

Update on the Cyanobacteria Harmful Algal Bloom Monitoring and Response Program

Rich Fadness

North Coast Regional Water Quality Control Board

September 6, 2018 – Santa Rosa, CA



Beth Schlanker - Press Democrat (June 23, 2016)

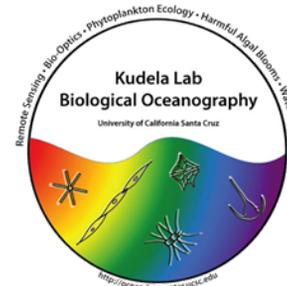


Trout Creek Campground – Eel River

Update on the Cyanobacteria Harmful Algal Bloom Monitoring and Response Program



Program



Item 3: Update on Freshwater Cyanobacteria Harmful Algal Bloom Response Efforts

North Coast Cyanobacteria Monitoring



Regional Strategy

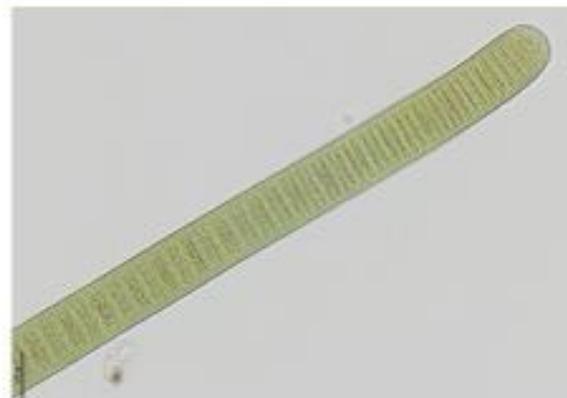
■ Public Workshop

- ✓ Overview of cyanoHABs & toxins
- ✓ Review California Strategy
- ✓ Case studies

■ Workgroup Meeting

- ✓ Build strong North Coast cyanoHAB responder partnerships
- ✓ Define each partner's role
- ✓ Begin planning for summer 2016

■ Develop CyanoHAB Monitoring & Response Program





Extracts from benthic anatoxin-producing *Phormidium* are toxic to three macroinvertebrate taxa at environmentally relevant concentrations

**Brian Anderson, Jennifer Voorhees, Bryn Phillips, Rich Fadness, Rosalina Stancheva,
Jeanette Nichols, Daniel Orr, Susanna A. Wood**

Presentation Topics

Cyanobacteria

- Responsible for the Earth's atmosphere and the air that we breathe
- From the arctic to the equatorial regions
- In the oceans, and
- In freshwater springs, lakes, and rivers
- Acting as the base of the aquatic food chain
- Providing Nitrogen to land-based plants, and
- Providing a high protein food source to people

SPIRULINA

HEALTH BENEFITS

- ◆ DETOXES HEAVY METALS
- ◆ ELIMINATES CANDIDA
- ◆ IMPROVES HIV/AIDS
- ◆ HELPS PREVENT CANCER
- ◆ LOWERS BLOOD PRESSURE
- ◆ REDUCES CHOLESTEROL
- ◆ LOWERS CHANCE OF STROKE
- ◆ BOOSTS ENERGY
- ◆ SPEEDS UP WEIGHT LOSS
- ◆ ALLEVIATES SINUS ISSUES

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SPIRULINA POWDER

NUTRITIONAL FACTS

60% PROTEIN

Dried plant contains 57-71% protein. It includes all essential amino acids.

290 CALORIES
20% NUTRIENTS

of the necessary daily value in 100 grams spirulina. This includes vitamins A, C1, B2, B12, iron, manganese and chromium.

[READ MORE](#)



SPIRULINA TABLETS

HEALTH BENEFITS

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Cyanotoxins	Acute Health Effects in Humans
Microcystin	Abdominal pain, Headache and Sore throat, Vomiting and nausea, Dry cough, and Pneumonia
Cylindrospermopsin	Fever, Headache, Vomiting
Anatoxins	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death
BMAA	Possible link to: Lou Gehrig's disease (ALS), Alzheimer's, and Parkinson's disease

