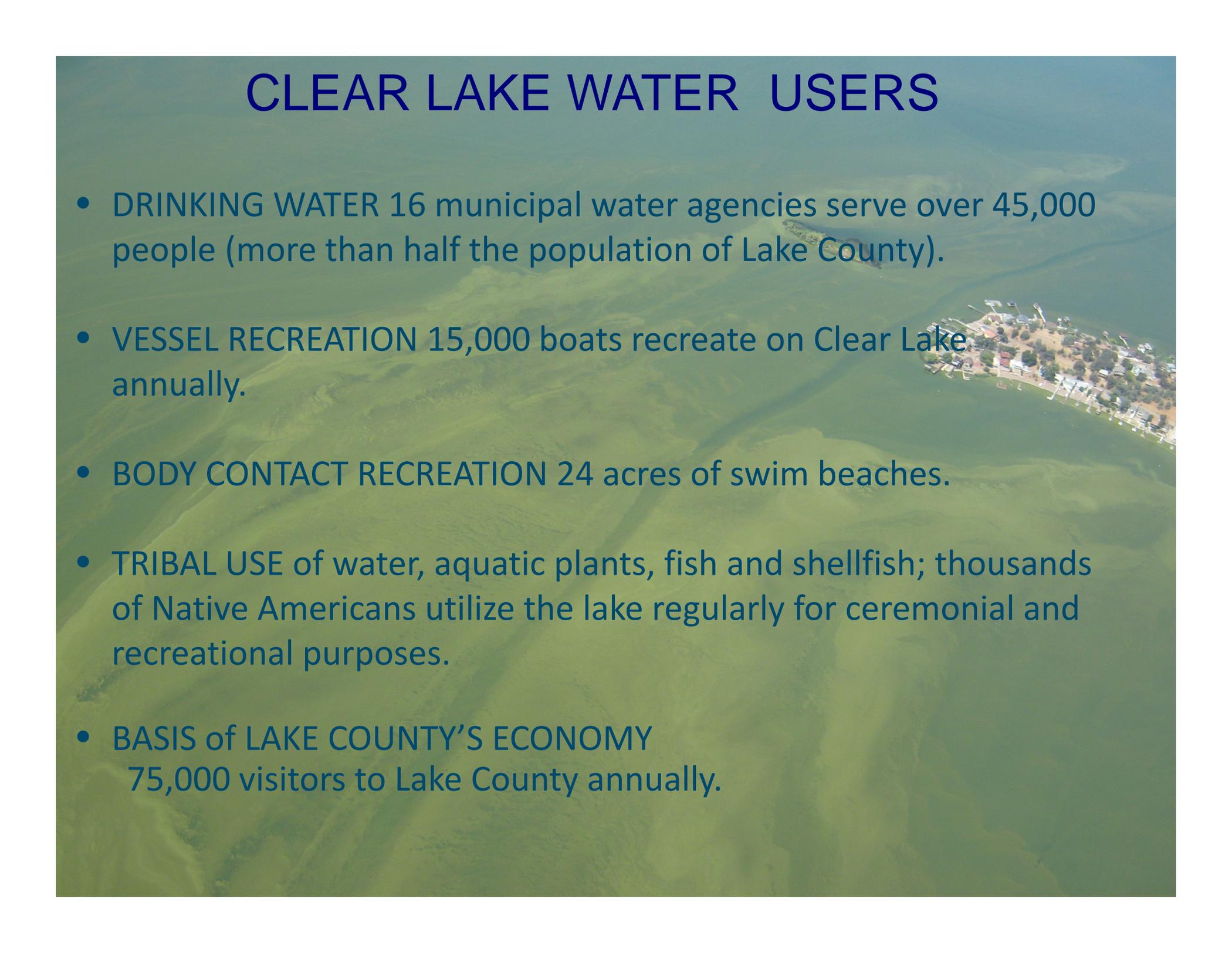


Clear Lake Cyanobacteria, CB



2010
Lyngbya robusta

CLEAR LAKE WATER USERS

An aerial photograph of Clear Lake, showing the water's surface with some greenish tints, likely due to algae. On the right side, there is a small town or village with several buildings and a marina area. The surrounding landscape is hilly and green.

