



Cyanobacteria: Their Toxins and Their Impacts to Tribal Water Uses

Being Proactive To Protect Tribal Communities



**Sarah Ryan, Environmental Director
Big Valley Band of Pomo Indians
2018 California Tribal Water Summit
April 4-5, 2018**



WHAT ARE CYANOBACTERIA?

- Formerly known as “Blue Green Algae”
- Marine or freshwater. Oceans, rivers, lakes and reservoirs.
- Naturally occurring water borne bacteria, produce oxygen. Why our atmosphere has oxygen in it.
- Occur when excess nutrient loads including Phosphorus and Nitrogen. Dense mats are called “blooms”.
- Some produce toxins – skin, liver and neural that are harmful to health.
- Harmful Algal Blooms is the term given to these mats that produce cyanotoxins.





CYANOBACTERIA IMPACTS

- As blooms die off, they deplete oxygen, leading to fish kills
- Blooms create questions about safety of being in the water.
- Strong odor, visually unpleasing.
- Bloom proliferation leads to reduced sunlight in water column, impacting plant growth
- Create increased costs for drinking water systems that have to filter for cyanobacteria and treat for their toxins.





WHAT ARE CYANOTOXINS?

- Exposure occurs when cyanotoxins are ingested through water, blooms, fish.
- Can cause illness and death in animals and humans.
- Can't be detected except through lab analysis, some field kits detect presence.
- Blooms don't always produce cyanotoxins, clear water isn't always cyanotoxin free.
- Require special treatment to be removed from drinking water.
- California has developed recommendations for waterbodies with cyanotoxins.

CAUTION

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



DO NOT SWIM OR WADE near algae or scum



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

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at shellfish from rs.



NO SWIMMING



STAY AWAY fr cloudy or discc



DO NOT use th drinking or coc Boiling or filter make the wate

For people, the t
• Skin rashes, eye ir
• Diarrhea, vomitin

Call your doctor or 1 For more information, contact



DO NOT let pets or livestock go

DANGER

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.



CYANOTOXINS' IMPACTS

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

ANIMAL DEATHS

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

New Diseases, Toxins Harming Marine Life

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



CYANOTOXINS' IMPACTS

DRINKING WATER

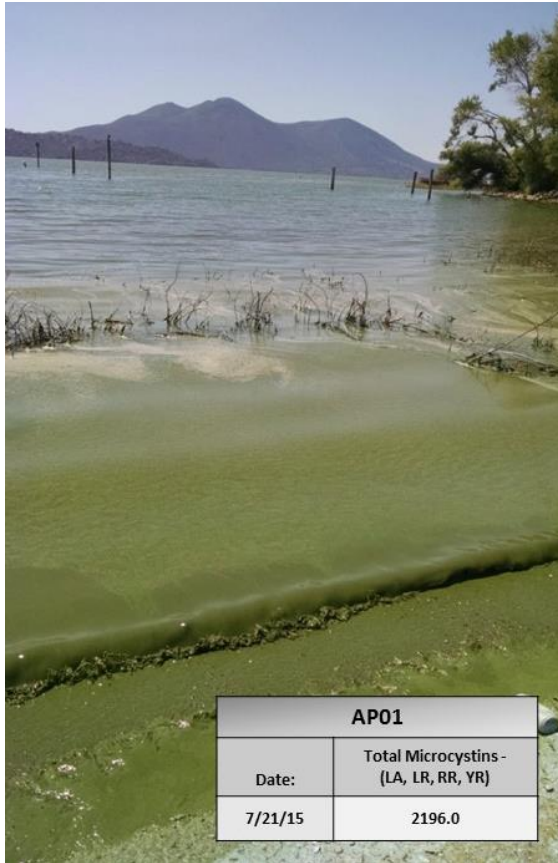
Clear Lake surface water serves 70% of Lake County residents.



