Cyanobacteria and Associated Compounds in the Kansas and Ohio Rivers

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KDHE Harmful Algal Blooms Stakeholder Meeting

January 7, 2016

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U.S. Department of the Interior
U.S. Geological Survey

January 2016

2011 Harmful Algal Blooms and Reservoir Releases in the Kansas River Watershed

Kansas River serves as a drinking water supply for 800,000 Kansans

Missouri River Flooding + Late Summer Reservoir Releases + Harmful Algal Blooms = Concerns About Transport of Cyanotoxins and Taste-and-Odor Compounds Potentially Affecting Drinking Water Supplies

Milford Lake, September 2011
Photo courtesy of E. Looper, USGS

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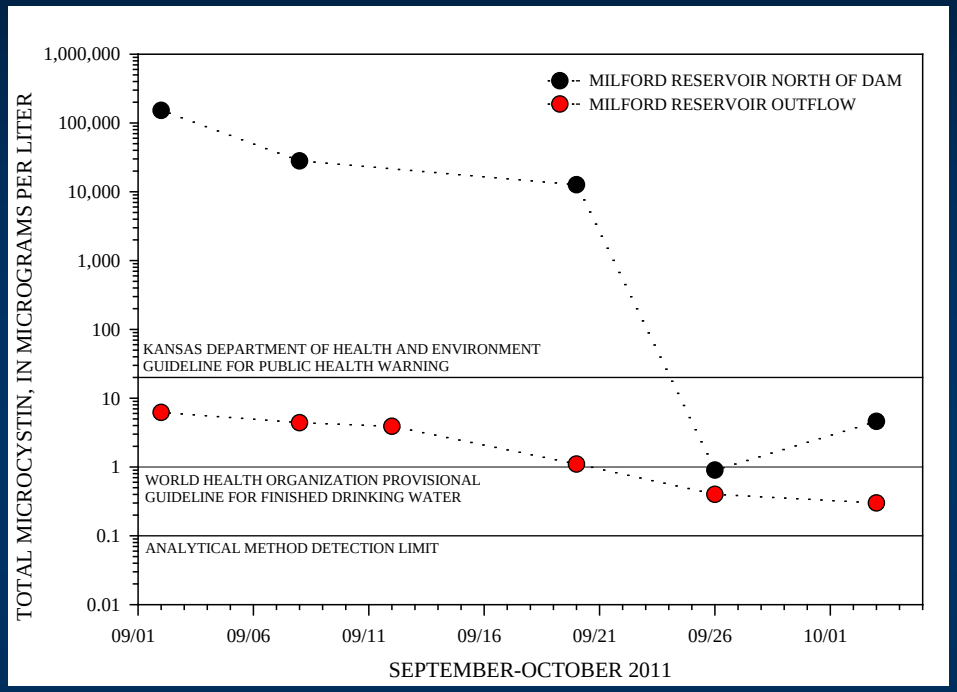
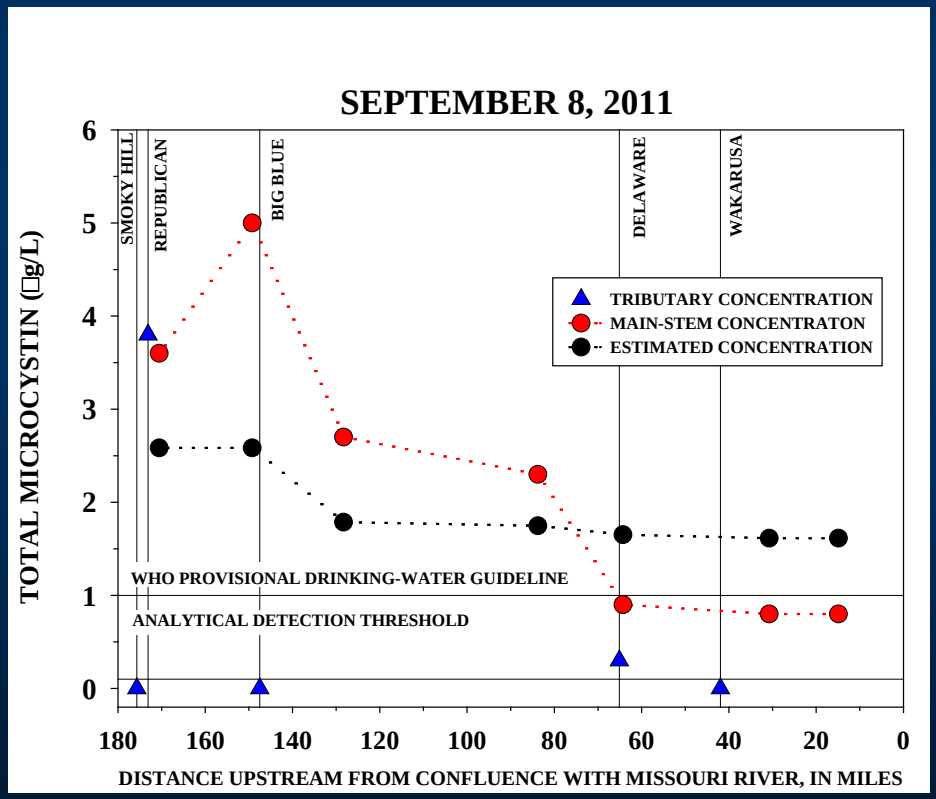
Water Office

