# Tribal Water Quality and Cyanotoxins: Leading a Multi-Jurisdictional Monitoring Program







SARAH RYAN, BIG VALLEY BAND OF POMO INDIANS

LAKE COUNTY FISH AND WILDLIFE ADVISORY COMMITTEE, 10/25/18

## Clear Lake Cyanobacteria Monitoring Program

- 2014: Tribes wanted more info on blooms, realized they had to do it.
- 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.





## What are Cyanobacteria?

- "Blue Green Algae"
- Marine or freshwater.
- Bacteria. 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"



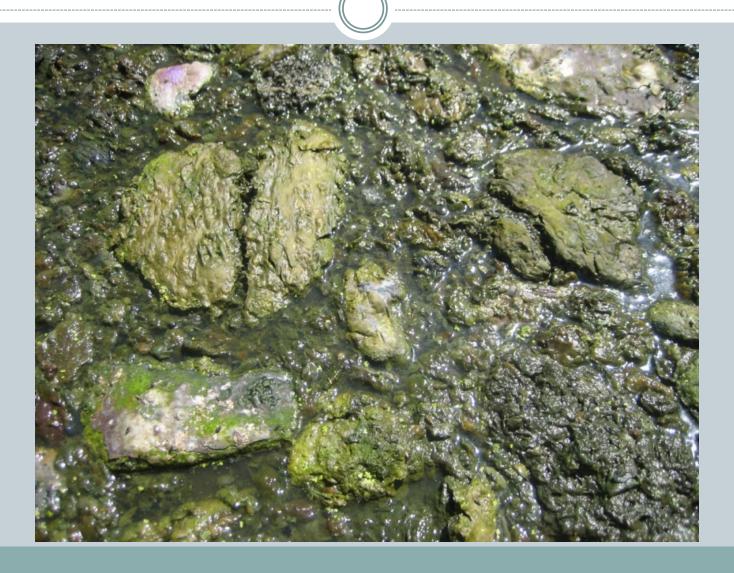


## Cyanobacteria Impacts

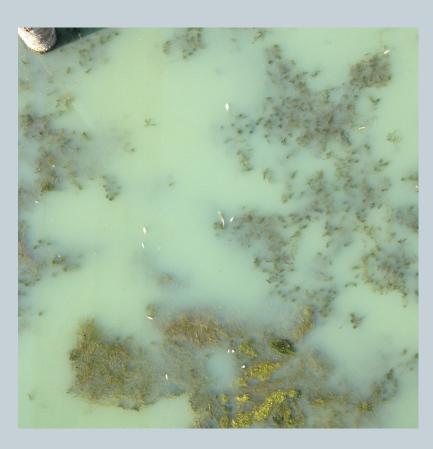
- Bloom proliferation reduced sunlight in water column, impacting plant growth
- Dying blooms → oxygen depletion → fish kills
- Questions about water safety
- Strong odor, visually unpleasing
- Increased filtration and treatment costs for drinking water systems



