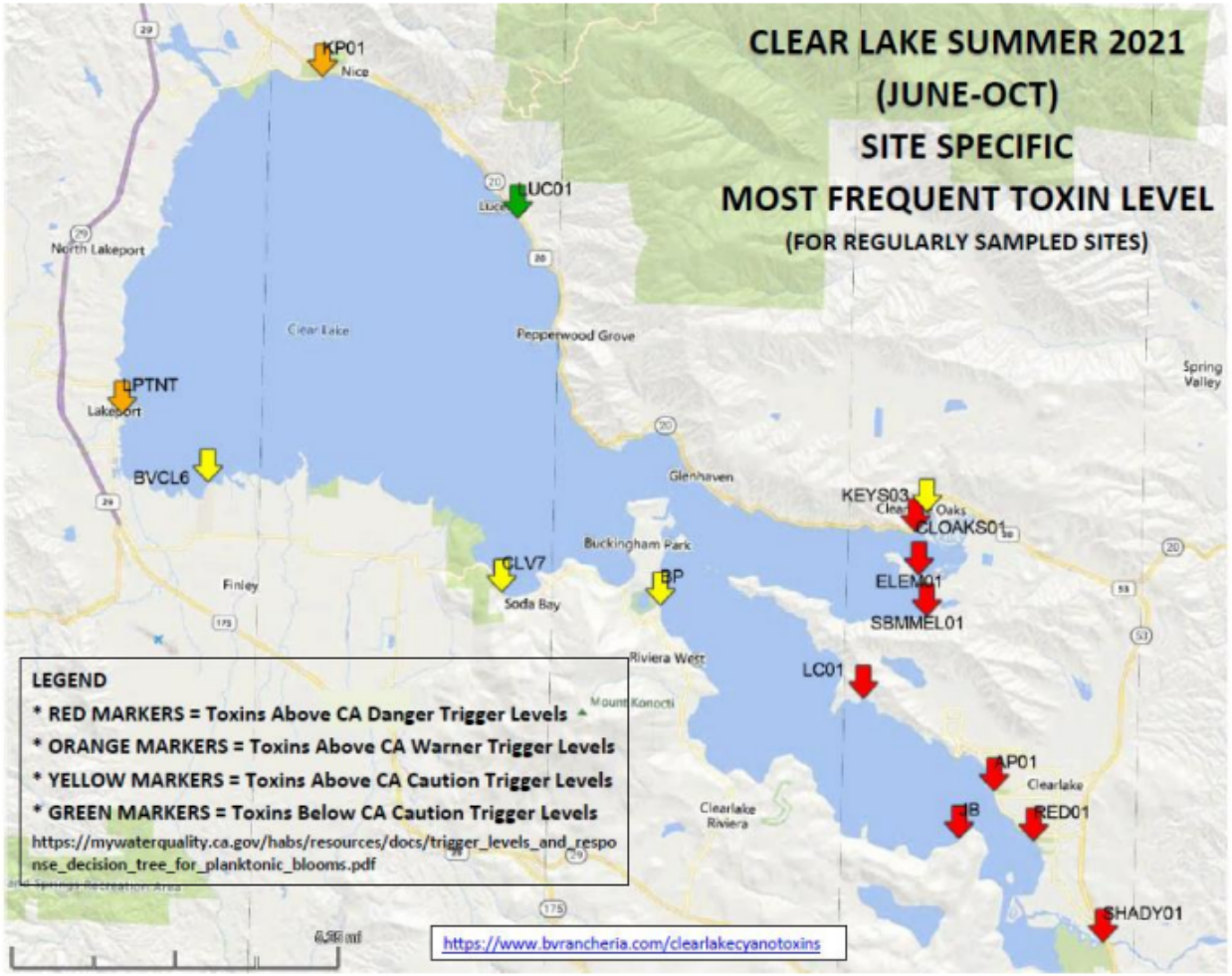
Evidence of bloom and low toxin levels

No evidence of bloom and caution toxin levels



Toxins can be present with no obvious bloom. Widespread blooms don't always have elevated toxin levels.

