Cyanotoxins in Midwestern Lakes

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EPA Web Based Expert Workshop on Cyanobacteria and Cyanotoxins

July 30, 2012

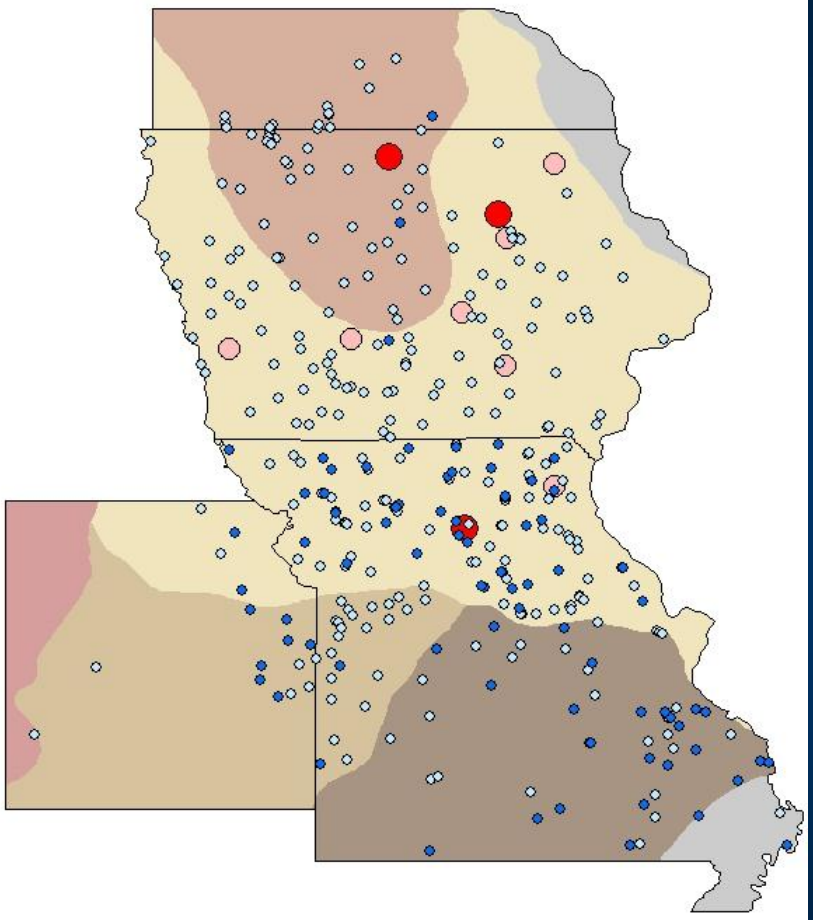
Overview

- Occurrence
- Temporal and Spatial Patterns
- Environmental Influences

St. Johns River, Florida
Photo courtesy of J. Pinto

Ohio Recreational Area
Photo courtesy of L. Merchant-Masonbrink

Microcystins are Widespread and Common in the Midwest

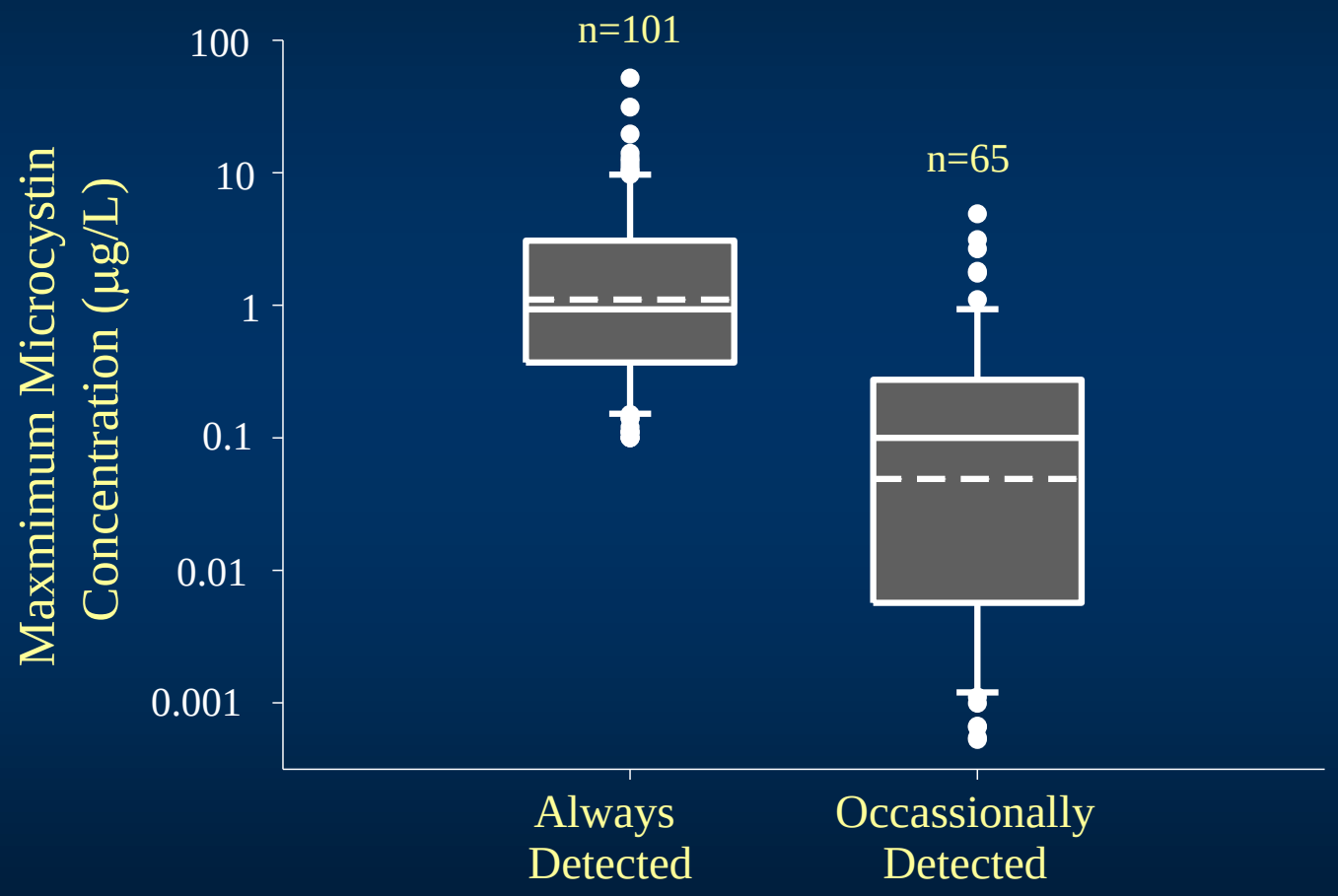


78% of lakes had detections (n=359)