## Lyngbya Cyanobacteria Bloom, Clear Lake 2009

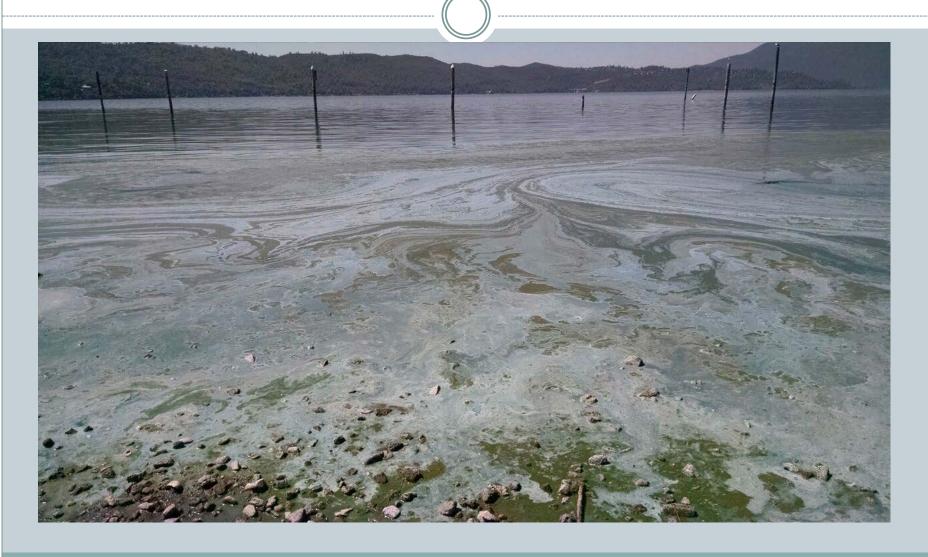


## Clear Lake Cyanobacteria Bloom and Fish Kill, September 2014

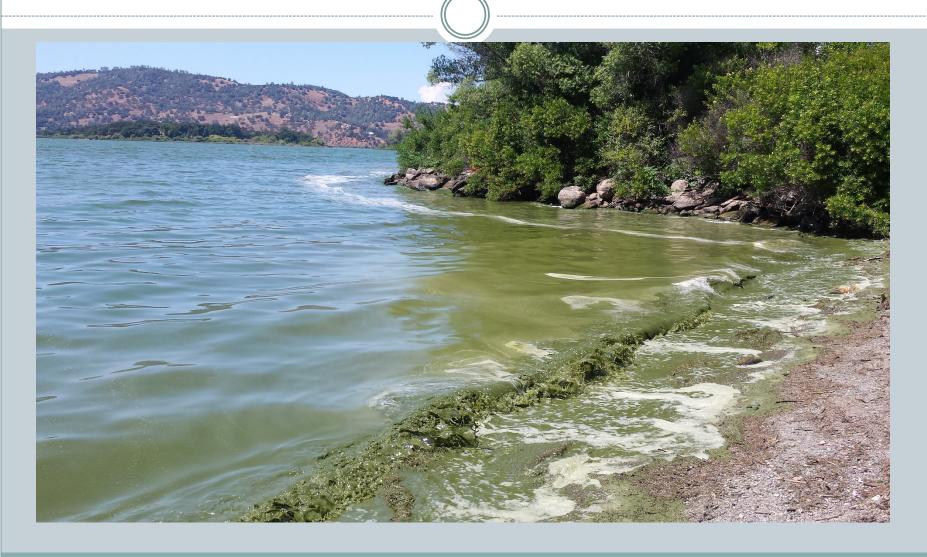




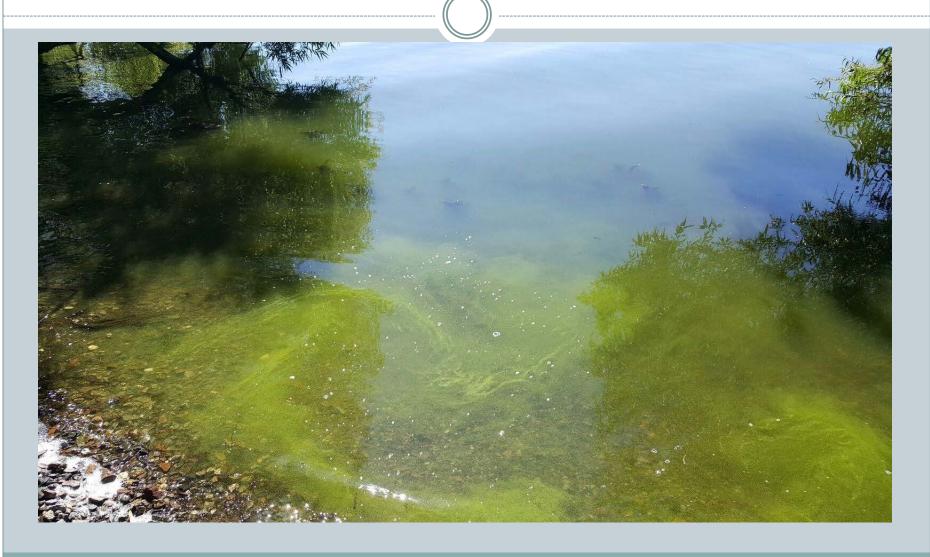
## Clear Lake Cyanobacteria Bloom, September 2014