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





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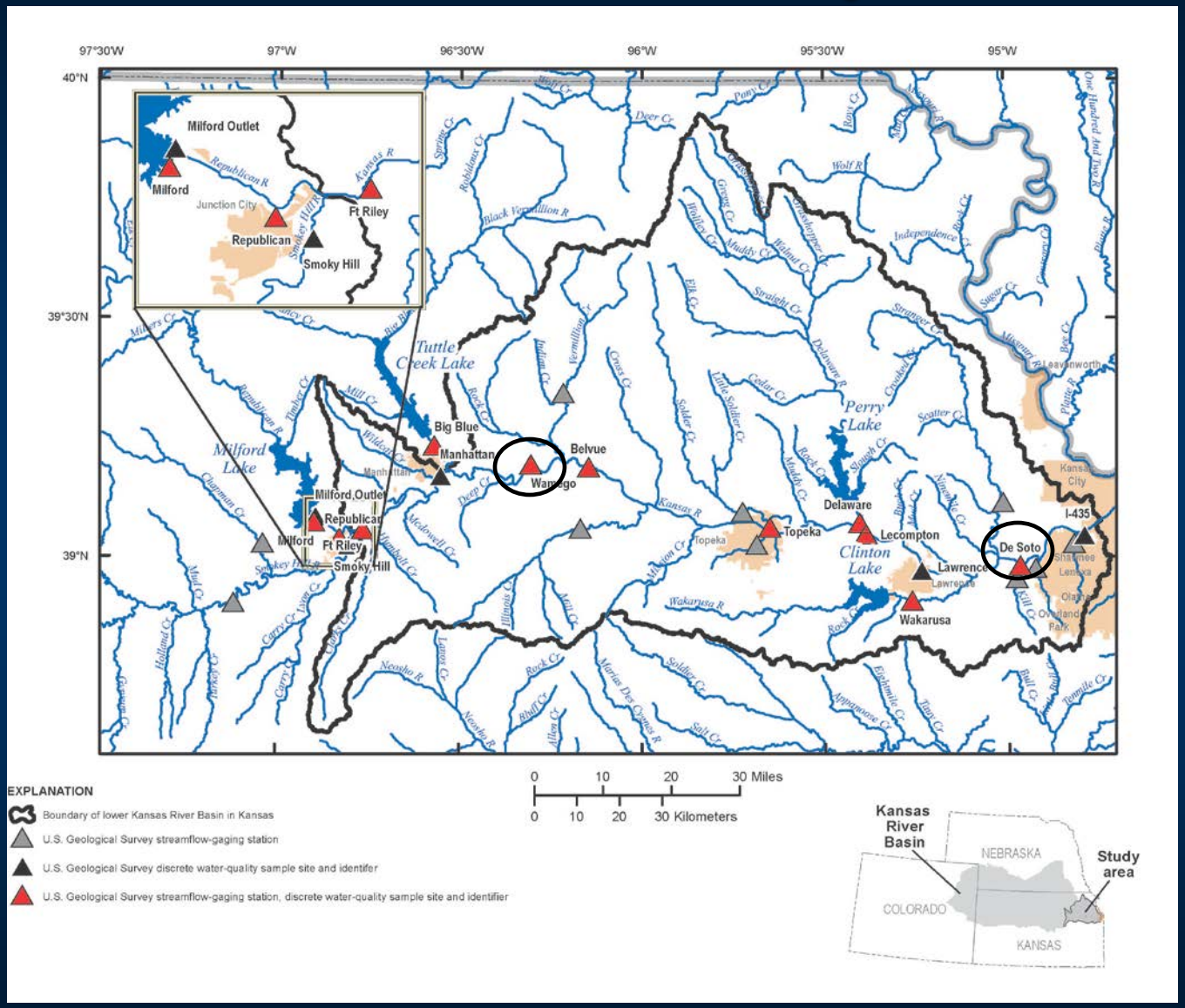
http://pubs.usgs.gov/sir/2012/5129/

Graham and others, 2012

5 Year Study in the Kansas River - Objectives

- Characterize sources, frequency of occurrence, and potential causes of cyanobacteria and associated compounds in the Kansas River.
- Develop models to provide real-time estimates for a number of constituents, including cyanotoxins and taste-and-odor compounds.

Kansas River Study Sites



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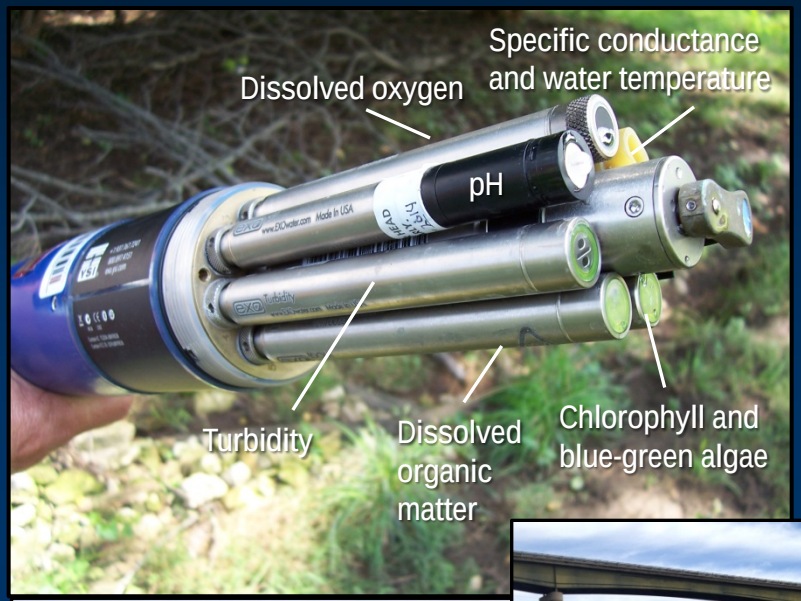
5 Year Study in the Kansas River - Approach

- Real-time water-quality monitors at USGS streamgages at Wamego and De Soto.
- Routine sample collection at these 2 sites about 18 times per year; reservoir outflows sampled during releases and cyanobacterial blooms.