Maximum concentration: 52 µg/L

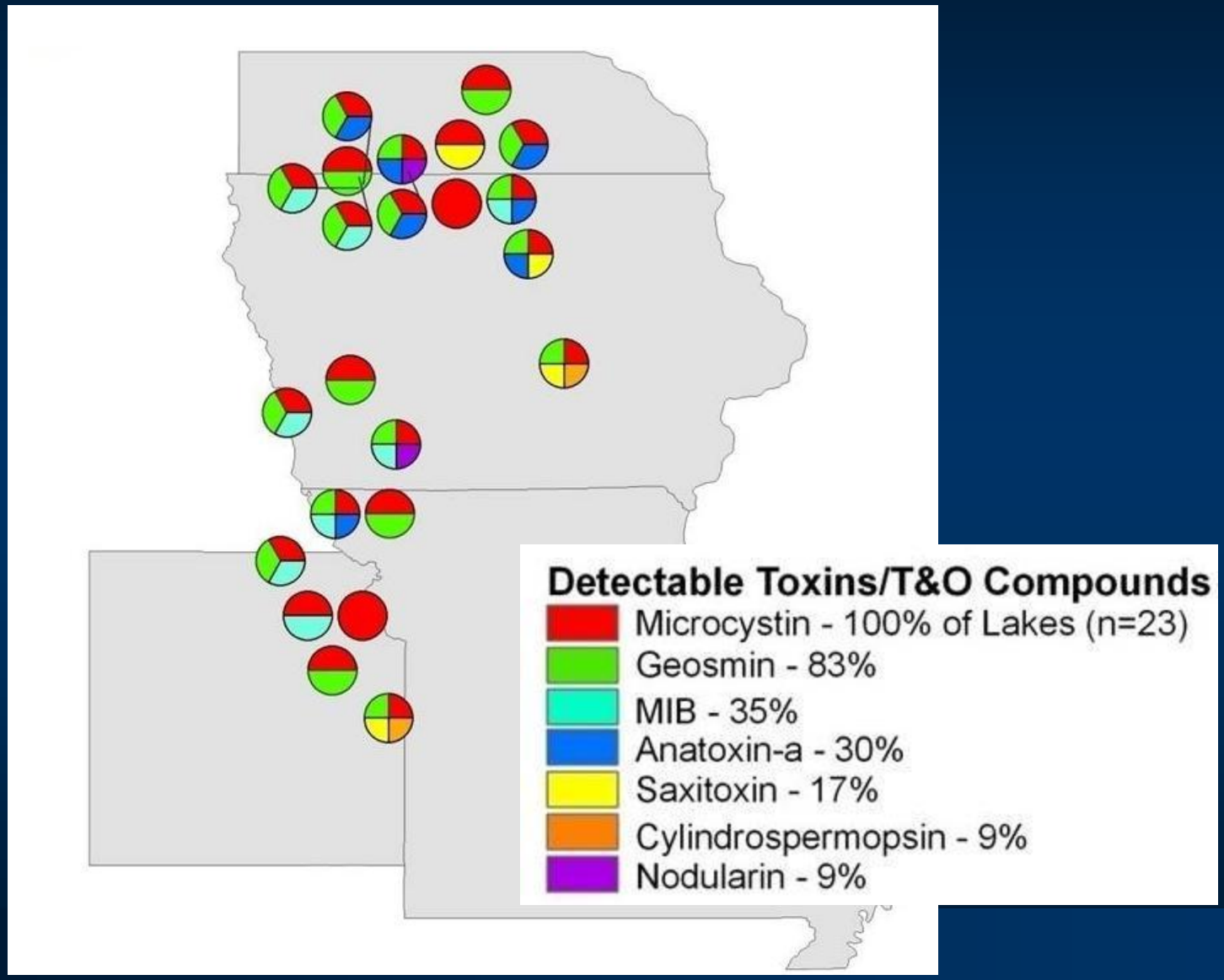
After Graham and others 2004, 2006, and 2009

Lakes with Frequent Microcystin Detections Also Had the Largest Microcystin Concentrations



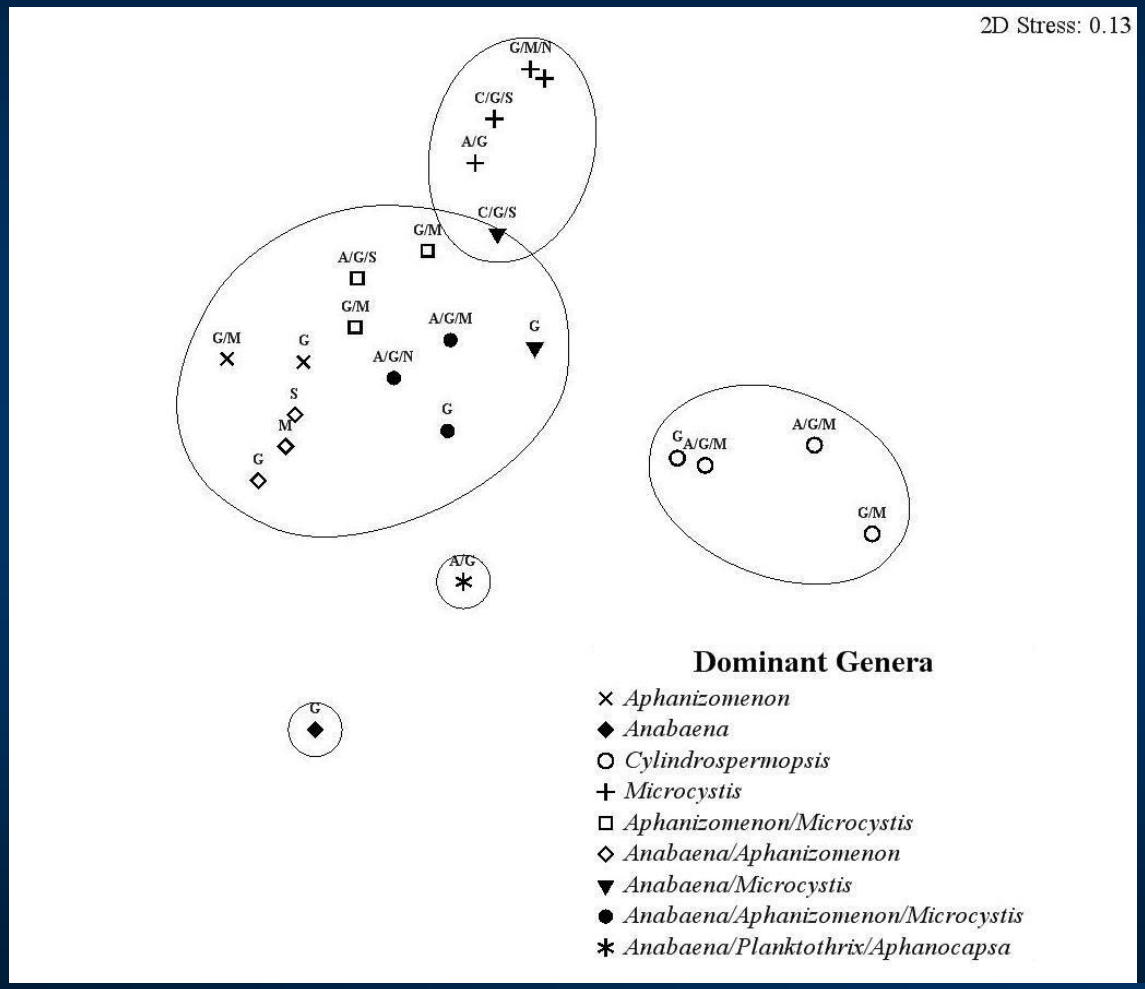
After Graham and others 2004, 2006, and 2009