Surface Water Public Water Systems, Clear Lake



CYANOTOXINS' IMPACTS



EXPOSURE



AP01	
Date:	Total Microcystins - (LA, LR, RR, YR)
7/21/15	2196.0



CYANOTOXINS' IMPACTS

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, ww¹)

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



CALIFORNIA CYANOTOXIN GUIDELINES

Action levels for selected scenarios

	Microcystins ¹	Anatoxin-a	Cylindrospermopsin	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

-from CA
OEHHA,
2012



CYANOTOXINS

Cyanobacteria and Known Toxins Chart

Cyanobacteria Genus	Cyanotoxin Class										References
	CYL	MC	NOD	ATX	SAX	NEO	LYN	BMAA	DAT	APL	
<i>Anabaenopsis</i>		✓									Lanaras and Cook, 1994; Graham et al., 2010
<i>Aphanizomenon</i>	✓	✓	✓	✓	✓	✓		✓			Graham et al., 2010; Jacoby and Kann, 2007; Pilotto et al., 1997; Vezie et al., 1998; Graham et al., 2008
<i>Aphanocapsa</i>		✓									Graham et al., 2010
<i>Calothrix</i>		✓						✓			Mohamed et al., 2006; Paerl and Otten, 2013
<i>Coelomoron</i>		✓									Dos S Vieira et al., 2005
<i>Coelosphaerium</i>		✓									Graham et al., 2010; Jacoby and Kann, 2007
<i>Cylindrospermopsis</i>	✓	✓		✓	✓			✓			Graham et al., 2010; Griffiths and Saker, 2002; Woods and Sterling, 2003; Graham et al., 2008; Paerl and Otten, 2013
<i>Cylindrospermum</i>		✓		✓	✓						Borges et al., 2015; Pandey and Tiwari, 2010; Sivonen et al., 1989
<i>Dolichospermum (Anabaena)</i>	✓	✓		✓	✓	✓		✓			Bruno et al., 1994; Graham et al., 2010; Harada et al., 1991; Jacoby and Kann, 2007; Mohamed et al., 2006; Pilotto et al., 1997; Sivonen et al., 1989; Spoof et al., 2006; Vezie et al., 1998; Graham et al., 2008
<i>Fischerella</i>		✓									Otten and Paerl, 2015
<i>Geitlerinema</i>		✓			✓						Aboal et al., 2005; Borges et al., 2015; Myers et al., 2007
<i>Gloeotrichia</i>		✓									Carey et al., 2007; Graham et al., 2010; Jacoby and Kann, 2007
<i>Hapalosiphon</i>		✓									Prinsep et al., 1992
<i>Limnothrix</i>		✓									Graham et al., 2010
											Berry et al., 2004; Dos S Vieira et al., 2005; Foss et al.,



CLEAR LAKE CYANOBACTERIA MONITORING PROGRAM

- Began 2014, 2 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.
- Initially used EPA Clean Water Act 106 funds to pay for time and lab analysis. Other funding used in the program: CalEPA EJ, BIA Water Resources, GAP, US Fish and Wildlife.





CONTINUALLY DEVELOPING PROGRAM

2014

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

2015

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

2016

- Began monitoring toxins in drinking water systems
- Using Fluorometer to get chlorophyll-a/phycoerythrin levels for TMDL
- Microcystin analysis at every site and every sampling event