Identifying Trends For Toxin Levels



Ongoing Review of Conditions for the Tribe and Community

Summer 2021 Most Sampled Sites Percentage of Times at Elevated Toxin Levels

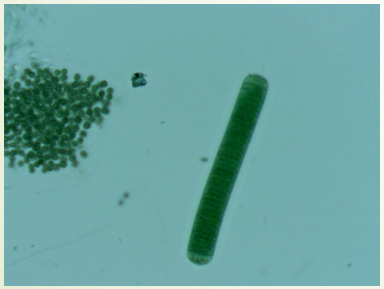
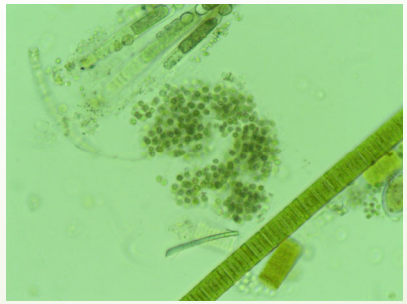
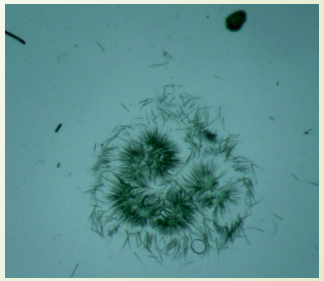
SITE ID	ARM	6/21	7/14	7/28	8/11	8/25	9/7	9/21	10/12	10/26	CAUTION	WARNING	DANGER	% OF SAMPLING EVENTS AT C/W/D
AP01	L	CAUTION	CAUTION	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	22%	22%	56%	100%
BP	L	CAUTION	CAUTION	CAUTION	WARNING	CAUTION	CAUTION	DANGER	WARNING	WARNING	56%	33%	11%	100%
BVCL6	U	NONE	NONE	CAUTION	NONE	CAUTION	CAUTION	CAUTION	NONE	NONE	44%	0%	0%	44%
CLOAKS01	O	CAUTION	NONE	WARNING	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	11%	33%	44%	89%
CLV7	U	CAUTION	NONE	NONE	CAUTION	CAUTION	DANGER	CAUTION	NONE	NONE	44%	0%	11%	56%
ELEM01	O	DANGER	CAUTION	DANGER	DANGER	DANGER	CAUTION	CAUTION	DANGER	N/A	38%	0%	63%	100%
JB	L	CAUTION	WARNING	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	CAUTION	22%	33%	44%	100%
KEYS03	O	WARNING	WARNING	CAUTION	DANGER	CAUTION	CAUTION	N/A	N/A	NONE	43%	29%	14%	86%
KP01	U	CAUTION	NONE	WARNING	WARNING	CAUTION	WARNING	CAUTION	NONE	NONE	33%	33%	0%	67%
LC01	L	WARNING	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	WARNING	WARNING	0%	56%	44%	100%
LPTNT	U	NONE	CAUTION	WARNING	DANGER	DANGER	WARNING	WARNING	CAUTION	CAUTION	33%	33%	22%	89%
LUC01	U	NONE	NONE	NONE	CAUTION	NONE	CAUTION	NONE	NONE	NONE	22%	0%	0%	22%
RED01	L	WARNING	DANGER	WARNING	WARNING	DANGER	DANGER	DANGER	DANGER	DANGER	0%	33%	67%	100%
SBMMEL01	O	CAUTION	CAUTION	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	22%	11%	67%	100%
SHADY01	L	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	DANGER	WARNING	NONE	0%	11%	78%	89%

Cal-WATCH Program: Testing of Private Taps

- Cal-WATCH = California Water: Assessment of Toxins for Community Health
  - CDC grant awarded to Tracking California/Public Health Institute
  - Collaboration with Big Valley Band of Pomo Indians and
    - California Dept. of Public Health (Env. Health Investigations and Env. Health Lab)
    - Office of Environmental Health Hazards Assessment
    - State Water Resources Control Boards
    - California's Environmental Laboratory Capacity Building Grant at Heluna Health
  - Five year, multi component award for environmental health capacity building