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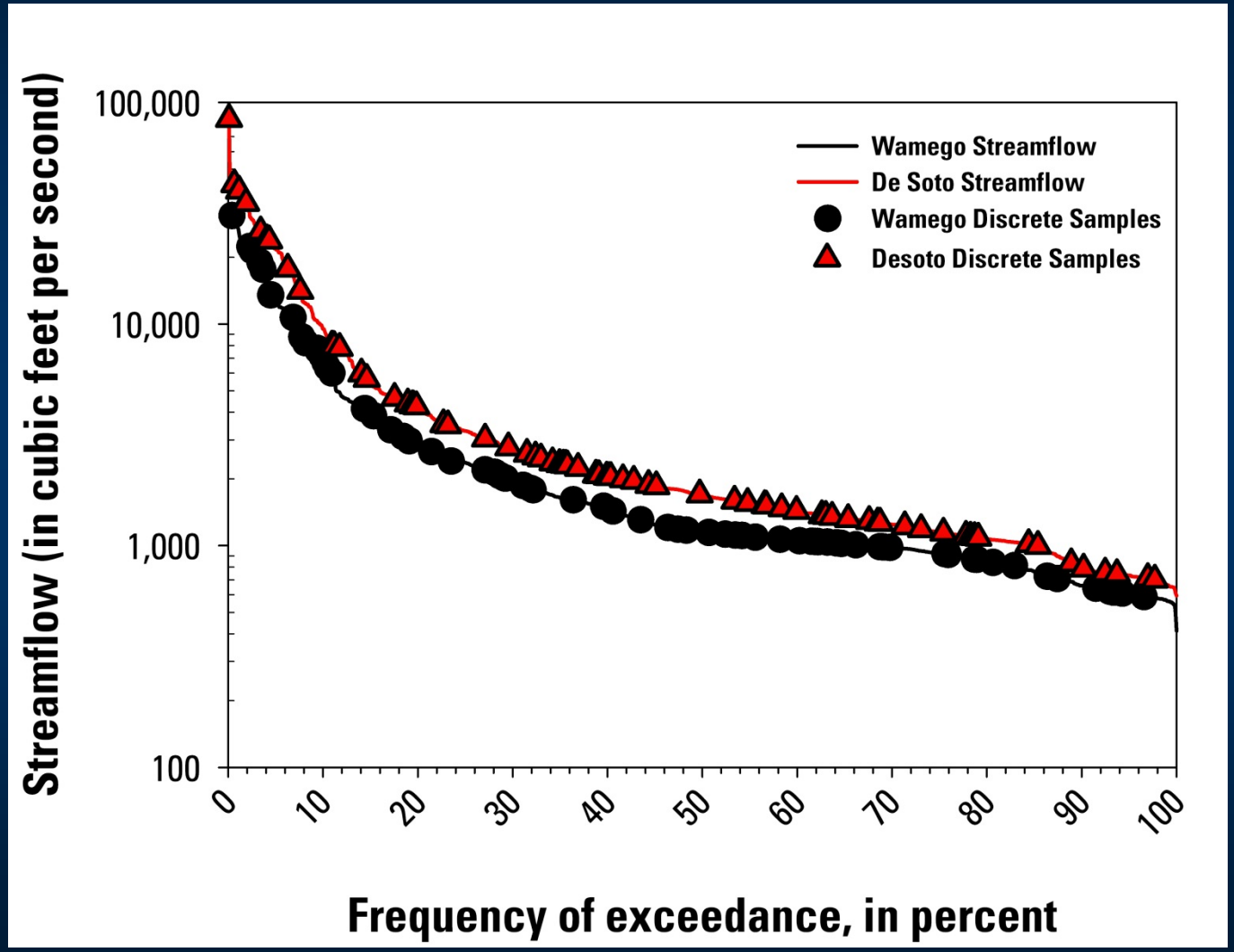
Discrete Samples Have Been Collected Over a Range of Streamflow Conditions, Including Reservoir Releases



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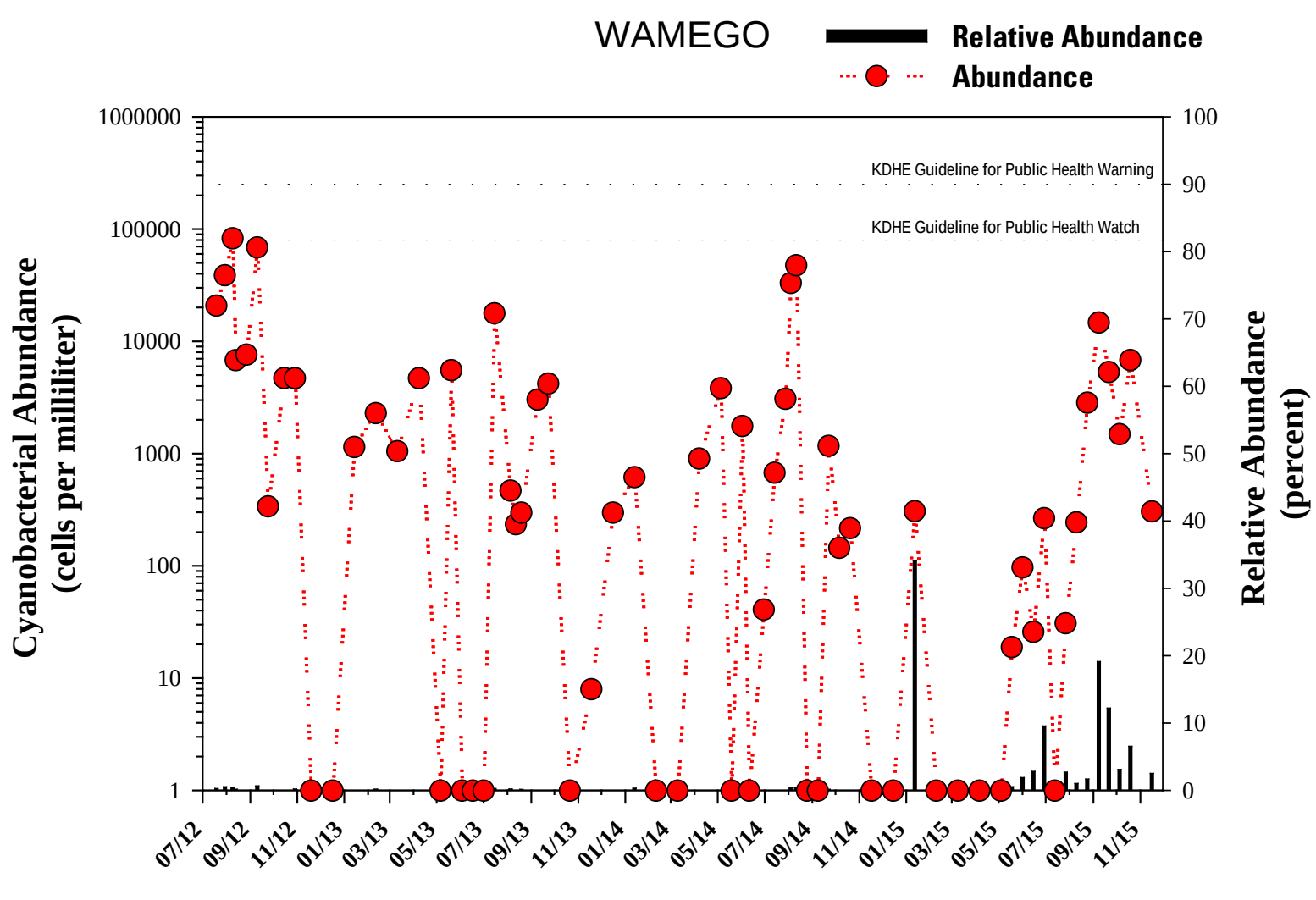
Cyanobacteria Rarely Dominated the Phytoplankton Community at Wamego During July 2012-November 2015