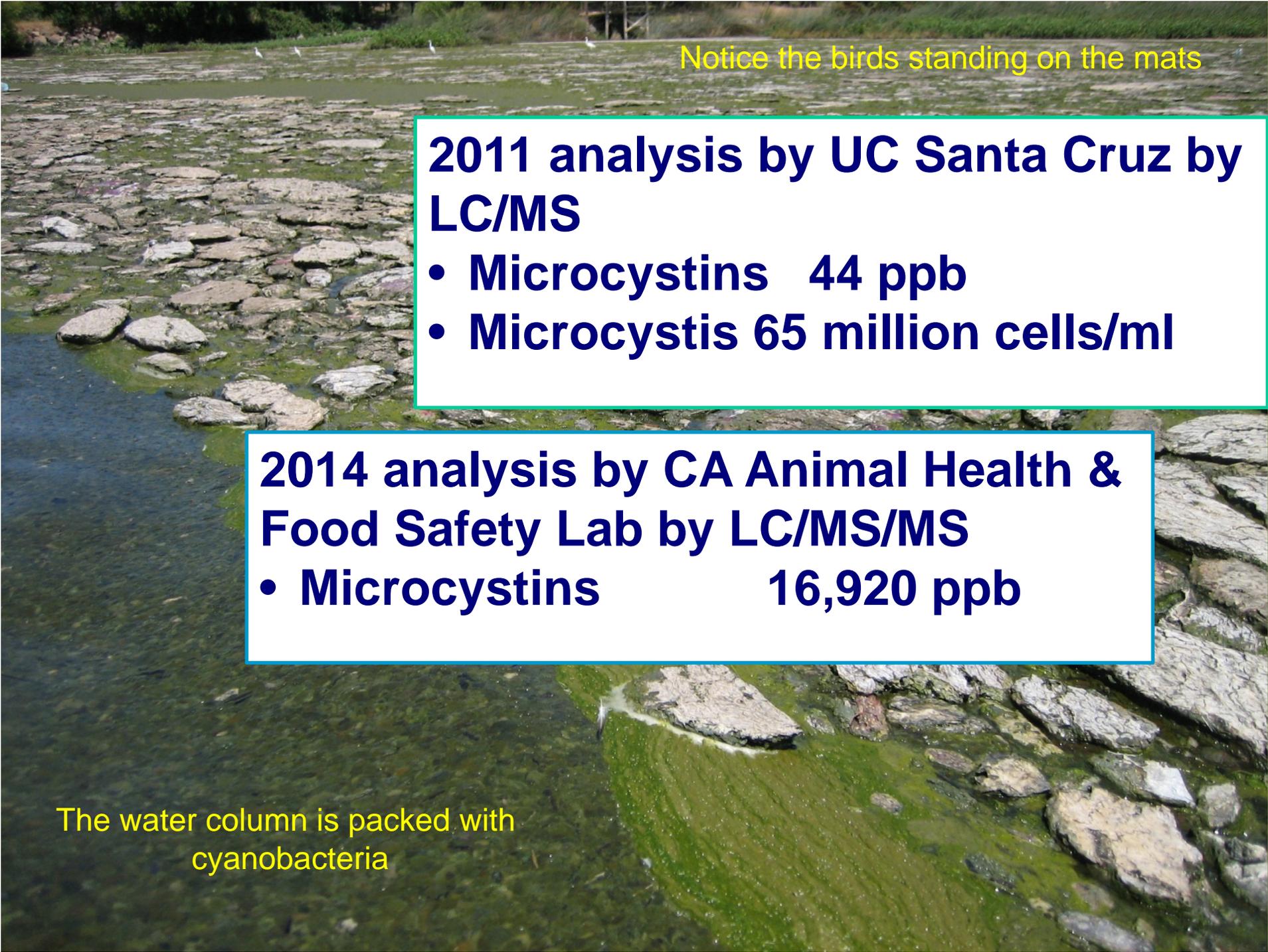
- DRINKING WATER 16 municipal water agencies serve over 45,000 people (more than half the population of Lake County).
- VESSEL RECREATION 15,000 boats recreate on Clear Lake annually.
- BODY CONTACT RECREATION 24 acres of swim beaches.
- TRIBAL USE of water, aquatic plants, fish and shellfish; thousands of Native Americans utilize the lake regularly for ceremonial and recreational purposes.
- BASIS of LAKE COUNTY'S ECONOMY
75,000 visitors to Lake County annually.