Multiple Toxins and Taste-and-Odor Compounds Frequently Co-Occur in Cyanobacterial Blooms



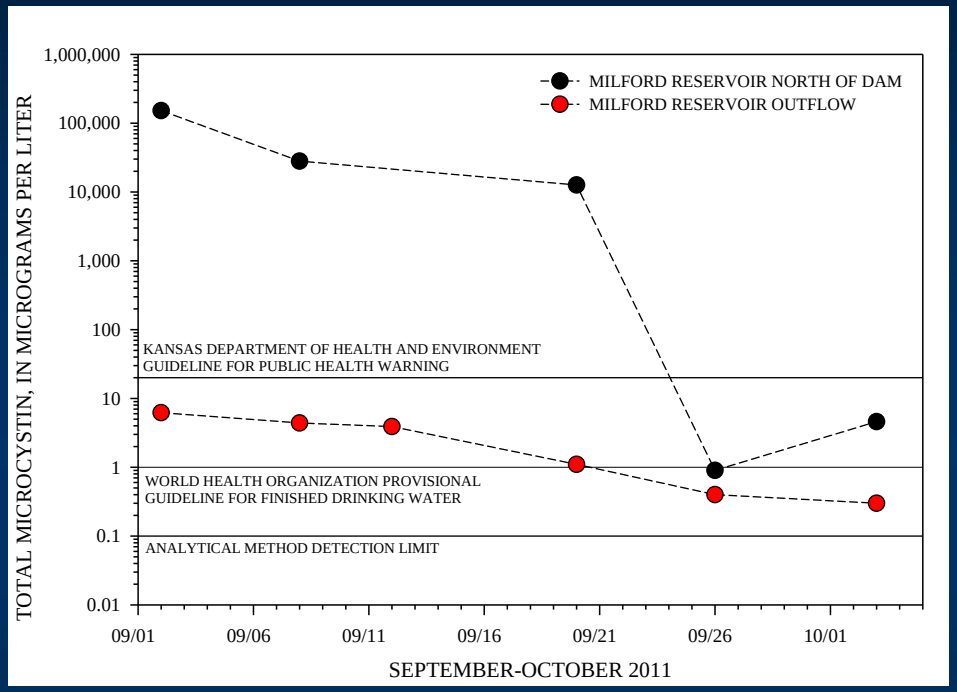
After Graham and others, 2010

Occurrence of Cyanotoxins and Taste-and-Odor Compounds is Not Tightly Coupled to Cyanobacterial Abundance or Community Composition



After Graham and others, 2010

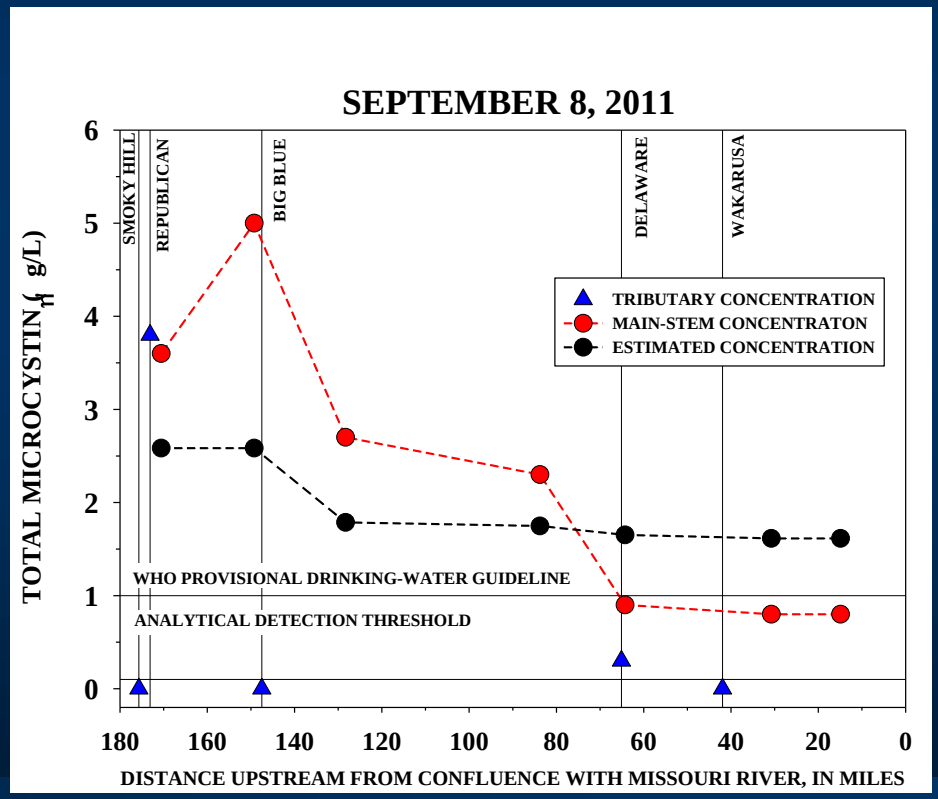
Cyanobacterial Toxins and Taste-and-Odor Compounds May Be Transported for Relatively Long Distances Downstream from Lakes and Reservoirs