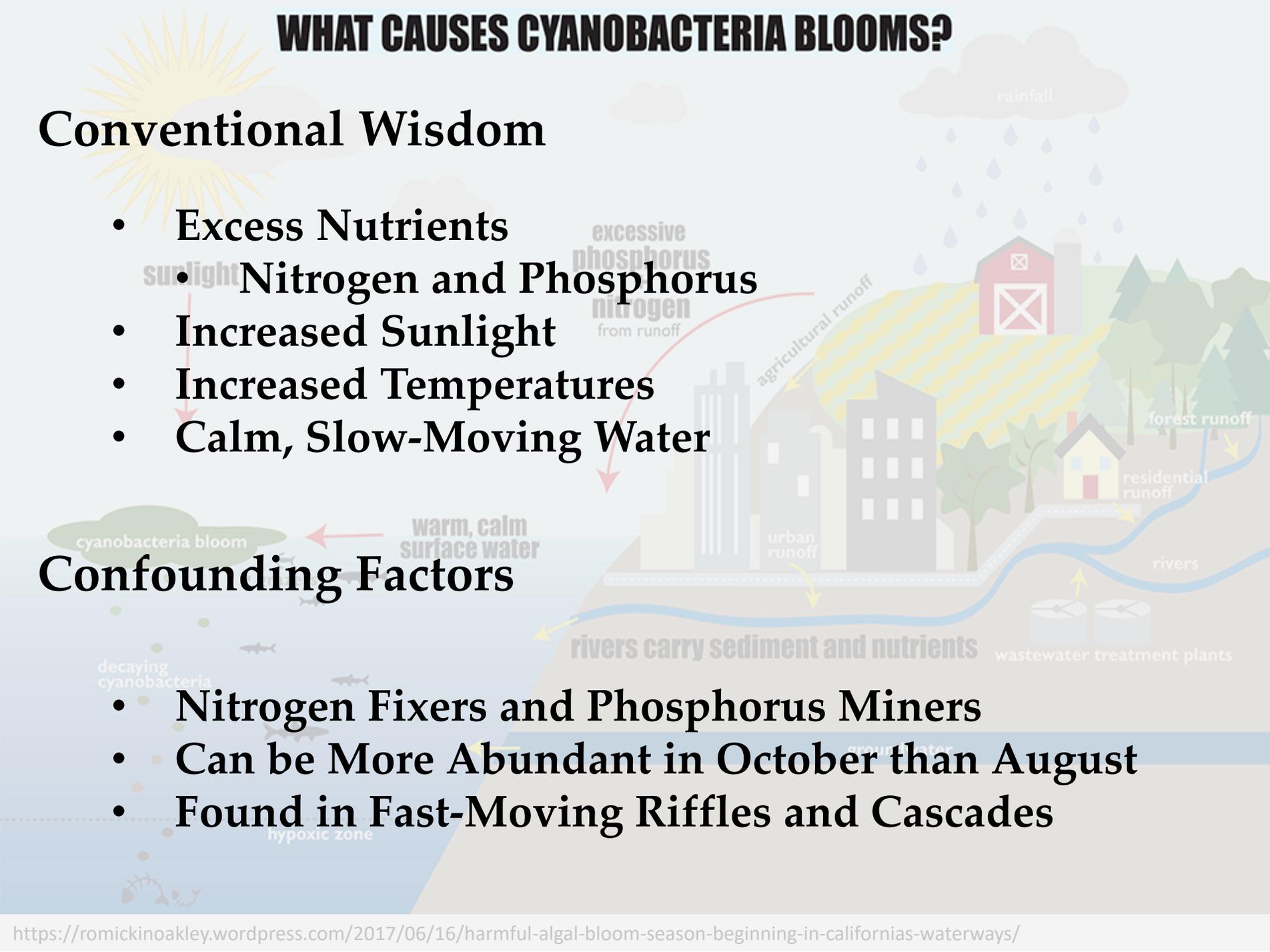
WHAT CAUSES CYANOBACTERIA BLOOMS?

Conventional Wisdom

- Excess Nutrients
- Nitrogen and Phosphorus
- Increased Sunlight
- Increased Temperatures
- Calm, Slow-Moving Water

Confounding Factors

- Nitrogen Fixers and Phosphorus Miners
- Can be More Abundant in October than August
- Found in Fast-Moving Riffles and Cascades





Dog Deaths and Human Illnesses in the North Coast Region 2001-2015

- Big Lagoon
- Trinity River
- Van Duzen River
- South Fork Eel River
- Eel River
- Russian River

KlamathValley.com, Klamath Lake, OR



Lake Wilson, Riverfront Park, Santa Rosa



PLANKTONIC

Russian River, Cloverdale



Russian River, Guerneville



BENTHIC



STATE-WIDE COLLABORATIVE

DEVELOPMENT OF GUIDANCE

FIELD MONITORING

REFE

MONITORING STANDARD

OPER

**INTERNATIONAL BENTHIC
CYANOBACTERIA WORKGROUP**



Toxic Species?