## Clear Lake Cyanobacteria Bloom, July 2015



## Clear Lake Cyanobacteria Bloom, August 2017



## Dolichospermum, Clear Lake, May 2016



## Anabaenopsis, Clear Lake, July 2016



## Dolichospermum, Clear Lake, May 2017



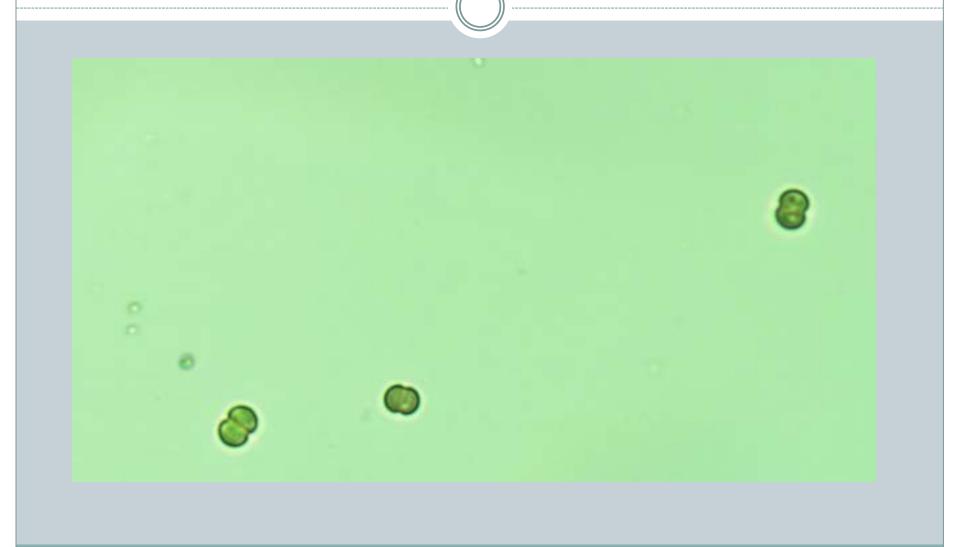
## Aphanizomenon, Clear Lake, June 2017



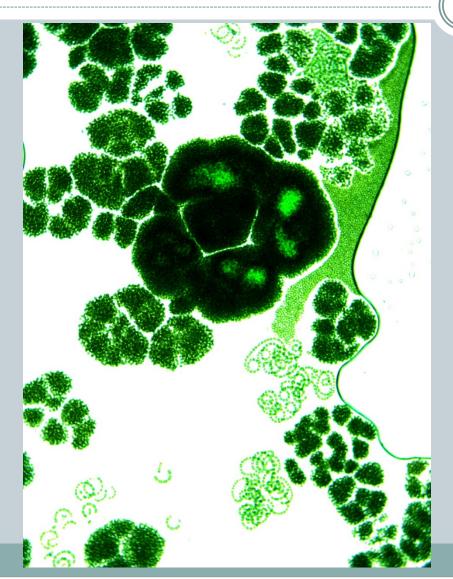
## Dolichospermum, Clear Lake, July 2017

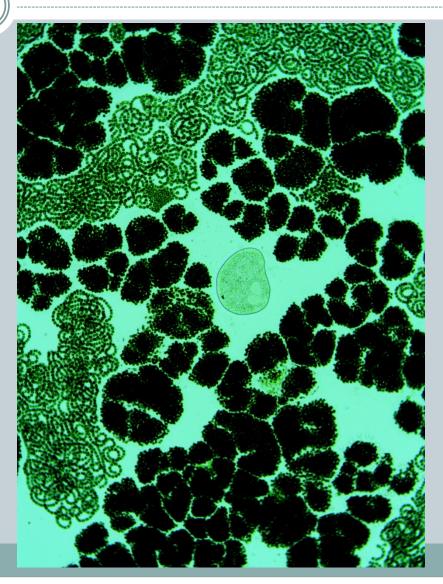


## Synechosystis, Clear Lake, August 2017



## Microcystis and Dolichospermum, Clear Lake, August 2018





## What Are Cyanotoxins?

- Produced by some cyanobacteria
- Exposure from contact, ingestion of mats/water/fish;
- Can cause illness/death in animals/humans.
- Field kits can detect presence, lab analysis to confirm.
- Blooms don't always produce cyanotoxins, clear water isn't always cyanotoxin free.
- Require special treatment to be removed from drinking water.
- Federal and state recommendations for waterbodies with cyanotoxins.