CB MONITORING on CLEAR LAKE

- Sediment cores of the Lake show long term existence of CB.
- In 2009 we had our first lakewide experience with *Lyngbya robusta*.
- UC Santa Cruz Raphael Kudela's lab, SWRCB grant funded monitoring, 2010 and 2011.
- Dog death 2013, post death monitoring.

Why do we monitor?

- Protect Tribal beneficial uses of Clear Lake through real-time data collection and education
- Lake County has the responsibility to protect the public's interest in Clear Lake by State law
- Share resources and information in collaborative approach for monitoring the lake
- Provide data on cyanobacteria related toxins in a timely manner to support public health decisions such as posting advisory signs at HAB affected beaches and access points
- To inform small, locally regulated drinking water systems of potential presence of cyanotoxins.
- To evaluate the impact of mitigation methods that may result in cell lysis and transient increases in cyanotoxins



Notice the birds standing on the mats

2011 analysis by UC Santa Cruz by LC/MS

- **Microcystins 44 ppb**
- **Microcystis 65 million cells/ml**

2014 analysis by CA Animal Health & Food Safety Lab by LC/MS/MS

- **Microcystins 16,920 ppb**

The water column is packed with cyanobacteria

2013 Lakeport

2013 Lucerne

Clear Lake Cyanobacteria Task Force

- Clear Lake Tribes
- Lake County Water Resources
- Lake County Environmental Health
- Lake County Public Health
- US EPA, Region 9 Water Programs and Tribal Programs
- State Water Resources Control Board
- California Office of Environmental Health Hazard Assessment
- California Department of Public Health
- Cal EPA
- Central Valley Regional Water Quality Control Board

2012 Clearlake

2012 Clearlake Oaks

CB monitoring evolution

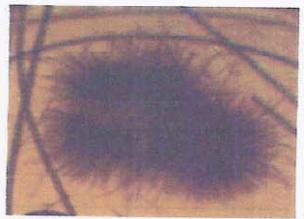
- 2014 Program
 - Monitored 8 lakeshore sites
 - Mainly focusing on Microcystin levels – used Abraxis Algal Toxin strip test kits for detection
- 2015 Program
 - Monitoring 18 lakeshore sites
 - Cyanobacteria cell identification under microscope to determine toxins to analyze
 - Analyzing for Microcystin, Anatoxin-a, Cylindrospermopsin, Saxitoxin
- 2016 Program
 - Will be adding more sites in Oak Arm and Lower Arm
 - Using Fluorometer to get chlorophyll-a and phycocyanin levels
 - Microcystin lab analysis and Abraxis Strip test kit at every site and every sampling event

SITE #	SITE NAME	IDENTIFIED CELLS
1	KP	Lyngbya anabaena Microcystis - few
2	LUCO1	Lyngbya-anabaena Few
3	CLOAKS1	Anabaena Microcystis Few
4	ELEM01	Anabaena, Lyngbya Lyngbya Microcystis - few
5	AP01	Microcystis Anabaena Lyngbya Few
6	RED	Microcystis Anabaena Lyngbya Few
7	SHAD AC	Microcystis Lyngbya Anabaena / Few
8	HIGH WC	not done
9	SBMEL01	Lyngbya, Anabaena Gloeotrichia Microcystis Few
10	CLO WD	not done
11	RodS	now detected
12	PITS	Microcystis, Lyngbya, (+) Anabaena
13	LPTNT	Anabaena Microcystis Lyngbya - few -
14	M4	anabaena - few -
15	BVCL6	- few -
16	CP	anabaena - few -
17	CLSP	not done
18	CLV7	anabaena zooplankton - few -
19	HB	anabaena
20	BP	microcystis zooplankton - few -
21	RP	1) Lyngbya 2) microcystis lots -