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.

For people, the toxins can cause:

- Skin rashes, eye irritation
- Diarrhea, vomiting

For animals, the toxins can cause:

- Diarrhea, vomiting
- Convulsions and death

Call your doctor or veterinarian if you or your pet get sick after going in the water.
For more information, contact:

Biomass

*Toxin
Production*

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



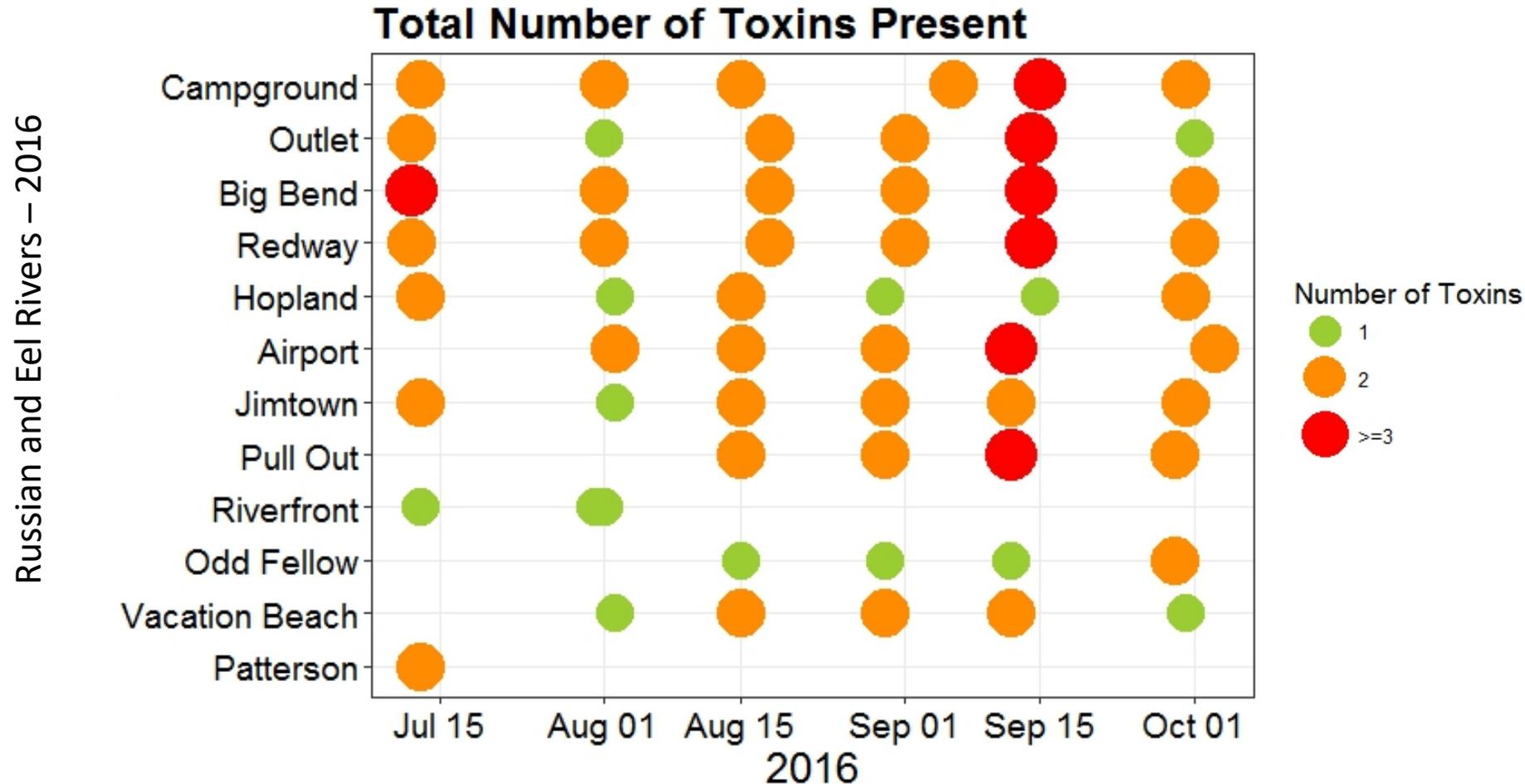


Beth Schlanker/Press Democrat (June 23, 2016)





Synergistic Stressors? : Simultaneous Detection of Multiple Toxins



Recreational and drinking water health thresholds are based on single toxin exposure....