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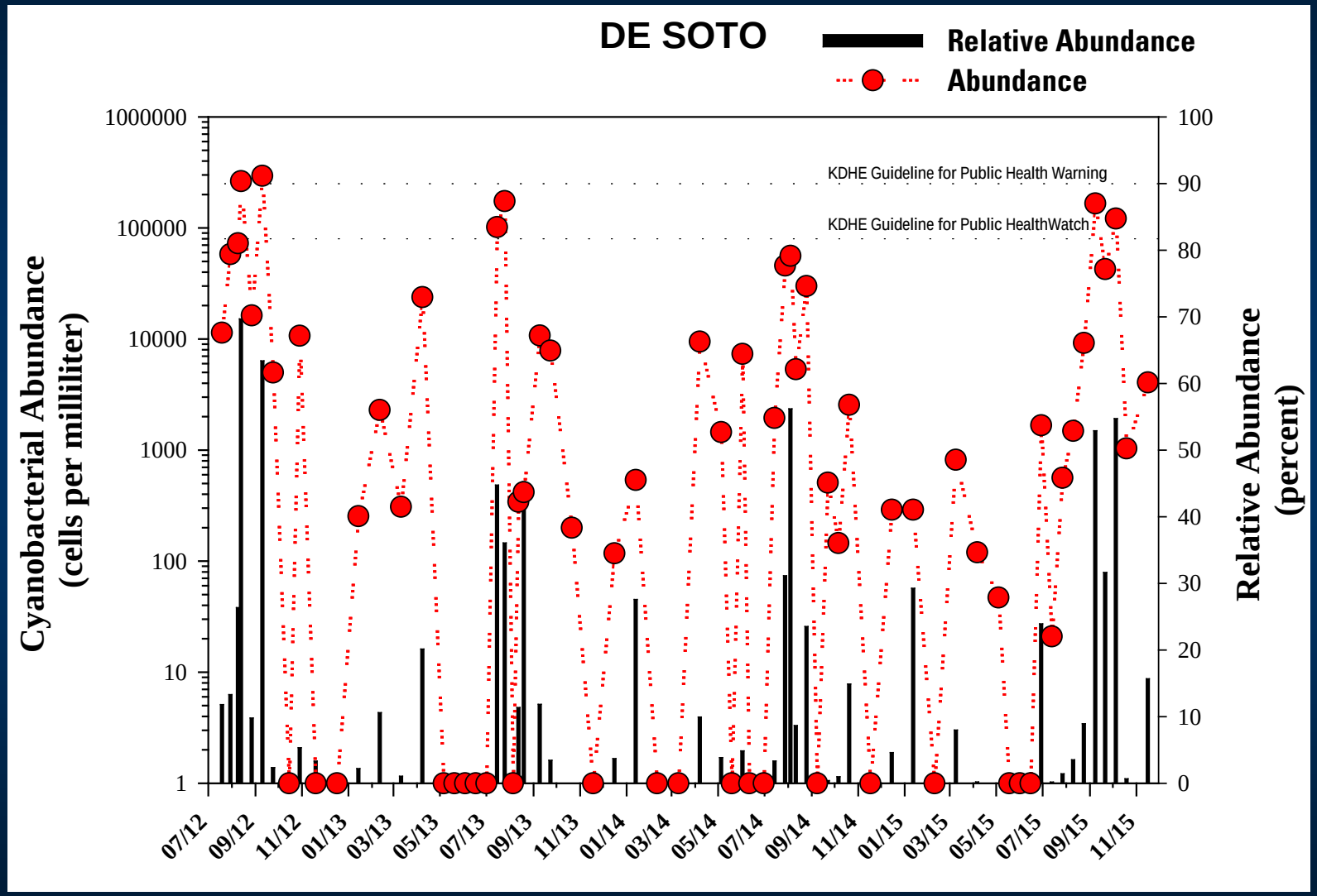
Cyanobacteria Were More Abundant at De Soto than Wamego, But Rarely Dominated the Phytoplankton Community During July 2012-November 2015



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Potential Microcystin and Taste-and-Odor Producers in the Kansas River July 2012-November 2015

Potential Taste-and-Odor Producers

- *Anabaena*, *Aphanizomenon*, *Oscillatoria*, *Phormidium*, *Planktolyngbya*, *Pseudanabaena*
- Present in 58% of samples (n=130) collected during July 2012-November 2015

Potential Microcystin Producers

- *Anabaena*, *Anabaenopsis*, *Aphanocapsa*, *Microcystis*, *Oscillatoria*, *Phormidium*, *Planktolyngbya*, *Pseudanabaena*
- Present in 48% of samples (n=130) collected during July 2012-November 2015

Geosmin was Detected More Frequently at the Kansas River Study Sites than Microcystin or MIB during July 2012-November 2015