DATE: 7/21/15



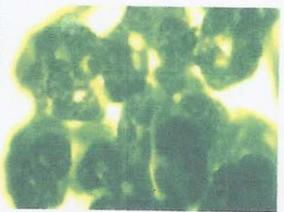
WORONICHIA



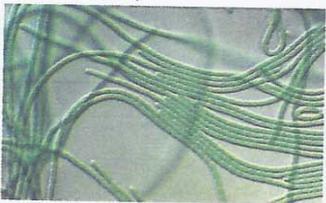
GLOEOTRICHIA



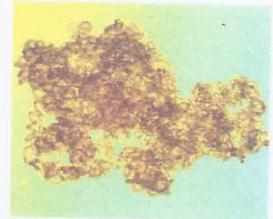
LYNGBYA



MICROCYSTIS



CYLINDROSPERMOPSIS



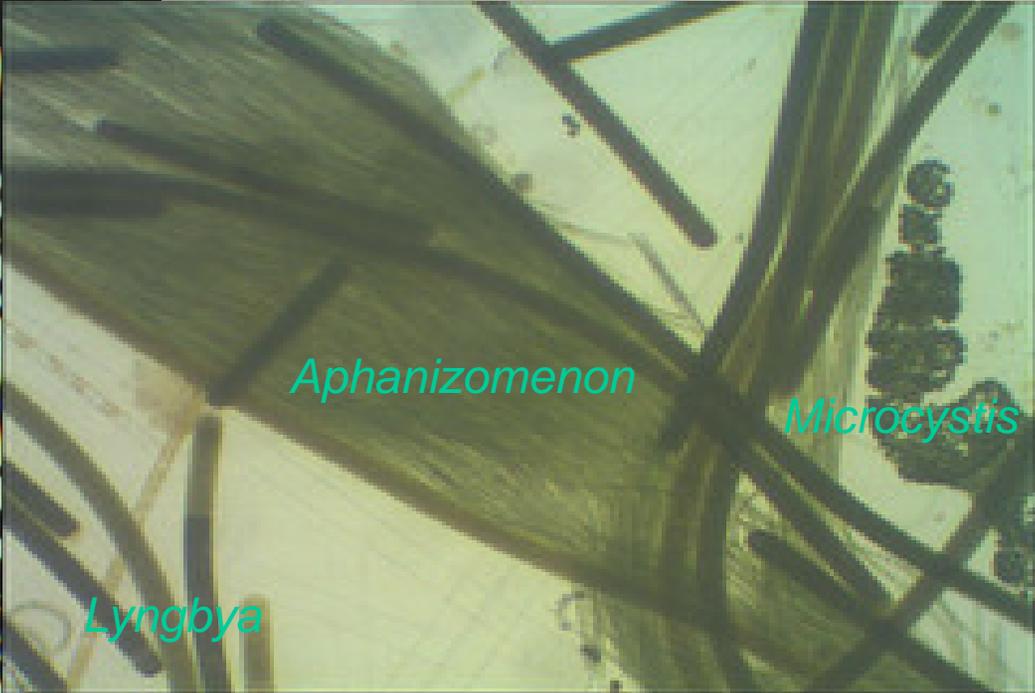
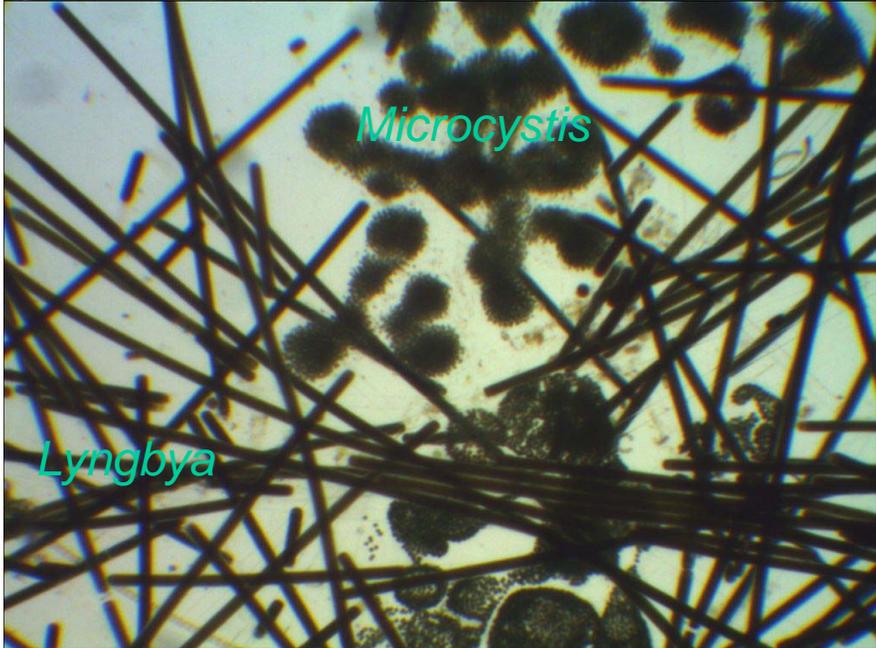
ANABAENA