What are the consequences of exposure to multiple toxins for human, wildlife and ecological health?

- *LCMS analysis only verifies 6 variants and Nodularin*
- *ELISA analysis incorporates all 100+ variants and Nodularin*
- *SPATT samplers may be better at adsorbing microcystins*
- *Water grab samples may not document the potential risk*

Big Bend	MCY-NOD		1.11	<.010	0.84	0.32	1.79	2.13
Jimtown	MCY-NOD		<.010	<.010	0.63	0.14	0.24	4.67
Location	Toxin Analysis	6/15 to 6/27	6/27 to 7/12	7/12 to 8/1	8/1 to 8/15	8/15 to 8/29	8/29 to 9/11	9/11-10/2
	LCMS	SPATT Bag Results (ng/g resin)						
Campground	Anatoxin-a <i>(only)</i>	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pull Out					<MDL	<MDL	<MDL	<MDL
Airport				<MDL	<MDL	<MDL	<MDL	<MDL
	LCMS	Water Grab Results (ug/L)						
Campground	Total Anatoxins	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Pull Out					<MDL	<MDL	<MDL	<MDL
Airport				<MDL	<MDL	<MDL	<MDL	<MDL
	ELISA	Algal Mat Grab Results (ug/L)						
Campground	Total Anatoxins		0.64	1.29	18.5	13.6	45.3	6.94
Pull Out					2204	2054	>15750	8143
Airport				53.5	1002	619	3396	1217

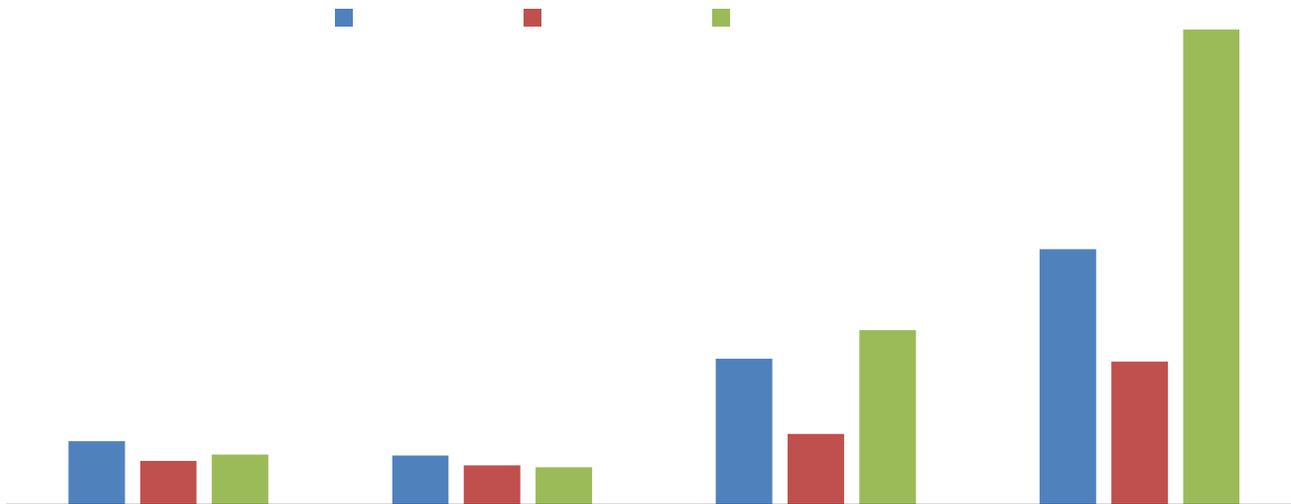
Location	Toxin Analysis	6/15 to 6/27	6/27 to 7/12	7/12 to 8/1	8/1 to 8/15	8/15 to 8/29	8/29 to 9/11	9/11-10/2
	LCMS	SPATT Bag Results (ng/g resin)						
Campground	MCY-LA	<MDL	115.830	197.278	116.490	112.140	160.032	416.873
Big Bend	MCY-LR		131.400	26.161	15.790	15.600	12.554	<MDL
Big Bend	Big Bend		450.750	111.514	156.010	15.270	89.488	2.655
Jimtown	Big Bend	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
	Jimtown	Water Grab Results (ug/L)						
Campground		<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Big Bend	Campground	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Big Bend	Big Bend	TRACE	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Jimtown	Jimtown	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
		Algal Mat Grab Results (ug/L)						
Campground			0.25	0.12	0.51	<0.10	0.86	1.56
Big Bend			1.11	<.010	0.84	0.32	1.79	2.13
Jimtown	Campground		<.010	<.010	0.63	0.14	0.24	4.67
	Pull Out							