#### **CAUTION**

Harmful algae may be present in these waters. For your family's safety:





**DO NOT** let pets or livestock go into or drink the water, or eat scum on the shoreline.

#### **WARNING**

Toxins from algae in these waters can harm people and kill pets and livestock



NO SWIMMING



DO NOT let pets or livestock go into or drink the water, or go





Toxins from algae in these waters can harm people and kill pets and livestock



STAY OUT OF THE WATER UNTIL FURTHER NOTICE. Do not touch scum in the water or on shoreline.



**DO NOT** let pets or livestock drink or go into the water or go near the scum.



DO NOT eat fish or shellfish from these waters.



**DO NOT** use these waters for drinking or cooking. Boiling or filtering will not make the water safe.







Call yo



ANIMAL DEATHS

HOME / SCIENCE / EARTH/ENVIRONMENT

## Clear Lake contaminated by algae in potentially hazardous bloom



7 September 2014, 10:12 am EDT By James Maynard Tech Times

LOCAL NEWS

Toxin known to kill dogs within 30 minutes found in several California lakes, rivers

NOAA Fisheries mobilizes to gauge unprecedented West

Coast toxic algal bloom

Offshore survey will measure extent and severity of largest harmful algal bloom in more than a decade

June 2015

Contributed by Michael Milstein

NATIONAL GEOGRAPHIC

New Diseases, Toxins Harming Marine Life

Dolphins, other marine mammals weakened by pollution, scientists say.

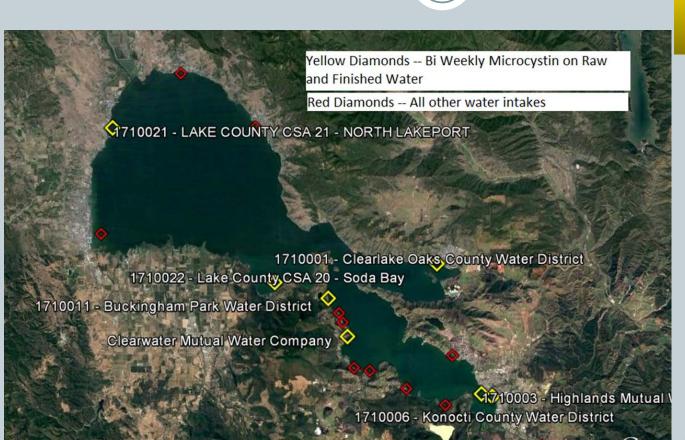


## **EXPOSURE**









Surface Water Public Water Systems, Clear Lake

## DRINKING WATER

Clear Lake surface water serves 65% of Lake County residents.

The Safe
Drinking Water
Act currently
does not have
standards on
cyanotoxins but
does have
guidelines



## FISH CONSUMPTION





		DATE COLLECTED	SPECIES NAME		
INVENT		(see seasonal	*species are	Microcystin	Microcystin
ORY	SITE ID	color chart at	categorized by	RESULT TISSUE	RESULT LIVER
NAME		bottom of	different	(ng/g)	(ng/g)
~	~	spreadsheet) ▼	colors ▼	Ţ,	▼.
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	нітсн	13.34 🏠	52.42
88	AC1	3/25/2010	нітсн	16.5 🤺	10.89
89	AC1	3/25/2010	нітсн	9.08	1.65
90	AC1	MAY, 2010	нітсн	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	СР	12/14/2017	MUSSEL	22.95	

Table 12: Sport Fish and Shellfish Action Levels for Consumption (ng/g, ww¹)

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

## California Cyanotoxin Guidelines

#### Action levels for selected scenarios

	Microcystins <sup>1</sup>	Anatoxin-a	Cylindro- spermopsin	Media (units)
Human recreational uses <sup>2</sup>	0.8	90	4	Water (µg/L)
Human fish consumption	10	5000	70	Fish (ng/g) ww³
Subchronic water intake, dog4	2	100	10	Water (μg/L)
Subchronic crust and mat intake, dog	0.01	0.3	0.04	Crusts and Mats (mg/kg) dw <sup>5</sup>
Acute water intake, dog6	100	100	200	Water (µg/L)
Acute crust and mat intake, dog	0.5	0.3	0.5	Crusts and Mats (mg/kg) dw <sup>5</sup>
Subchronic water intake, cattle <sup>7</sup>	0.9	40	5	Water (µg/L)
Subchronic crust and mat intake, cattle <sup>7</sup>	0.1	3	0.4	Crusts and Mats (mg/kg) dw <sup>5</sup>
Acute water intake, cattle7	50	40	60	Water (µg/L)
Acute crust and mat intake, cattle <sup>7</sup>	5	3	5	Crusts and Mats (mg/kg) dw <sup>5</sup>