Milford Lake release sends algae to Kansas River

MARIA SUDEKUM FISHER, Associated Press

Published 09:10 p.m., Wednesday, September 21, 2011

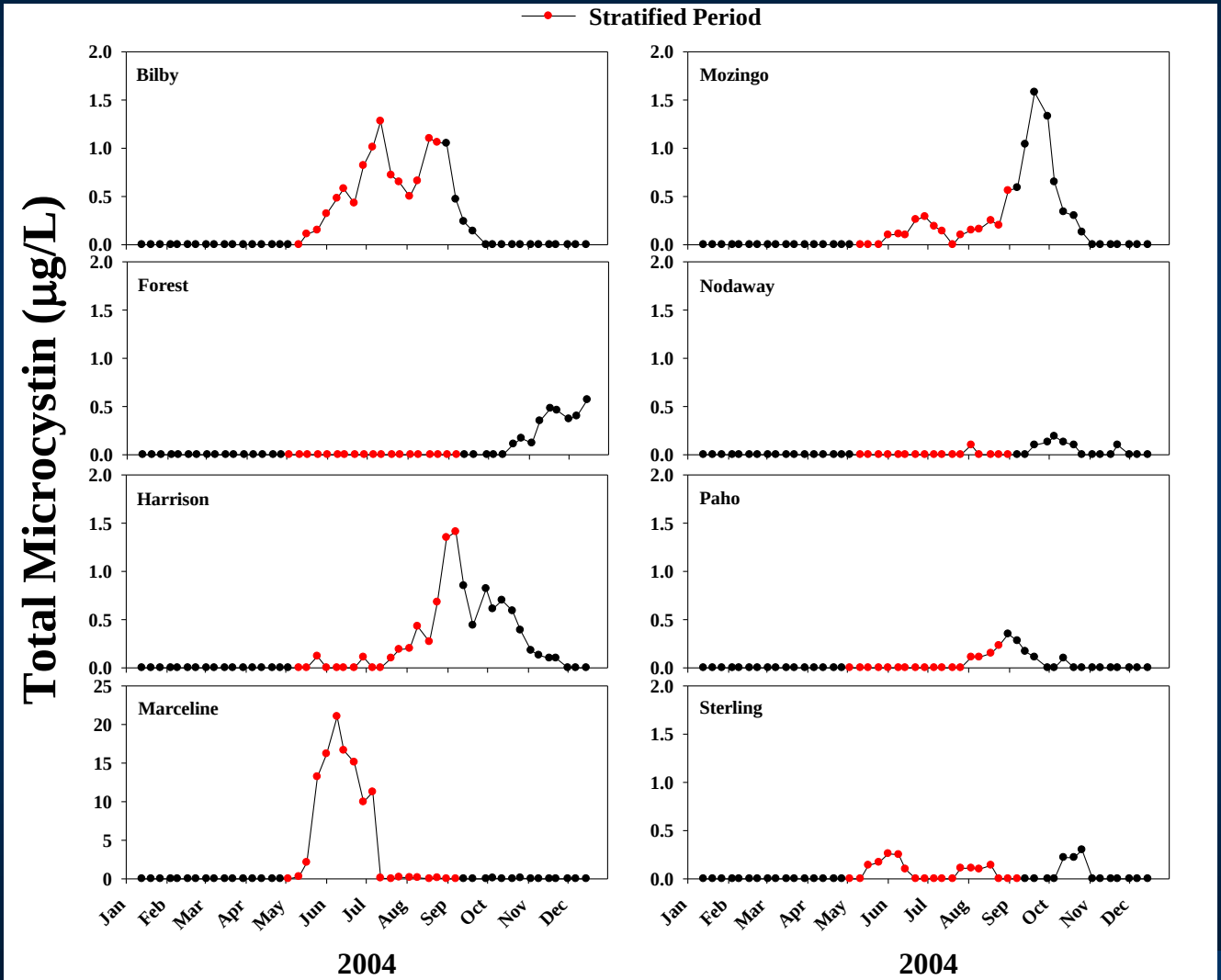


USGS science for a changing world

http://pubs.usgs.gov/sir/2012/5129/

Graham and others, 2012

Seasonal Patterns in Microcystin Concentration are Unique to Individual Lakes and Peaks May Occur Anytime Throughout the Year



After Graham and others, 2006

Temporal and Spatial Patterns

Vertical Migration or Wind Movement of Surface Accumulations May Rapidly Change the Areal Distribution of Cyanobacteria

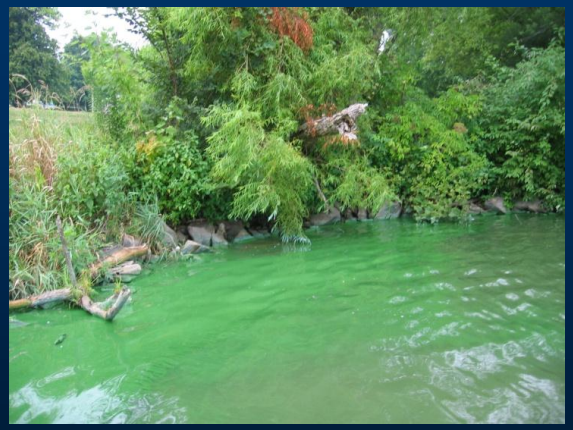
Rock Creek Lake, Iowa
2006 Beach Closure Event

Beach Area
Monday
July 31

Photos Courtesy of IA DNR

Beach Area
Thursday
August 3

Photo Courtesy of IA DNR



Boat Ramps
Friday
August 11

Temporal and Spatial Patterns

Vertical Migration or Wind Movement of Surface Accumulations May Rapidly Change the Aerial Distribution of Cyanobacteria

Rock Creek Lake, Iowa
2006 Beach Closure Event

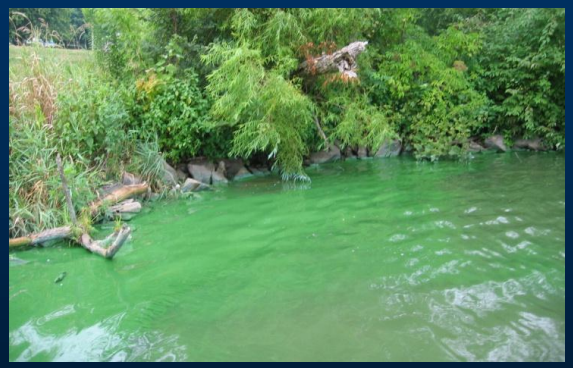
Beach Area

Beach Area
Thursday
August 3

WHERE DID THE CYANOBACTERIA GO?