Site	n	% MC[1] Detection	% MIB[2] Detection	% GEOS[2] Detection
Wamego	73	23	44	71
De Soto	74	23	34	84
Republican	23	56	61	91
Big Blue	17	12	82	65
Delaware	22	8	64	95
Overall	**209**	**27**	**47**	**81**

[1]Microcystin was analyzed by –adda specific ELISA with an analytical detection threshold of 0.1 µg/L
[2]Geosmin and MIB were analyzed by GC/MS with an analytical detection threshold of 1.0 ng/L

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Microcystin was Detected in 27% of Samples Collected at the Kansas River Study Sites from July 2012 through November 2016

Site	n	MC > 0.1 µg/L (n)	MC > 0.3 µg/L (n)	MC > 1.6 µg/L (n)
Wamego	73	17	5	1
De Soto	74	17	6	3
Overall	**147**	**34**	**11**	**4**

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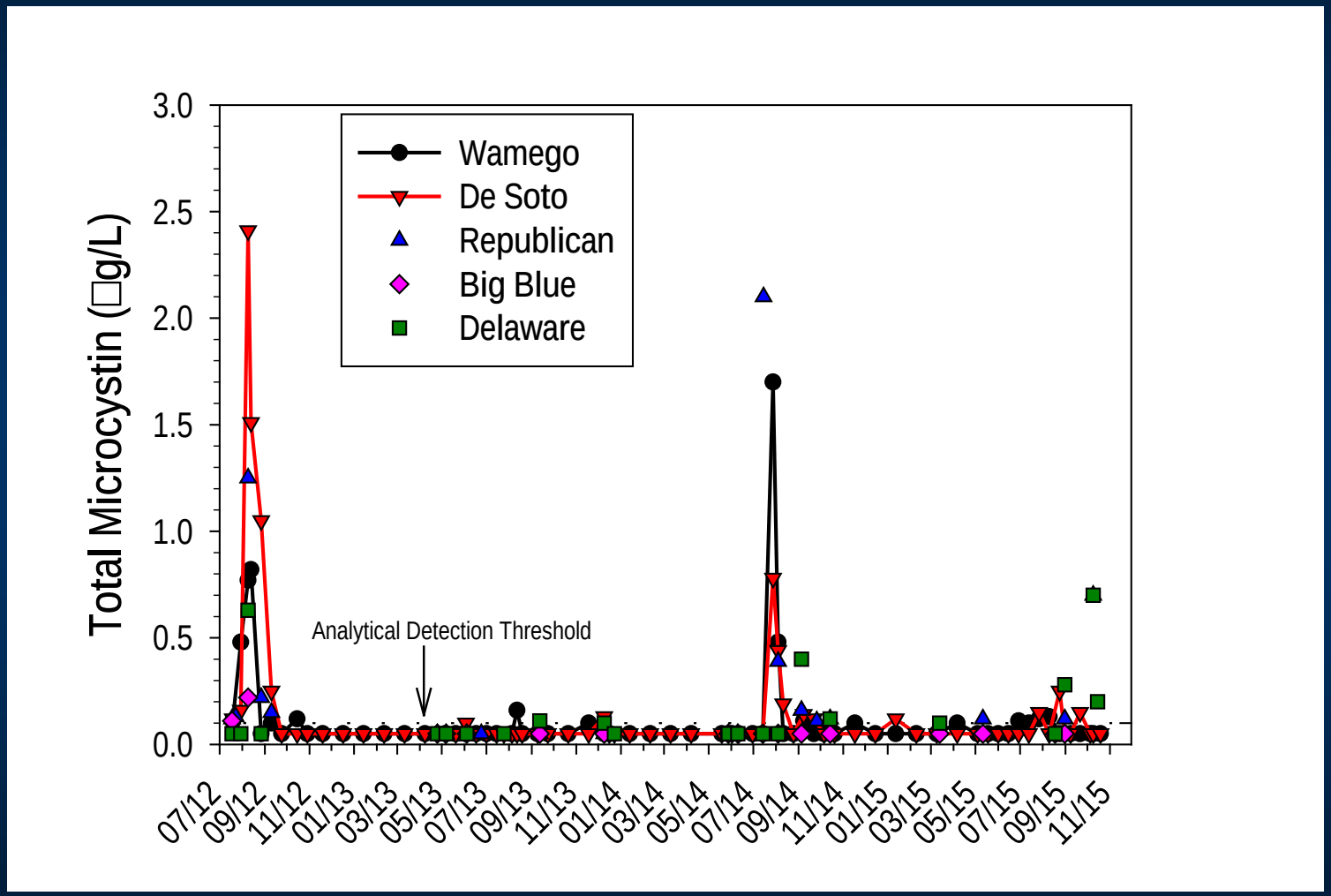
Water Office

With the Exception of Late Summer 2012 and 2014, Microcystin Detections in the Kansas River Have Been Relatively Uncommon