'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

## Cyanobacteria and Known Toxins

Cyanobacteria		Cyanotoxin Class									
Genus	CYL	MC	NOD	ATX	SAX	NEO	LYN	BMAA	DAT	APL	Neurotoxins
Anabaenopsis		1									
Aphanizomenon	1	1	1	1	1	1		1			<b>Dermatoxins</b>
Aphanocapsa		/									
Calothrix		1						1			Hepatotoxins
Coelomoron		1									Tiepatotoxiiis
Coelosphaerium		1									
Cylindrosperm- opsis	1	1		1	1			1			
Cylindrospermum		1		/	1						
Dolichospermum (Anabaena)	1	1		/	1	1		1			
Fischerella		1									
Geitlerinema		1			1						
Gloeotrichia		1									

https://drive.google.com/file/d/0B40pxPC5g-D0RWtJZVIoUnhnWm8/view

## **Continually Developing Program**

#### 2014

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

#### 2015

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

Saxitoxin



#### Big Valley Rancheria Environmental Protection Department Abraxis Test Strip Results

Title of the sampling event: CyanoHUB Clear Lake Sampling
PROJECT ID: HAB
Analyte: Microcysmic

Date: 8/07/18

Test Start Time: 5:15 Pm
Test End Time: 6:30 ?m

Activity ID	Site ID	Test Strip	Result (ppb)	Comments
	ELEmo)	Strome Prisons Region Assess Assess  1 Maryon Strome Region Assess Assess  2 Maryon Strome Region Assess  Assess Strome Region Assess  Assess Strome Region Assess  Assess Strome Region Assess  Assess Strome Region Assess	0	
	58mmelo,	* Totally retain freque Andrew Avenue Area Avenue	≥10	
	APOI	Zerma Alegin Alexan Arigan Adapt  * Alexan Arigan Alexan Arigan Adapt  * Arican Arigan Arigan Arigan  * Arican Arigan Arigan Arigan  * Arican Arigan Arigan Arigan  **Arican Arigan Arigan Arigan  **Arigan Arigan Arigan  **A	≥/0	
	REPO!	E Fallant Fallant Fallant Fallant Fallant FA	≥10	
	SHAPYO)	E TATIONE PRODUCT PROD	≥10	
705	RF	# Alternation Advanta, Princips Astronomy	0	
708	CLV7	Whiten Army Army Krisel N.  - The Army Army Army N.  - The Army Army N.  - The Army Army Army N.  - The Army Army N.  - The Army Army N.  - The Ar	1	
709	CP	Seguith Angeles Adequate Adequ	5	
-				

For additional information see the Sampling Event Log

Updated Oct 2017

## **Continually Developing Program**

#### 2016

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

#### 2017

- Other waterbodies in County
- qPCR analysis (toxin producing genes)



#### **Bend Genetics, LLC**

87 Scripps Drive, Ste. 301 Sacramento, CA 95825 Tel: (916) 550-1048 Project: Big Valley Rar

Analysis for T

Project #:

Reported: 7/19/2018 11:

#### SAMPLE RESULTS

				Quantitation	
Sample ID	Method	Target	Result	Limit	Units
702-KP01	QPCR	Anatoxin-a	ND	100	copies/mL
702-KP01	QPCR	Cylindrospermopsin	ND	100	copies/mL
702-KP01	QPCR	Microcystin	84,317	100	copies/mL
702-KP01	QPCR	Saxitoxin	ND	100	copies/mL
703-RP	QPCR	Anatoxin-a	ND	100	copies/mL
703-RP	QPCR	Cylindrospermopsin	ND	100	copies/mL
703-RP	QPCR	Microcystin	354,656	100	copies/mL
703-RP	QPCR	Saxitoxin	ND	100	copies/mL

## Continually Developing Program



#### 2018

- Analysis of fish and shellfish for Microcystin
- Began collaboration with CA
   DWR to get water samples
   from interior of lake
- Tribal data URL is installed on county signs, county press releases

www.bvrancheria.com/clearlakecyanotoxins











#### Welcome to Lake County

Be advised that Blue-Green Algae (Cyanobacteria) are in many lakes and streams, and some produce toxins that can harm humans and animals