Most likely explanation is redistribution in the water column

Photos Courtesy of IA DNR



Boat Ramps
Friday
August 11

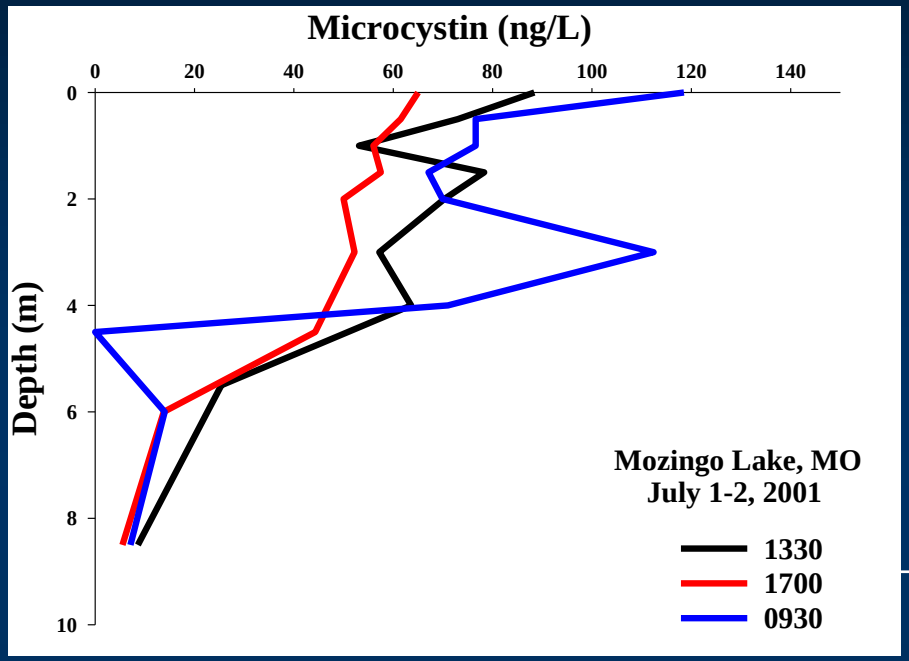
Sample Concentrations Can Vary Considerably Depending on When, Where, and How Samples Are Collected

Microcystin: 13 µg/L
Geosmin: 0.25 µg/L

Microcystin: 4 µg/L
Geosmin: Not Detected

Cheney Reservoir, Kansas
September, 2006

Sample Concentrations Can Vary Considerably Depending on When, Where, and How Samples Are Collected

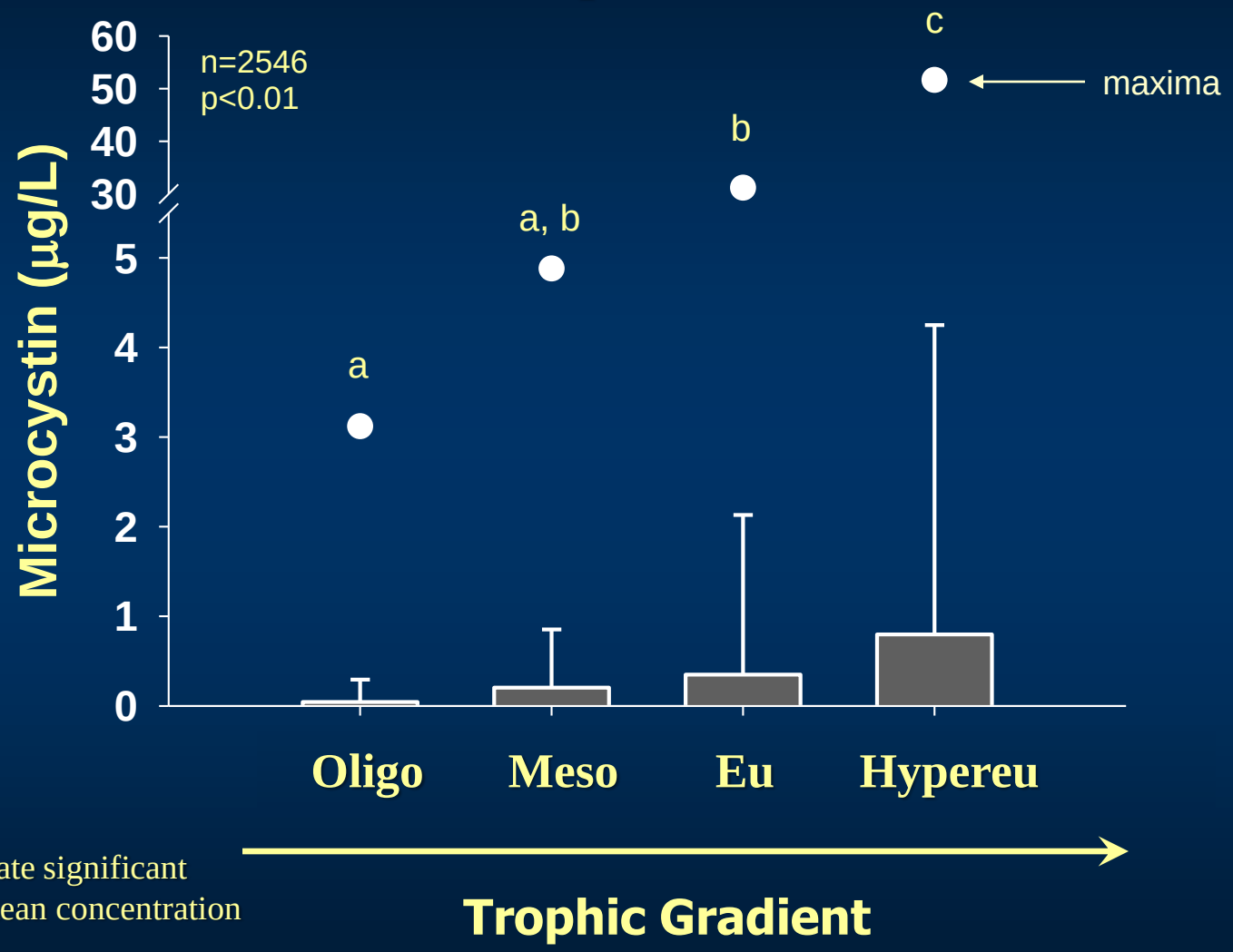


Microcystis aeruginosa colonies

	Sample Type and Microcystin Concentration (ng/L)			
Time	Surface	Integrated Photic Zone	Integrated Epilimnion	Integrated Water Column
0930	118	74	84	61
1330	88	64	70	58
1700	65	50	55	45