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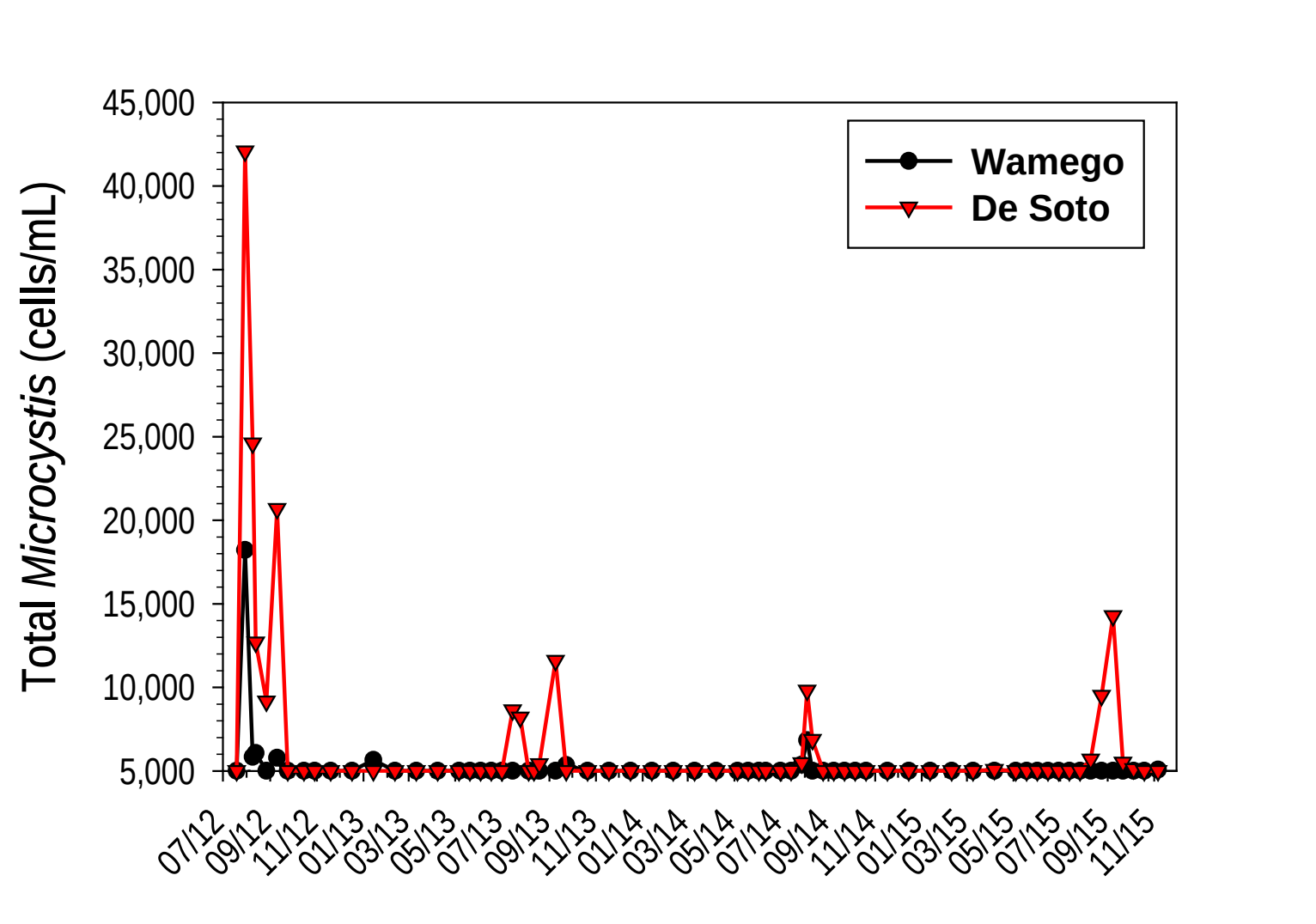
Microcystin Occurrence in the Kansas River is Associated with *Microcystis*



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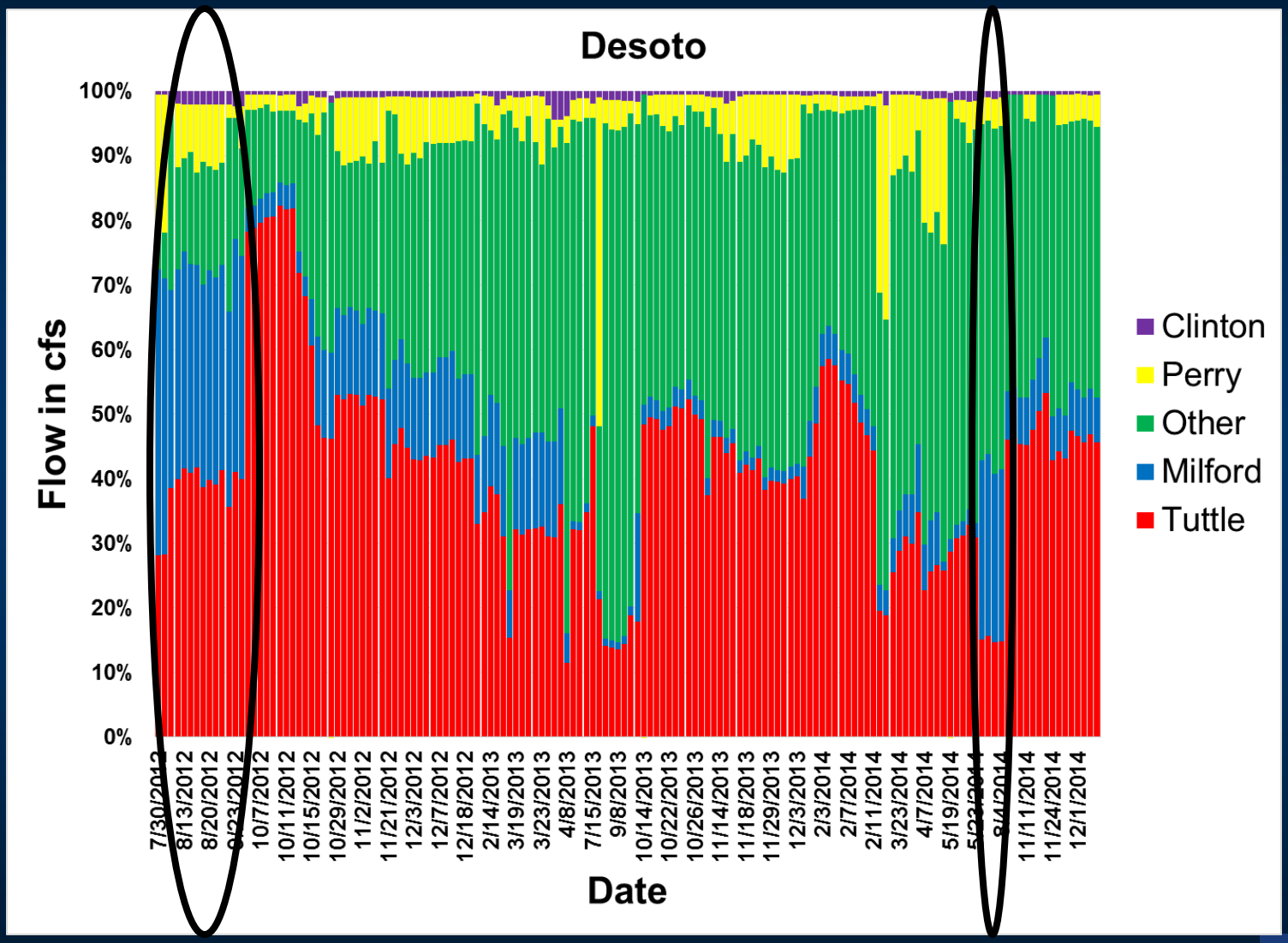
Microcystin Occurrence in the Kansas River is Associated with Flow Contributions from Milford Reservoir Greater than 30%