CONTINUALLY DEVELOPING PROGRAM

2017

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

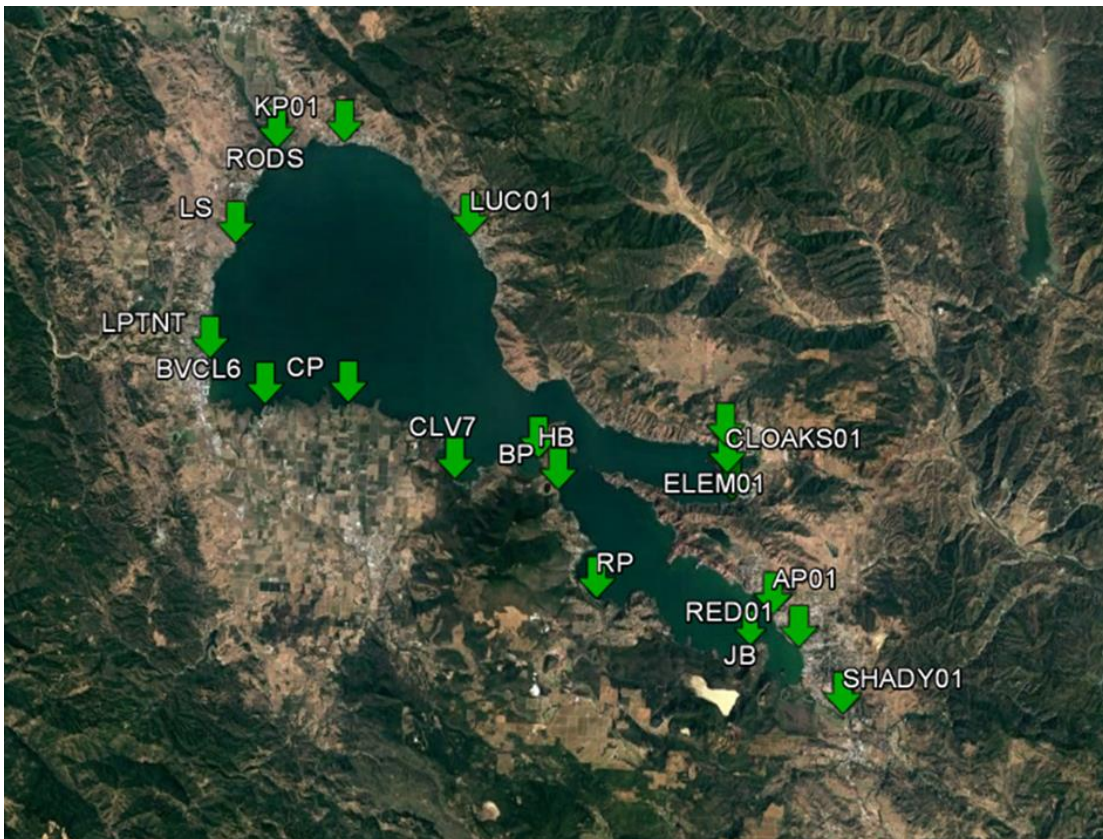
2018

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





CLEAR LAKE CYANOTOXIN MONITORING LOCATIONS



- Choose locations that are Tribally important
- Do monitoring to coincide with important Tribal uses of the water
- Inform other Tribes and the public about the results



PROCESSING THE WATER SAMPLES



7/26/16 Sampling

Microcystin

CLV7		0
CP		0
HB		0
LS		0
Rods		0
LPTNT		0
BVCLL		0
JB		0
BP		0
RP		0

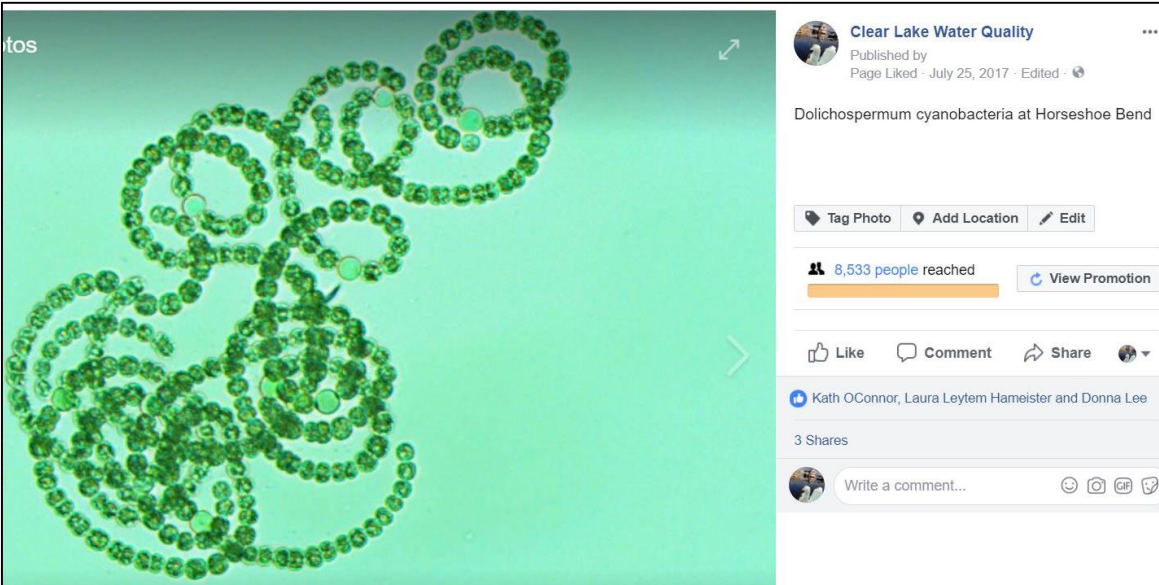
Anatoxin

RP		0.4
CLOAKSON		0.4

Testing for presence of microcystin with Abraxis recreational test strips (measures to 10ppb)