After Graham and others, 2006

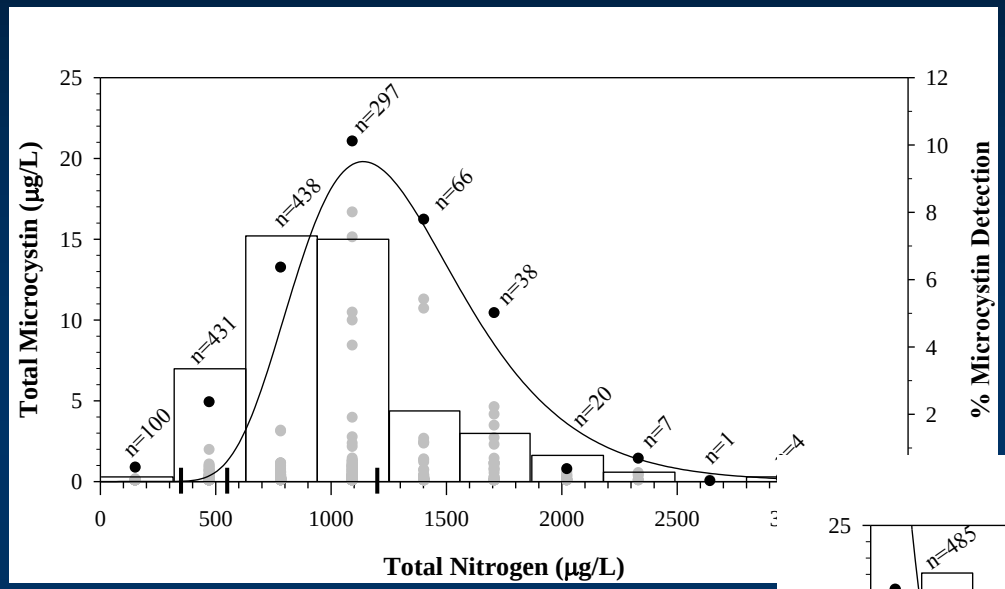
Microcystin Occurrence and Concentration Increases with Trophic Status

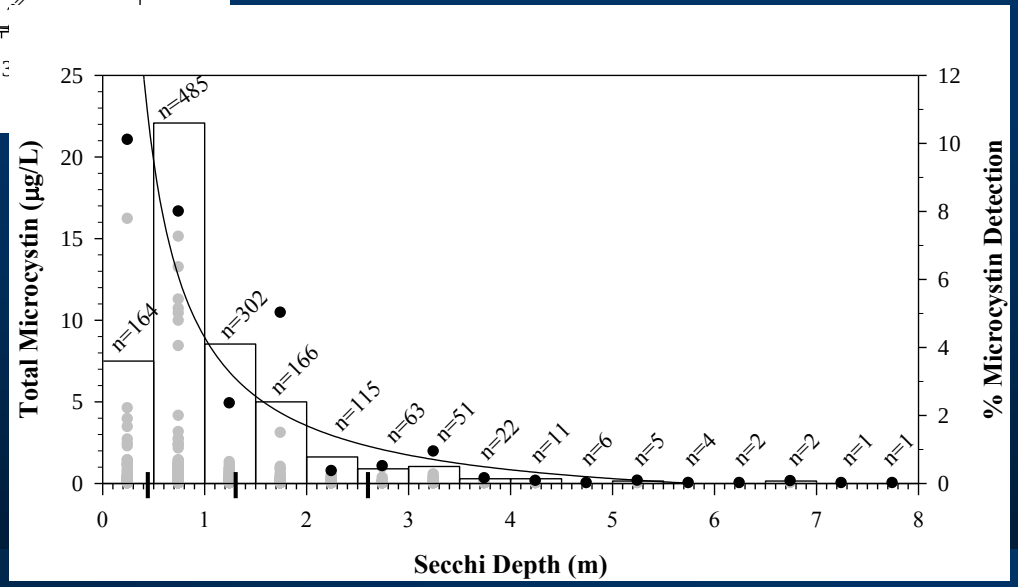


a, b, and c indicate significant differences in mean concentration

After Graham and others 2004, 2006, and 2009

Regional Associations Between Microcystin and Environmental Variables Are Not Linear