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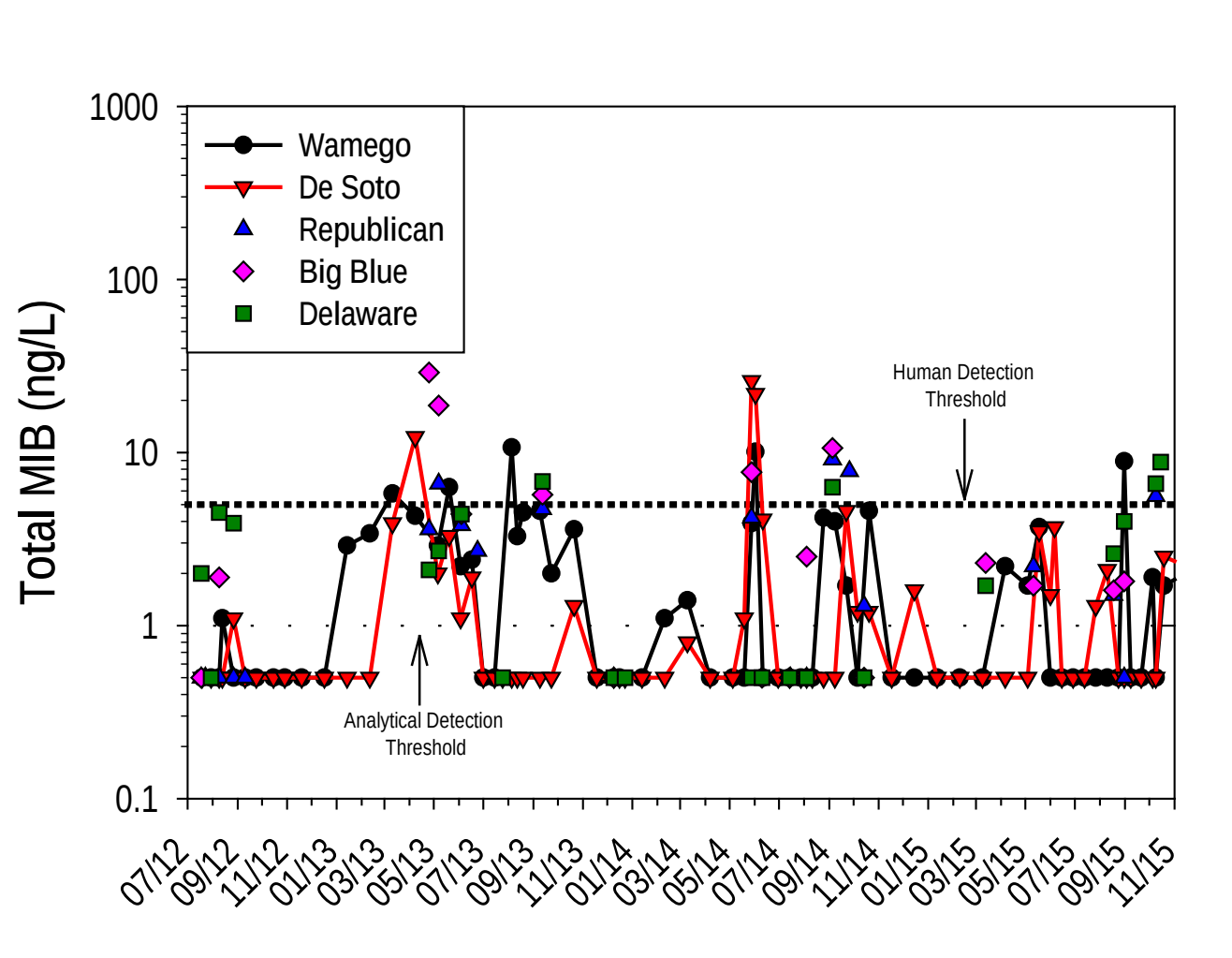
MIB Dynamics Differed Among Sites and Relations with the Cyanobacterial Community and Flow Conditions were More Complex than Microcystin Relations