APHANIZOMENON

CB
ID form

The microscope view



6/23/15 Samples

1 TNT LKPT



2 Pit Stop



3 Rodman Slough



4 Keeling Park



5 LUCO1



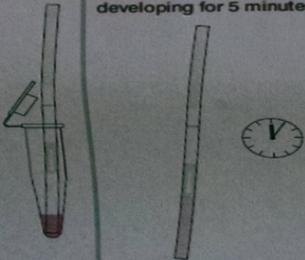
10 Shady Acres



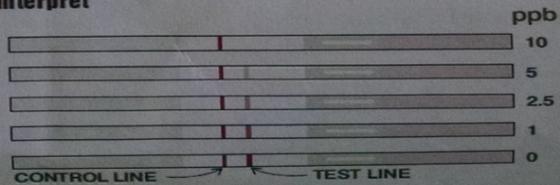
ABRAXIS FIELD TEST STRIPS

7. Dry

Remove test strip. Lay flat and allow to continue developing for 5 minutes.



8. Interpret



CONTROL LINE	TEST LINE	INTERPRETATION
NO CONTROL LINE PRESENT	NO TEST LINE PRESENT	INVALID RESULT
CONTROL LINE PRESENT	NO TEST LINE PRESENT	> 10 ppb
CONTROL LINE PRESENT	MODERATE INTENSITY TEST LINE PRESENT	BETWEEN 0 AND 10 ppb

For Ordering or Technical Assistance Contact:

ABRAXIS, LLC 54 Steamwhistle Drive, Warminster, PA 18974 Phone: 215-357-3911 Fax: 215-357-5232 www.abraxiskits.com

Results Table from 2015

Cyanotoxin Monitoring Sites		Cell ID		Field Results (in ppb)	Lab Results (in ppb)			
Site ID	Dates	Dominant Genus	Other Identified	Microcystins - Elisa Test Kit	Total Microcystins (LA, LR, YR, RR)	Anatoxin-a	Saxitoxin	Cylindrospermopsin
Elem Sites								
APO1	5/1/2015	-	-	>10	-	-	-	-
	5/3/2015	-	-	>10	-	-	-	-
	5/7/2015	-	-	2.0	-	-	-	-
	5/20/2015	-	-	>10	140.0	ND	-	-
	6/8/2015	-	-	>10	1000.0	-	-	-
	6/23/2015	<i>Gloeotrichia</i>	<i>Microcystis, Woronichinia</i>	-	93.7	-	-	-
	7/7/2015	<i>Lyngbya</i>	<i>Gloeotrichia, Microcystis</i>	-	33.2	-	-	-
	7/21/2015	<i>Microcystis</i>	<i>Lyngbya, Anabaena*</i>	-	2196.0	-	ND	-
	8/4/2015	<i>Microcystis</i>	<i>Lyngbya, Anabaena*</i>	-	10162.0	-	-	-
	8/17/2015	<i>Microcystis</i>	<i>Lyngbya*, Anabaena*</i>	>10	45.0	-	-	-
	8/31/2015	Dying <i>Microcystis*</i>	None	2.0	ND	-	-	-
	9/8/2015	<i>Microcystis</i>	None	0.0	-	-	-	-
	9/15/2015	<i>Microcystis*</i>	None	1.0	-	-	-	-
	9/22/2015	<i>Microcystis</i>	None	-	-	-	-	-
	9/29/2015	None Detected	N/A	-	-	-	-	-
10/14/2015	None Detected	None	-	-	-	-	-	
11/10/2015	None Detected	None	-	-	-	-	-	

Monitoring Tips

- Need a PLAN – procedural document.
- Need a QAPP – quality control/confidence level.
- Need to be able to identify CB to genus to know which toxin to test for.
- Need to be able to choose how many, how often, when in relation to bloom, why, where in the water column, which field test kit to use, which lab to use, best way to ship.
- Need a planned response to toxin results

Challenges of Risk Communication

- Health risks are seemingly uncommon, but may be under-reported
- Many “unknowns” about predicting health risks both acute and chronic
- Negative perceptions about the safety of the lake can have economic consequences
- Outrage factor would be high if warnings are inadequate
- “Don’t post ever” versus “Post more”

CyanoHABs Laboratory List

The purpose of this laboratory list is to readily provide information about laboratories capable of analyzing water samples for cyanobacteria and the toxins cyanobacteria can produce. This list is not intended to describe any regulatory requirements or make any laboratory endorsements. The laboratories are listed in alphabetic order. Please note –laboratories should be contacted prior to submitting any samples. Many laboratories discussed flexibility in prices and the need to coordinate any sampling and analysis.