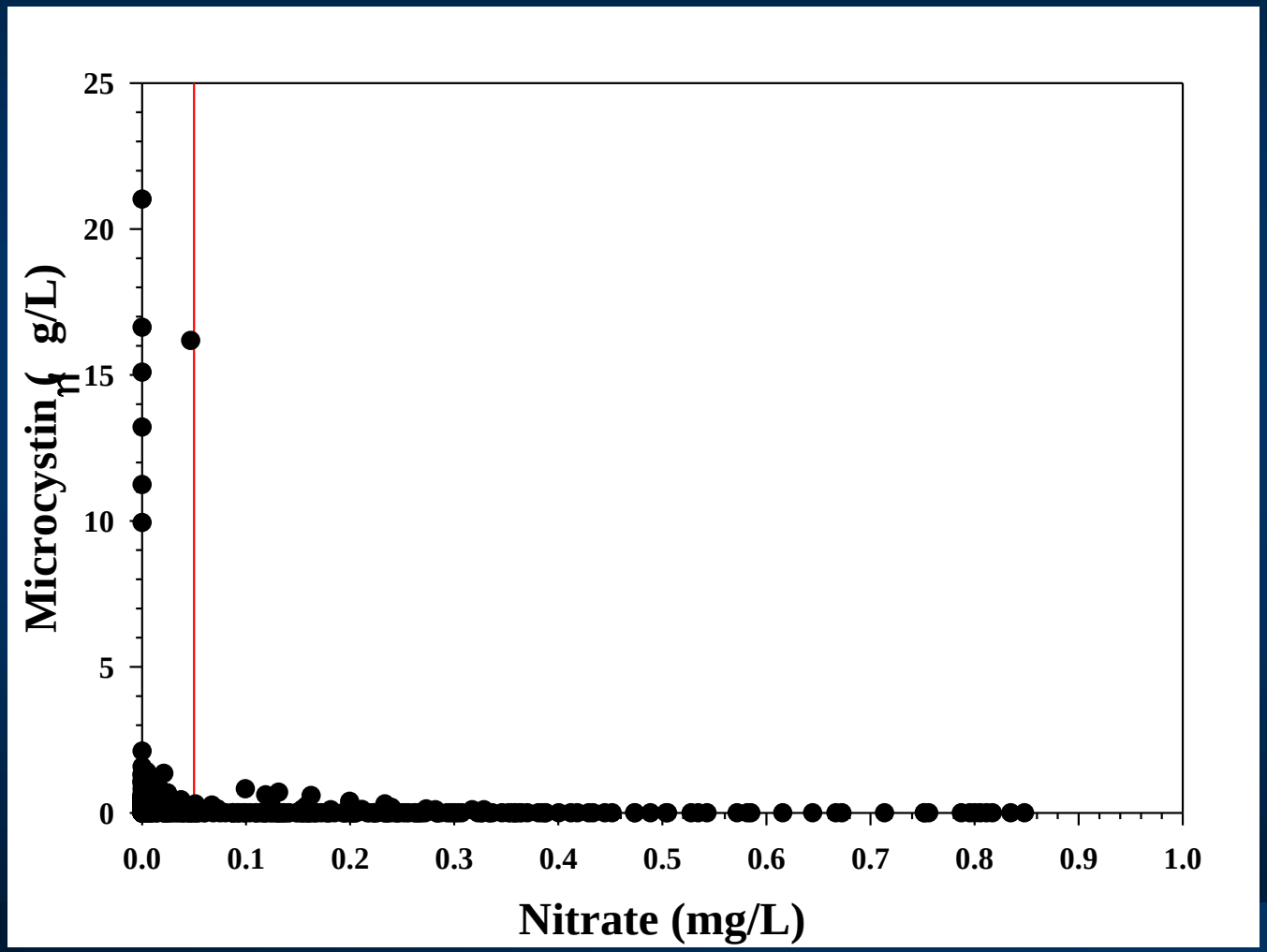
After Graham and Jones, 2009

There is No Single Environmental Variable that is Consistently Associated with Microcystin Occurrence and Concentration

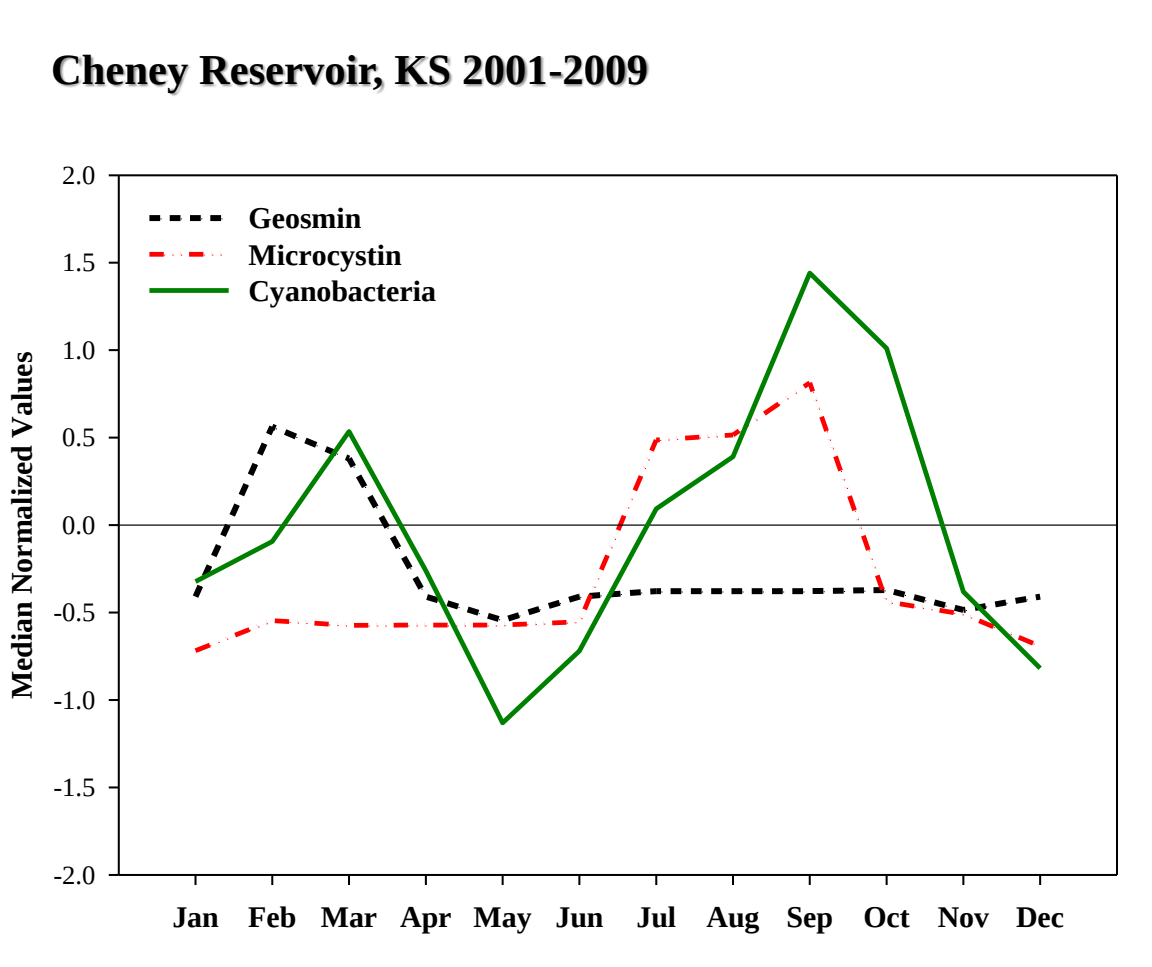
Reservoir*	Strongest Correlate	r_s	p-value	n
Bilby	Conductance	-0.86	<0.01	48
Forest	Chlorophyll > 35 µm	0.67	<0.01	49
Harrison	Total Nitrogen	0.78	<0.01	49
Marceline	Dissolved Organic Carbon	0.66	<0.01	49
Mozingo	Magnesium	-0.84	<0.01	13
Nodaway	Nitrate	-0.46	<0.01	49
Paho	*Ceriodaphnia* abundance	0.81	<0.01	28
Sterling	Sodium	0.60	0.03	13