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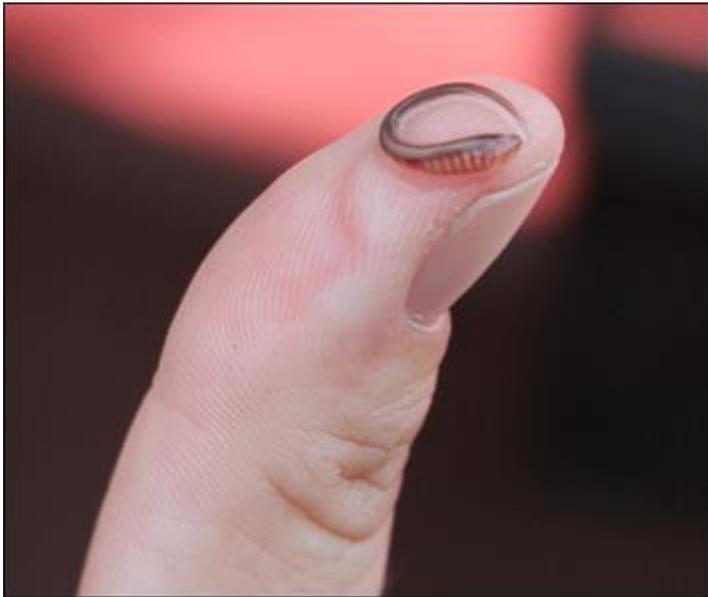
Laboratory Method: **LCMS** verifies 1 variant
 Laboratory Method: **ELISA** incorporates all 4 variants
 Laboratory Method: **SPATT** samples may adsorb low-level concentrations (2017 data)
 Laboratory Method: **Water grab** samples may not document the potential risk



ATX-a ($\mu\text{g/L}$)	dhATX ($\mu\text{g/L}$)	Method	Genus
maybe	maybe	LC-MS/MS	<i>Anabaena oscillarioides</i>
0.66	331	LC-MS/MS	<i>Phormidium</i>
0.38	363	LC-MS/MS	<i>Phormidium</i>
0.47	483	LC-MS/MS	<i>Phormidium</i>
Total Anatoxin ($\mu\text{g/L}$)		Method	Genus
0.14		ELISA	<i>Phormidium</i>
0.10		ELISA	<i>Anabaena+Geitlerinema</i>
>125		ELISA	<i>Phormidium</i>
3.36		ELISA	<i>Phormidium</i>
2.86		ELISA	<i>Phormidium</i>
0.10		ELISA	<i>Anabaena+Amoeba</i>
0.65		ELISA	<i>Phormidium</i>
2.60		ELISA	<i>Phormidium</i>