Cyanotoxin Analysis								
Laboratory	Matrix	Cyanotoxin	Method	DLR (µg/L)	MDL (µg/L)	Response Time	Sample Storage/ Shipping Condition	Shipping Preference
Beagle Bioproducts Inc. Contact: 614-682-6588 info@beaglebioproducts.com Location: Columbus, OH	DW, AW	microcystin	ELISA	contact lab	contact lab	2 day response time. 24 hours response time upon request and additional fees.	Go to Beaglebioproduct.com for sampling kits & shipping containers for purchase.	Fedex overnight. Samples collected over weekend for toxin analyses should be frozen and shipped Monday.
	DW, AW	microcystin	LC-MS	contact lab	contact lab			
	DW, AW	microcystin	LC-MSMS	contact lab	contact lab			
	DW, AW	anatoxin-a	ELISA	contact lab	contact lab			
	DW, AW	cylindrospermopsin	ELISA	contact lab	contact lab		Go to beaglebioproducts.com for sampling guide and more details.	
	DW, AW	saxitoxins	ELISA	contact lab	contact lab			
	DW, AW	anatoxin-a	LC-MS	contact lab	contact lab			
	DW, AW	cylindrospermopsin	LC-MS	contact lab	contact lab			
BEND GENETICS, LLC LABORATORY Contact: 541-600-GENE or customer_service@bendgenetics.com Location: Corvallis, OR	DW, AW	microcystin	ELISA	contact lab	0.10	Response time ~ 36 hours from sample receipt (Mon. – Thurs. delivery), and rush services (same day) can be arranged.	Frozen or on wet ice	No preference
	DW, AW	anatoxin-a	RBA	contact lab	10			
	DW, AW	cylindrospermopsin	ELISA	contact lab	0.04			
	DW, AW	saxitoxins	ELISA	contact lab	0.015			
	DW, AW	Domoic acid	ELISA	contact lab	6			
	Tissue (shellfish)	microcystin	ELISA	contact lab	contact lab			
	Tissue (shellfish)	saxitoxins	ELISA	contact lab	0.015			
	Tissue (shellfish)	Domoic acid	ELISA	contact lab	30			
CA Animal Health and Food Safety Lab (CAHFS), UC Davis Contact: 530-752-7578 Location: Davis, CA	Note: Lab analyzes samples related to <i>animal health</i> . The lab can analyze animal samples (tissues and stomach contents) related to possible animal exposures to cyanotoxins from harmful algal blooms.			contact lab	contact lab	contact lab	contact lab	No preference