EDUCATING THE PUBLIC



Clear Lake Water Quality added 5 new photos. ...
 Published by [Profile Picture] · October 2, 2017 · [Location Icon]

LAB UPDATE ON CLEAR LAKE AND BLUE LAKES CYANOTOXIN LEVELS: 14 of our 20 sites came back with levels of MICROCYSTIN toxins from our last lakewide sampling event which was 9/25/17. One of those sites are above the Action Level set by the state - the site at Clearlake Keys had elevated results and are at the CAUTION LEVEL threshold set by the state. The results were as follows:
 Clearlake Keys 4.0 ug/L (CAUTION LEVEL)
 Jago Bay 0.30 ug/L
 Austin Park 0.28 ug/L... See More

CAUTION

**Harmful algae may be present in this water.
 For your family's safety:**

- You can swim in this water, but **stay away from algae and scum** in the water.
- Do not** let pets and other animals go into or drink the water, or eat scum on the shore.
- Keep children away** from algae in the water or on the shore.
- Do not** drink this water or use it for cooking.
- For fish caught here, **throw away guts and clean fillets** with tap water or bottled water before cooking.
- Do not** eat shellfish from this water.

Call your doctor or veterinarian if you or your pet get sick after going in the water.
 For information on harmful algae, go to mywaterquality.ca.gov/monitoring_council/cyanohab_network
 For local information, contact: _____

Enter your contact information in this text box.

anoHAB Trigger Levels for Hu

Parameter	Action Levels for selected scenarios			Notes
	Caution	Warning	Threat	
Microcystin-LR (µg/L)	0.5	1.0	1.5	Microcystin-LR is a potent toxin that can cause liver damage and other health issues.
Microcystin-LY (µg/L)	0.5	1.0	1.5	Microcystin-LY is a potent toxin that can cause liver damage and other health issues.
Microcystin-LR+LY (µg/L)	0.5	1.0	1.5	Microcystin-LR+LY is a potent toxin that can cause liver damage and other health issues.
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+2

4,469 people reached Boost Post



Big Valley Band of Pomo Indians

UPDATE ADVISORY, BIG VALLEY MEMBERS

FRIDAY JULY 14, 2017, 4:30PM:

CYANOBACTERIA (BLUE GREEN ALGAE) BLOOM AT THE POINT CONTINUES.



Dolichospermum, Big Valley Point

BIG VALLEY EPA HAS IDENTIFIED CYANOBACTERIA ALONG BIG VALLEY'S SHORELINE AND AT OTHER LOCATIONS ON CLEAR LAKE. LAB TESTING OF BIG VALLEY'S SHORELINE SHOWED LOW DETECT FOR 1 TOXIN - Microcystin, AT 0.21 ug/L. The state has set a level of 0.8 ug/L, to be protective of kids swimming. The lab results at the Point are below the level of concern.

TAKE CAUTION IF YOU ENTER THE LAKE. UNLESS YOU CAN KEEP YOURSELF AND CHILDREN FROM SWALLOWING LAKE WATER WHILE PLAYING, IT IS BEST TO STAY OUT OF THE LAKE AT THIS TIME. DO NOT SWALLOW LAKE WATER OR ALLOW CHILDREN TO SWALLOW ANY LAKE WATER. KEEP DOGS FROM THE LAKE BECAUSE THEY WILL LICK THEIR FUR AND CONSUME ANY TOXINS THAT MIGHT BE PRESENT.

THIS ADVISORY IS IN EFFECT UNTIL FURTHER NOTICE. NEXT SAMPLING DATE IS JULY 17, 2017 AND WE WILL PROVIDE RESULTS SOON AFTER. IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT ENVIRONMENTAL DIRECTOR SARAH RYAN AT 707-340-4040.

RESULTS FROM OTHER SITES ON THE LAKE:

Soda Bay Cove	3.5 ug/L
Sulphur Bank	
Mercury Mine	2.4 ug/L
Buckingham	1.3 ug/L
Richmond Park	1.2 ug/L
Elem shoreline	0.38 ug/L
Horseshoe Bend	0.35 ug/L
Keeling Park	0.34 ug/L
Austin Park	0.27 ug/L
Clearlake Oaks	0.22 ug/L
Big Valley shoreline	0.21 ug/L
Redbud Park	0.11 ug/L
Jago Bay	No Detect
Lakeside County Park	No Detect
Lakeport 5th Street Ramp	No Detect
Rodman Slough	No Detect
Lucerne Alpine Park	No Detect
Cache Creek	No Detect
Upper Blue Lakes	No Detect
Lower Blue Lakes	No Detect