#### BE ALERT and AVOID WATER THAT:

- Looks like spilled paint, has surface scum, mats or films
- Has green globs floating below the surface

BE ADVISED toxins may be present even if there are no visible signs

DO NOT DRINK water directly from the lake
DO NOT ALLOW children or pets to swim where Blue-Green Algae
(Cyanobacteria) are present

RINSE OFF AFTER being in the water, shower with clean water, wash hands, and rinse off your pets thoroughly

Take appropriate precautions for people and pets while having fun on the water

Current Toxin Levels: <a href="http://www.bvrancheria.com/clearlakecyanotoxins">http://www.bvrancheria.com/clearlakecyanotoxins</a> Information or Report a Bloom: <a href="http://www.mywaterquality.ca.gov/habs/">http://www.mywaterquality.ca.gov/habs/</a> Call Local County Departments:

Water Resources (707) 263-2344 or Environmental Health (707) 263-1164











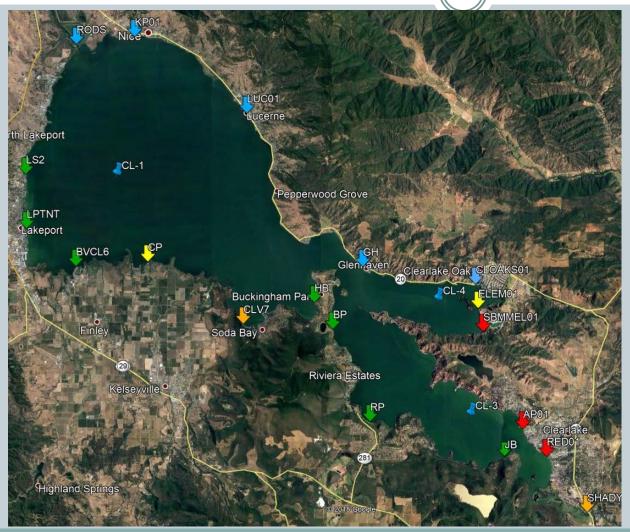


## Clear Lake Cyanobacteria Task Force

- Local Tribes: Big Valley, Elem, Scotts Valley, Upper Lake, Robinson
- County agencies: Lake County Water Resources, Environmental Health, Public Health
- City agencies: City of Lakeport, City of Clearlake
- Local elected officials: Lake County, Cities of Lakeport and Clearlake
- US EPA: Region 9 Water and Tribal Programs, Research Triangle
- CalEPA: SWRCB, OEHHA, Division of Drinking Water
- Regional water quality: Central Valley Regional Water Quality Control Board
- California Dept of Public Health
- California State Parks, Clear Lake



## Clear Lake Cyanotoxin Monitoring Locations



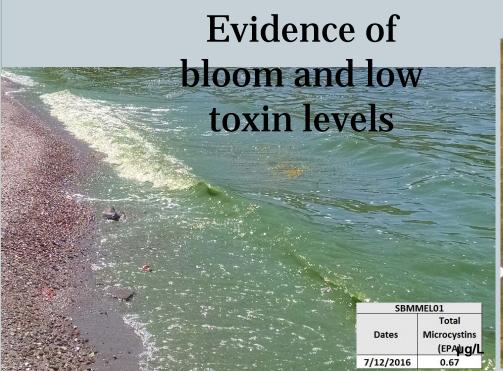
- Included locations that are Tribally important
- Monitoring to coincide with important dates of Tribal uses of the water
- Communicate
   with Tribes and
   the public about
   the results

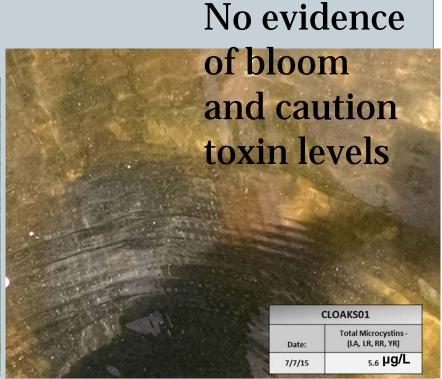
## Educating the Public About Water Quality Conditions





### Research from Tribal Work





Toxins can be present with no obvious bloom. Widespread blooms don't always have elevated toxin levels. We have many pictures of instances of this.