COSTS of MONITORING

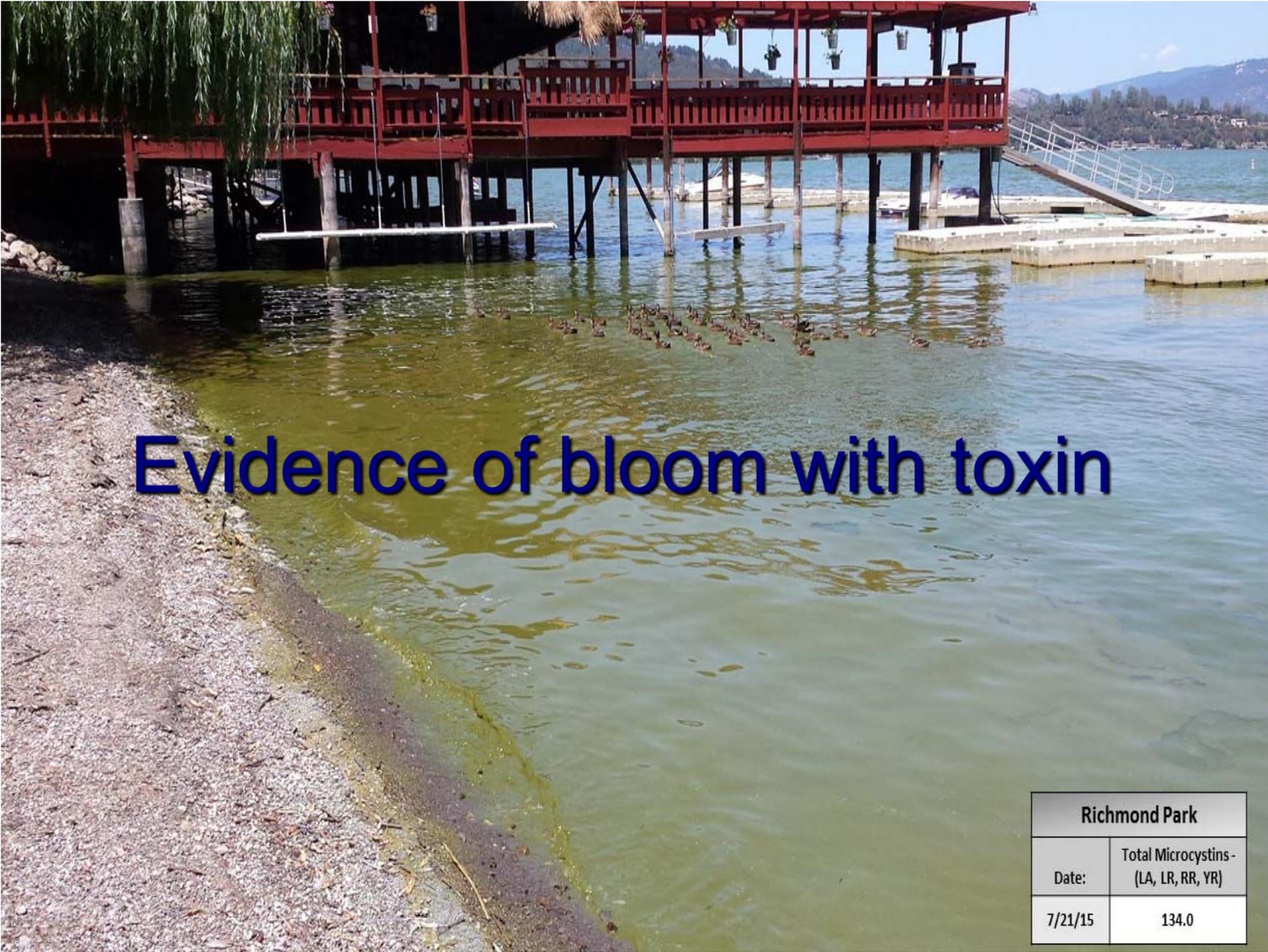
- Collaborate with others, share costs especially shipping costs
- ABRAXIS IMMUNOCHROMATOGRAPHIC STRIP TEST KITS \$489.00 (20 samples)
- ENVIROLOGIX ELISA MICROTITER TUBE ASSAY \$400.00 (10 samples)
- ABRAXIS MICROTITER ELISA PLATE KIT >\$1,000.00 (12+ samples)
must have reader also