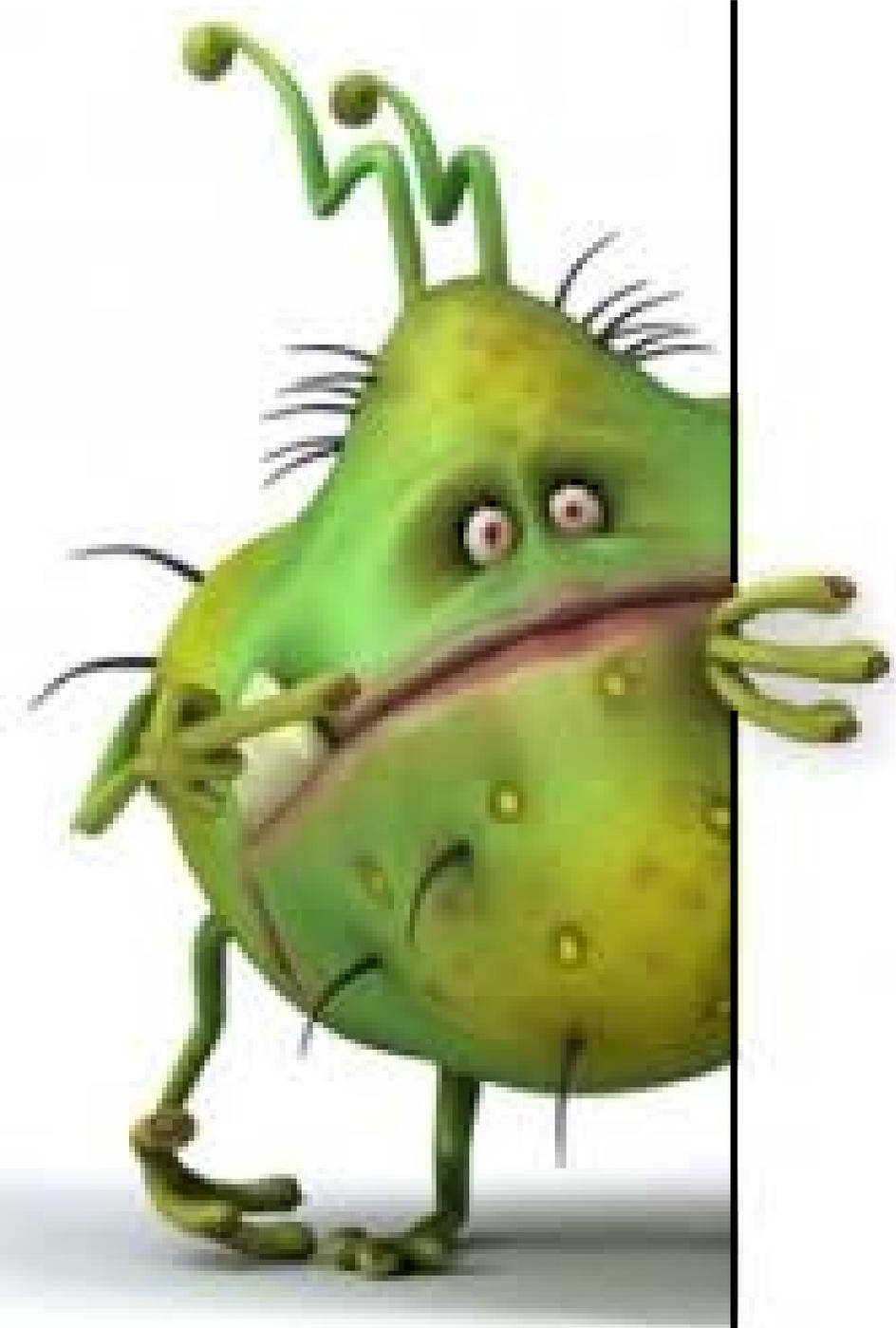
Phormidium strain	02/11/2016	6/28/2016	03/28/2017			
	Total Anatoxin (µg/L) - ELISA	Anatoxin-a (µg/L) - LCMS	Anatoxin-a (µg/g of dry culture) - LCMS	Homoanatoxin-a (µg/g of dry culture) - LCMS	Dihydro-anatoxin-a (µg/g of dry culture) - LCMS	Dihydro-homoanatoxin-a (µg/g of dry culture) - LCMS
Strain 1	525	ND	0.66	ND	331.2	ND
Strain 2	343	ND	0.38	ND	363.4	ND
Strain 3	193	ND	0.47	ND	483.3	ND



Russian River	9/12/2016	Phormidium	8115	6670	1217.0	> 3.0 mg/Kg
Russian River	9/12/2016	Phormidium	3396	7290	466.0	Dry Weight
Eel River	9/15/2016		45.3	800	57.0	
Eel River	9/15/2016	Cylindrospermum	15.6	1850	8.4	Acute for Cattle
Eel River	9/14/2016	Oscillatoria	38.0	4950	7.7	
Eel River	9/15/2016	Geitlerinema	11.5	2370	4.8	
Russian River	9/12/2016	Nostoc (?)	4.84	2140	2.3	
Eel River	9/15/2016	Not Identified	0.68	600	1.1	> 0.3 mg/Kg
Eel River	9/15/2016	Phormidium	12.5	12400	1.0	Dry Weight
Eel River	9/15/2016	Cylindrospermum	7.20	8690	0.8	
South Fork Eel River	9/14/2016		2.87	4120	0.7	Acute for Dogs
Russian River	9/12/2016	Anabaena	1.70	3980	0.4	
South Fork Eel River	9/14/2016	Phormidium	2.80	10200	0.3	
South Fork Eel River	9/14/2016		0.36	1410	0.3	
South Fork Eel River	9/14/2016	Scytonema	2.48	10300	0.2	NONE
Eel River	9/14/2016	Not Identified	0.67	8350	0.1	
Russian River	9/12/2016	Phormidium	0.49	9930	0.1	







Questions?