### Research from Tribal Work

Cyanotoxin	Monitoring Sites	Cell ID		Field Results					
Site ID	Dates	Dominant Genus	Chlorophyll-a (μg/L)	Phycocyanin (μg/L)	phyco/chloro- a ratio	Total Microcystins (EPA)			
BVCL6	6/14/2016	anabaenopsis	26.45	10.97	0.4	ND			
	8/23/2016	anabaena	65.2	118.6	1.8	0.11			
CLV7	6/27/2016	anabaena	35.22	627	17.8	0.34			
	8/23/2016	anabaena (v. small	84.53	100.51	1.2	ND			
LPTNT	6/14/2016	anabaenopsis	15.74	7.97	0.5	ND			
	8/23/2016	anabaena	249.8	277.55	1.1	ND			
RODS	6/14/2016	anabaena	39.77	16.32	0.4	ND			
	8/23/2016	-	99.4	95.2					

Lowest (green cells) and highest (red cells) phycocyanin measurement per site in 2016

Reviewing bloom conditions and toxins against phycocyanin/chlorophyll-a ratios

### How Often Did Clear Lake Cyanotoxin Monitoring Sites Exceed the Microcystin Threshold for Potential Health Risks?

0.8 micrograms per Liter (µg/L) is the CCHAB recommendation for public notification of microcystin cyanotoxins at potential health risk levels

http://www.mywaterquality.ca.gov/monitoring\_council/cyanohab\_network/docs/triggers.pdf

		0.8 μg/L EACH YEAR				ΑT	MICROCYST EACH SITE is highest v each	EACH YEAR	*
SAMPLING SITE ID	ARM OF LAKE	2014	2015	2016	2017	2014	2015	2016	2017
BVCL6	U	17%, n=6	<b>0%,</b> n=20	<b>0%,</b> n=9	<b>0%,</b> n=8	1.2	ND	0.14	0.21
CLV7	U	86%, n=7	<b>0%,</b> n=13	<b>0%,</b> n=9	13%, n=8	105	ND	0.34	3.5
M4	U	33%, n=6	0%, n=14	not sampled	not sampled	8.3	ND	not sampled	not sampled
LPTNT	U	83%, n=6	<b>0%,</b> n=12	<b>0%,</b> n=9	0%, n=8	877.6	ND	0.17	0.14
RODS	U	not sampled	0%, n=12	<b>0%,</b> n=9	0%, n=8	not sampled	ND	0.15	0.11
СР	U	not sampled	0%, n=11	<b>0%,</b> n=9	<b>0%,</b> n=9	not sampled	ND	0.16	ND
LS	U	not sampled	0%, n=11	<b>0%,</b> n=9	not sampled	not sampled	Trace	0.11	not sampled
LS2	U	not sampled	not sampled	not sampled	<b>0%,</b> n=3	not sampled	not sampled	not sampled	0.12
LUC01	U	<b>67%,</b> n=6	0%, n=13	<b>0%,</b> n=9	<b>0%,</b> n=8	13	ND	0.14	ND
НВ	U	not sampled	<b>0%,</b> n=9	<b>0%,</b> n=8	0%, n=8	not sampled	Trace	0.12	0.35
KP01	U	not sampled	0%, n=12	<b>0%,</b> n=9	0%, n=8	not sampled	ND	0.15	0.34
ELEM01	0	50%, n=4	29%, n=14	not sampled	0%, n=7	4.4	18.7	not sampled	0.38
SBMMEL01	0	100%, n=7	20%, n=10	<b>0%,</b> n=9	25%, n=8	5,311.70	278	0.67	2.4
CLOAKS01	0	100%, n=7	31%, n=16	<b>0%,</b> n=9	13%, n=8	16,920	21	0.16	46.00
GH	0	not sampled	not sampled	not sampled	0%, n=6	not sampled	not sampled	not sampled	0.2
BP	L	not sampled	27%, n=11	<b>0%,</b> n=9	13%, n=8	not sampled	9.4	0.16	1.3
RP	L	not sampled	33%, n=10	<b>0%,</b> n=9	13%, n=8	not sampled	134	0.13	1.2
SHADY01	L	not sampled	40%, n=10	<b>0%,</b> n=9	0%, n=8	not sampled	36.1	0.34	0.39
RED01	L	not sampled	33%, n=12	<b>0%,</b> n=9	0%, n=8	not sampled	65.5	0.28	0.44
AP01	L	<b>100%,</b> n=9	41%, n=17	<b>0%,</b> n=9	<b>0%,</b> n=9	769.2	10,162	0.21	0.52
JB	L	not sampled	not sampled	0%, n=9	0%, n=8	not sampled	not sampled	0.19	0.34
n = number of til	nessam	pled							
*= in µgiL									