Solid mat of *Lyngbya* on 10 ft of water

08.02.2012 02:40

FUNDING past, present and future

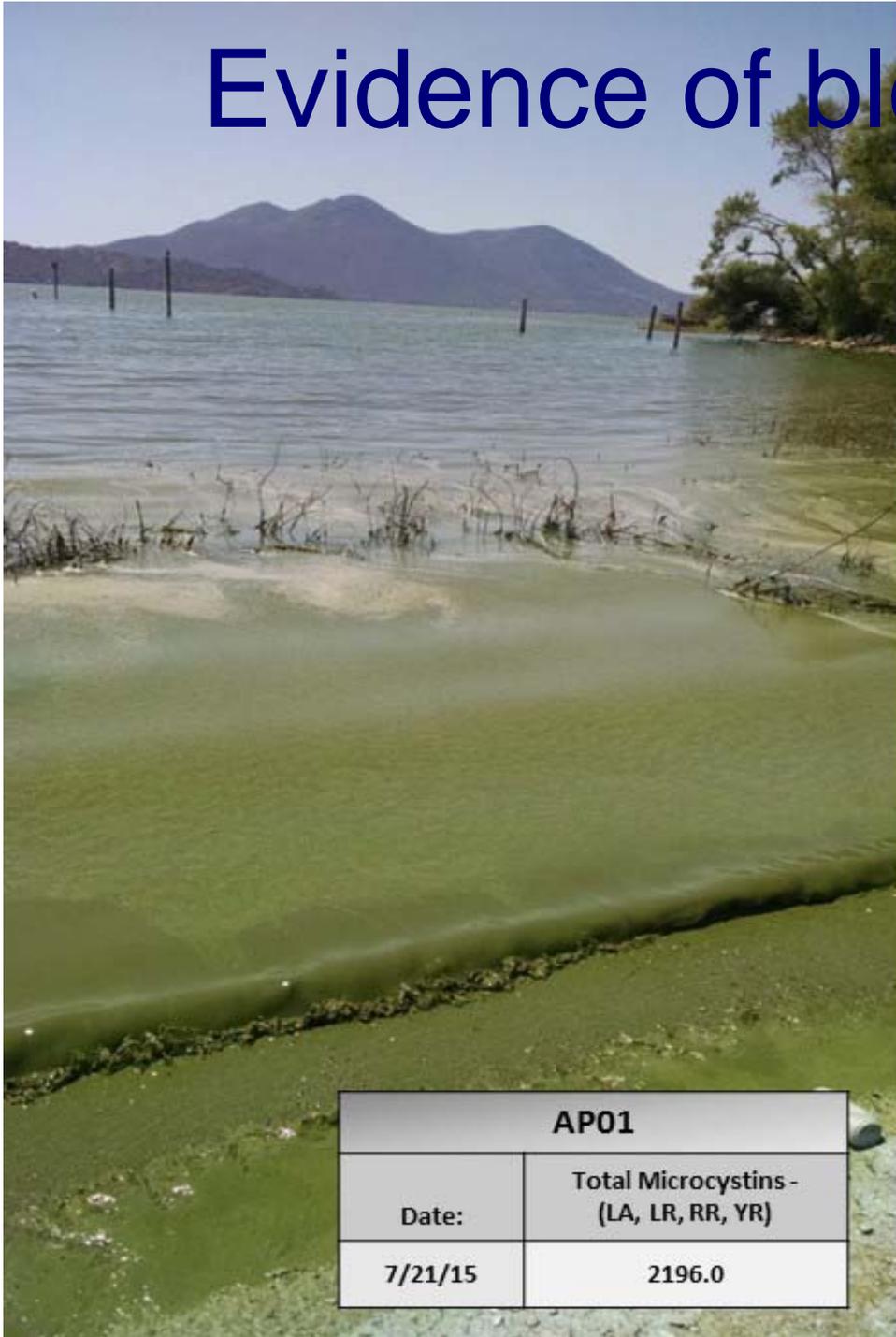
- Sales tax for Clear Lake (unsuccessful measure); General Fund
- SWRCB Cleanup and Abatement Grant.
- Academic monitoring using grants from state departments or other sources.
- Prop 1 Safe Drinking Water grants
- CalEPA Environmental Justice Small Grants, BIA and USEPA CWA and (Tribal) General Assistance Program funding
- Foundations and corporations



Evidence of bloom with toxin

Richmond Park	
Date:	Total Microcystins - (LA, LR, RR, YR)
7/21/15	134.0

Evidence of bloom with toxin



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



AP01	
Date:	Total Microcystins - (LA, LR, RR, YR)
8/4/15	10,162.0



Evidence of bloom with no toxin

AP01	
Date:	Total Microcystins - (LA, LR, RR, YR)
8/31/15	ND

Evidence of bloom with low toxin

LUC01	
Date:	Total Microcystins - (LA, LR, RR, YR)
9/30/14	4.6

Evidence of bloom with low toxin



CLOAKS01	
Date:	Total Microcystins - (LA, LR, RR, YR)
10/7/14	4.9

No evidence of bloom with toxin

CLOAKS01	
Date:	Total Microcystins - (LA, LR, RR, YR)
7/7/15	5.6

FUTURE WORK MONITORING FISH and SHELLFISH

Analysis of fish and shellfish samples
cost approx. \$700.00 per sample

OEHHA recommends 9 samples of 3 different
species for analysis

Shellfish and subsistence consumption of fish in
Clear Lake make testing a priority

Aphanizomenon bloom

Recommendations to Local Governments

- Install signage based on recent results to inform the public of risks and options.
- Issue press releases when toxin levels have exceeded guidelines for safe recreating.
- Nutrient reduction projects to reduce future blooms.
- Aerate shoreline to reduce cyanobacteria blooms.
- Consider requiring water purveyors to test for cyanotoxins in the treated drinking water when shoreline levels elevated.



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Environmental Director,

Big Valley Band of Pomo Indians

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Carolyn Ruttan

Invasive Species Program Coordinator,

Lake County Department of Water Resources

707-263-2256 carolynr@co.lake.ca.us