Results of Summer Testing for Cyanobacteria

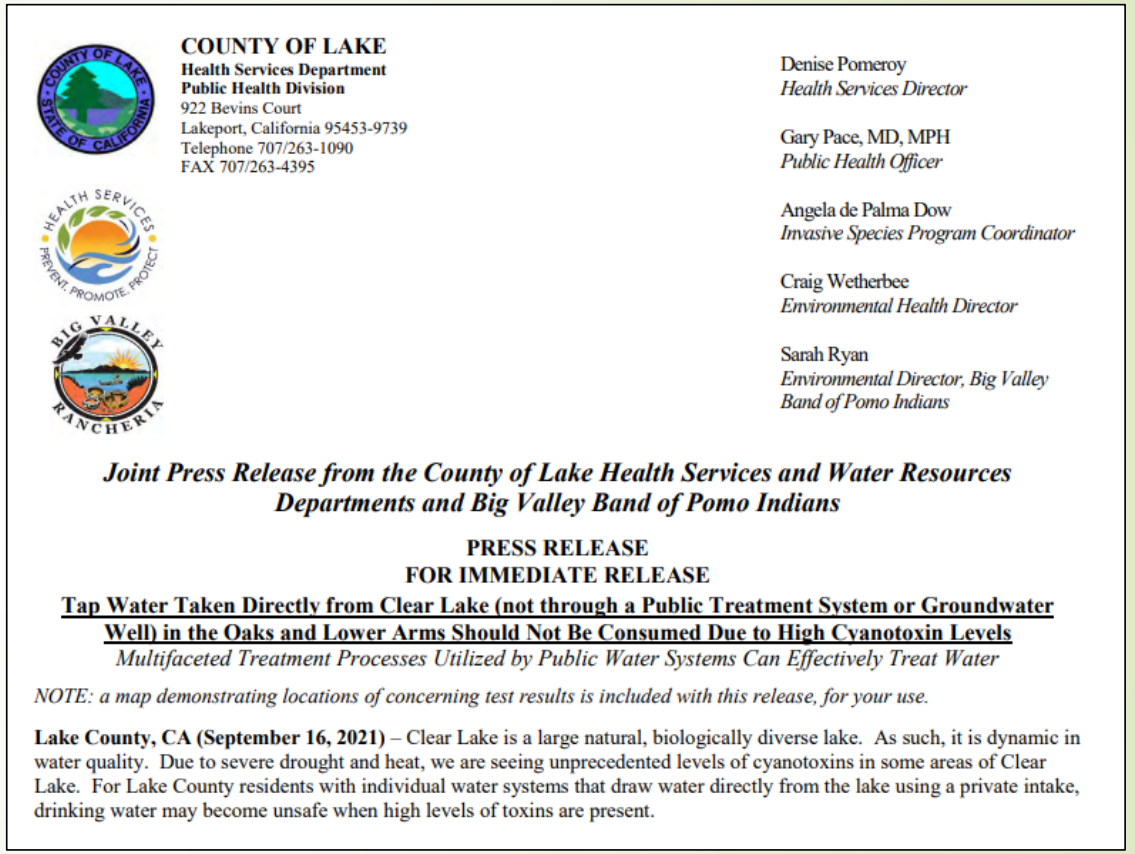
- June-October 2021, self supplied (private) tap water from 36 homes collected and analyzed.
- Microscopy identified *Microcystis, Gloeotrichia, Kamptonema spp*. in samples.
- Of the 36 homes, 20 had detectable microcystin in them, with 13 homes above the US EPA Health Advisory of 0.3 µg/L. The highest value in the tap water was 3.85 µg/L.
- Ambient lake microcystin levels reached 160,378 µg/L during September.

Photos from tap water samples from private intakes, Clear Lake

Public Health Advisory

Presence of cyanotoxins and cyanobacteria in tap water from privately supplied tap water in Clear Lake led to a Public Health Advisory from September 16- November 16th, lifted with improved lake conditions.



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Joint Press Release from the County of Lake Health Services and Water Resources Departments and Big Valley Band of Pomo Indians

PRESS RELEASE
FOR IMMEDIATE RELEASE

Tap Water Taken Directly from Clear Lake (not through a Public Treatment System or Groundwater Well) in the Oaks and Lower Arms Should Not Be Consumed Due to High Cyanotoxin Levels

Multifaceted Treatment Processes Utilized by Public Water Systems Can Effectively Treat Water

NOTE: a map demonstrating locations of concerning test results is included with this release, for your use.

Lake County, CA (September 16, 2021) – Clear Lake is a large natural, biologically diverse lake. As such, it is dynamic in water quality. Due to severe drought and heat, we are seeing unprecedented levels of cyanotoxins in some areas of Clear Lake. For Lake County residents with individual water systems that draw water directly from the lake using a private intake, drinking water may become unsafe when high levels of toxins are present.

Additional HAB related projects

- "Monitoring and Adaptation to Conserve Clear Lake Cultural Keystone Species" – funded by Southwest Climate Adaptation Science Center:
  - tule restoration, tule habitat inventory, tule replanting
  - Clear Lake hitch monitoring, analyze for methylmercury and cyanotoxin analysis
  - Clear Lake water monitoring using time series sondes located several hundred feet of the shoreline, to monitoring water chemistry, cyanobacteria pigment and chlorophyll a.
- "Data-Driven Planning for Multi-Species Climate Resiliency on Clear Lake" – funded by California Resilience Challenge
  - tule testing, fish/shellfish tissue testing, mudhen testing of methylmercury and cyanotoxins

Next Steps

- Using data to help drive the management of natural resources
- Co management of local natural resources
- Ongoing tissue and water testing for cyanotoxins and other contaminants to provide relevant and timely information

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