# Research From Tribal Work

Identifying health threshold exceedances on Clear Lake, 2014-2017

## 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.

## Fish Cyanotoxin Study, 2016

- 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

## Tissue Cyanotoxin Results

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

## Seasonal Cyanotoxin Results

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

## **Location Cyanotoxin Results**

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

		0.8 μg/L	S EACH SITE EACH YEAR ION THRESH ICYSTIN)	HIGHEST MICROCYSTIN LEVEL RECORDED  AT EACH SITE EACH YEAR *  Red cell is highest value for Clear Lake  each year				
ARM OF LAKE	2014	2015	2016	2017	2014	2015	2016	2017
U	17%, n=6	<b>0%,</b> n=20	<b>0%,</b> n=9	0%, n=8	1.2	ND	0.14	0.21
U	86%, n=7	<b>0%,</b> n=13	0%, n=9	13%, n=8	105	ND	0.34	3.5
U	33%, n=6	0%, n=14	not sampled	not sampled	8.3	ND		not sampled
U	83%, n=6	0%, n=12	0%, n=9	0%, n=8	877.6	ND	0.17	0.14
U	not sampled	0%, n=12	0%, n=9	0%, n=8	not sampled	ND	0.15	0.11
U	not sampled	0%, n=11	0%, n=9	0%, n=9	not sampled	ND	0.16	ND
U	not sampled	0%, n=11	0%, n=9	not sampled	not sampled	Trace	0.11	not sampled
U	not sampled	not sampled	not sampled	<b>0%,</b> n=3	not sampled	not sampled	not sampled	0.12
U	<b>67%,</b> n=6	0%, n=13	<b>0%,</b> n=9	0%, n=8	13	ND	0.14	ND
U	not sampled	<b>0%,</b> n=9	0%, n=8	0%, n=8	not sampled	Trace	0.12	0.35
U	not sampled	<b>0%,</b> n=12	<b>0%,</b> n=9	0%, n=8	not sampled	ND	0.15	0.34
0	50%, n=4	29%, n=14	not sampled	0%, n=7	4.4	18.7	not sampled	0.38
0	100%, n=7	<b>20%</b> , n=10	<b>0%,</b> n=9	25%, n=8	5,311.70	278	0.67	2.4
0	<b>100%,</b> n=7	31%, n=16	<b>0%,</b> n=9	13%, n=8	16,920	21	0.16	46.00
0	not sampled	not sampled	not sampled	0%, n=6	not sampled	not sampled	not sampled	0.2
L	not sampled	27%, n=11	0%, n=9	13%, n=8	not sampled	9.4	0.16	1.3
L	not sampled	33%, n=10	<b>0%,</b> n=9	13%, n=8	not sampled	134	0.13	1.2
L	not sampled	<b>40%</b> , n=10	<b>0%,</b> n=9	0%, n=8	not sampled	36.1	0.34	0.39
L	not sampled	33%, n=12	<b>0%,</b> n=9	0%, n=8	not sampled	65.5	0.28	0.44
L	<b>100%,</b> n=9	<b>41%</b> , n=17	0%, n=9	<b>0%,</b> n=9	769.2	10,162	0.21	0.52
L	not sampled	not sampled	<b>0%,</b> n=9	0%, n=8	not sampled	not sampled	0.19	0.34

## **Yearly Tissue Cyanotoxin Results**

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

## Next Steps, Fish Tissue Cyanotoxin Study

- 2018 collection of Clear Lake fish, analysis
- Review of data with OEHHA and development of subsistence consumption levels
- Working with researchers on stability of toxins in fish muscles and organs after cooking
- Working with researchers on bioaccumulation of cyanotoxins in fish tissue

## Questions?

Sarah Ryan,
Deputy Tribal
Administrator/
Environmental Director
Big Valley Band of
Pomo Indians
707-263-3924 x132