*Reservoirs were sampled weekly during January-December 2004

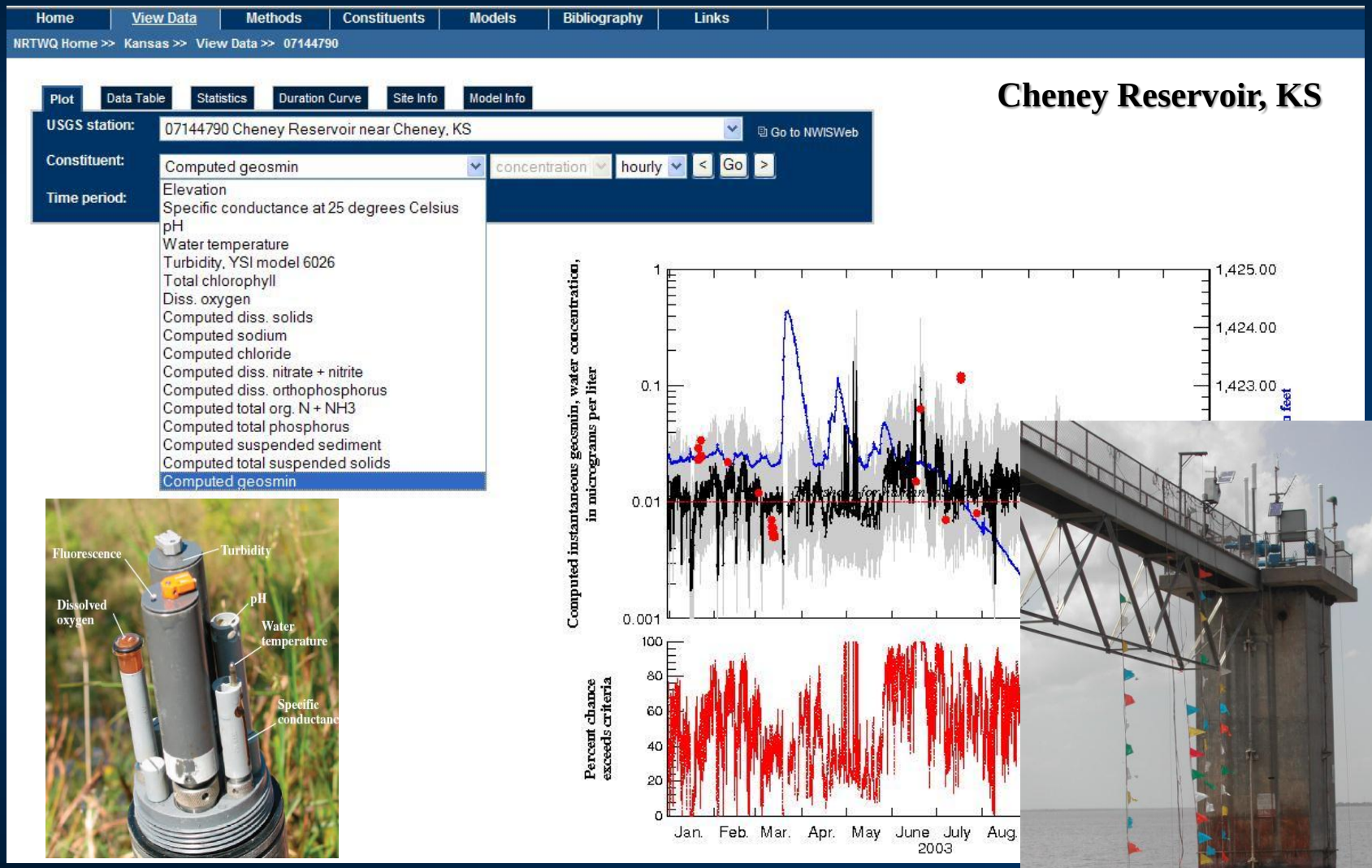
Thresholds and Probabilities May Better Define Relations Between Environmental Variables and Microcystin Occurrence and Concentration



Seasonal Patterns and Environmental Influences May Be Relatively Consistent Between Years in Some Lakes



Continuous Water-Quality Monitors Can Be Used to Develop Models to Compute Geosmin Concentrations in Real Time

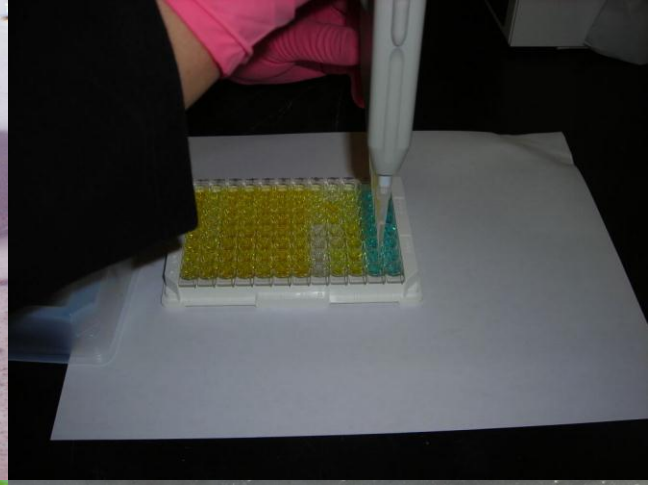


http://nrtwq.usgs.gov/ks/

Conclusions

- Cyanobacterial blooms and associated toxins and taste-and-odor compounds commonly occur in the Midwestern United States.
- The cyanotoxin microcystin is common in the Midwest and may reach levels that can cause health concerns.
- Much more study is needed to develop reliable means of predicting and responding to cyanobacterial blooms to ensure public health protection.

Milford Lake, Kansas
September 2011



Additional Information:

http://ks.water.usgs.gov/studies/qw/cyanobacteria/

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