4 SITES ABOVE LEVEL OF CONCERN ARE HIGHLIGHTED BLUE. BIG VALLEY SHORELINE AT THE POINT HIGHLIGHTED YELLOW BELOW LEVEL OF CONCERN **BUT TOXINS ARE PRESENT**

Additional information can be found at www.mywaterquality.ca.gov

ONE OF SEVERAL ADVISORIES PUT OUT BY TRIBES ON CLEAR LAKE IN 2017





RESEARCH

Evidence of bloom and low toxin levels

SBMMEL01	
Dates	Total Microcystins (EPA)
7/12/2016	0.67 $\mu\text{g/L}$

No evidence of bloom and caution toxin levels

CLOAKS01	
Date:	Total Microcystins - (LA, LR, RR, YR)
7/7/15	5.6 $\mu\text{g/L}$



RESEARCH

Collecting Chlorophyll-a and Phycocyanin Measurements for the Nutrient TMDL

- Lowest (green cells) and highest (red cells) phycocyanin measurement per site in 2016
- Ratio of phycocyanin to chlorophyll-a. 59% of time when ratio is below 1.0, toxin level is No Detect

Cyanotoxin Monitoring Sites		Cell ID	Field Results			Lab Results (in ppb)
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		



ANALYZING FOR MICROCYSTIN IN DRINKING WATER



	RAW WATER				FINISH WATER		
	ROUND 1 6/27/2016	ROUND 2 7/11/2016	ROUND 3 7/25/2016	ROUND 4 8/8/2016	ROUND 1 6/27/2016	ROUND 2 7/11/2016	ROUND 3 7/25/2016
20 - Soda Bay	0.16	0.18	0.18	<0.1	<0.1	<0.1	0.14
ounty Water District	0.73	0.38	0.26	<0.1	0.18	<0.1	0.16
21 - North Lakeport	0.33	0.21	0.19	<0.1	<0.1	<0.1	0.15
: Water District	0.12	0.27	0.24	<0.1	0.2	<0.1	0.18
al Water Company		0.3	0.21	<0.1		<0.1	<0.1
l Water Company	0.38	0.27	0.19	<0.1	0.16	<0.1	0.14
Water District		0.16	0.28	<0.1			0.17



NON POINT SOURCE MANAGEMENT



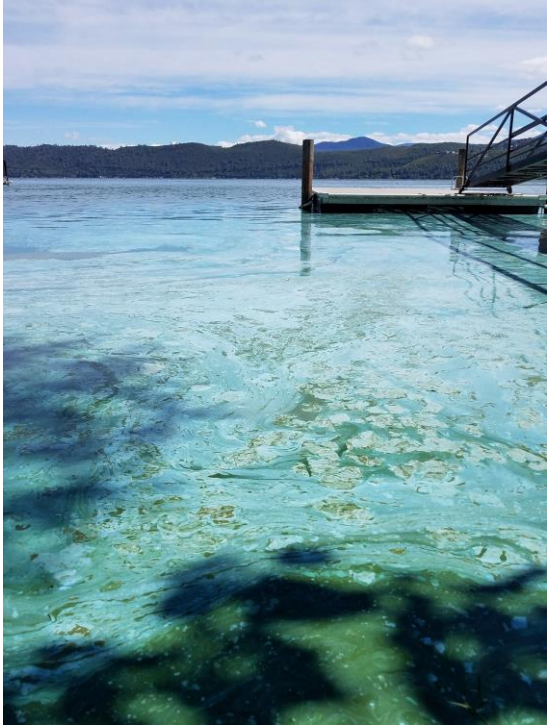
**REDUCES
NUTRIENTS
AND
IMPROVES
WATER
CHEMISTRY
TO CONTROL
BLOOMS**





SUMMARY

- Be proactive to protect your waters if you suspect blooms
- Both USEPA and the CA State Water Resources Control Board have programs and funding that can help develop monitoring programs
- Tribes in Northern and Central California have strong monitoring programs, reach out for assistance
- Conduct research, collaborate, educate the public, take action on watershed management and help create policy to protect your waters



AP01	
Date:	Total Microcystins - (LA, LR, RR, YR)
7/21/15	2196.0



Recreation, Tribal traditional uses, fisheries, drinking water impacts

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707-263-3924 x132