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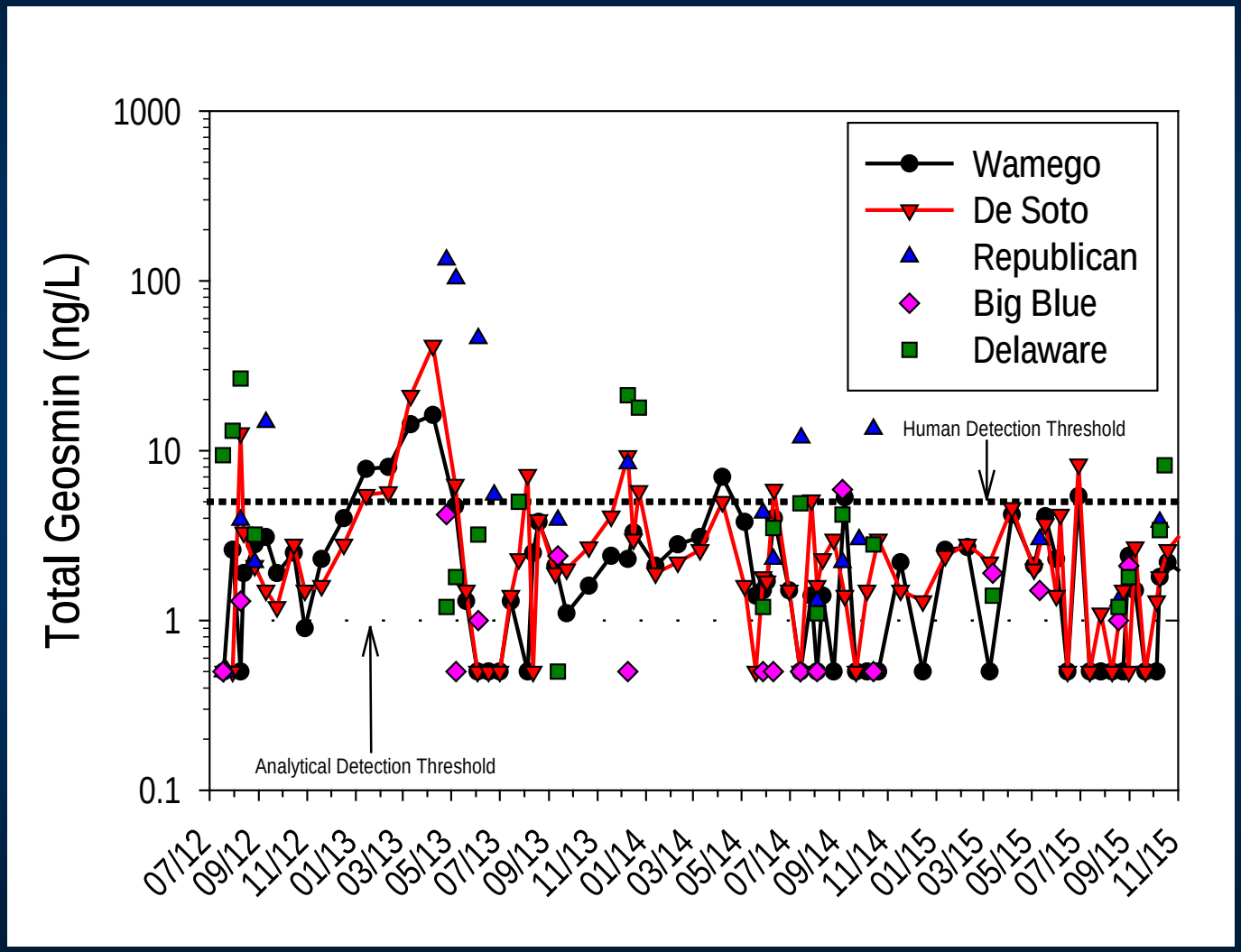

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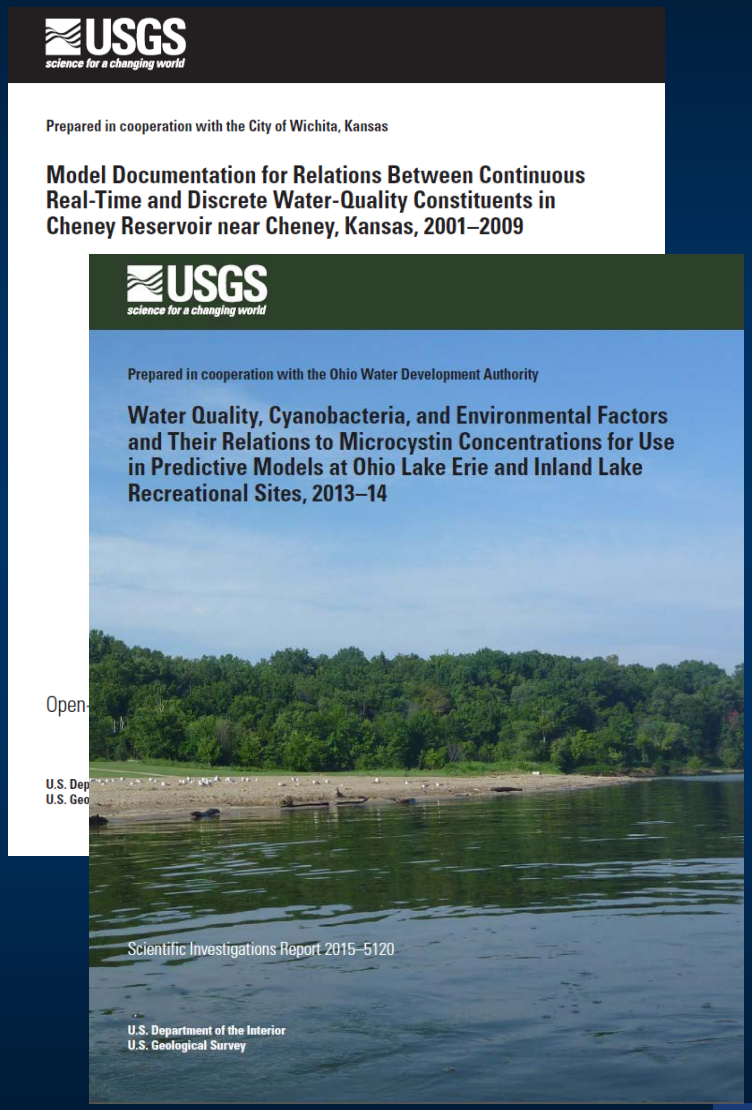
Real-Time Water-Quality Notification System for the Kansas River

- Real-time water-quality notification systems have been successfully developed for Cheney Reservoir and recreational beaches in Ohio.
- Logistic regression models for the Kansas River have been developed for cyanobacterial abundance, geosmin, and microcystin.
- The report for the logistic regression models is in preparation for publication.



Cheney Report: http://pubs.usgs.gov/of/2013/1123/
Ohio Report: http://pubs.er.usgs.gov/publication/sir20155120

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Kansas River Study - Next Steps

- Online publication of real-time water-quality models.
- Validation and verification of models through continued data collection.
- Final analyses for interpretive report for publication in 2017.

Kansas River at Wamego, September 22, 2014

Kansas River at De Soto, September 22, 2014

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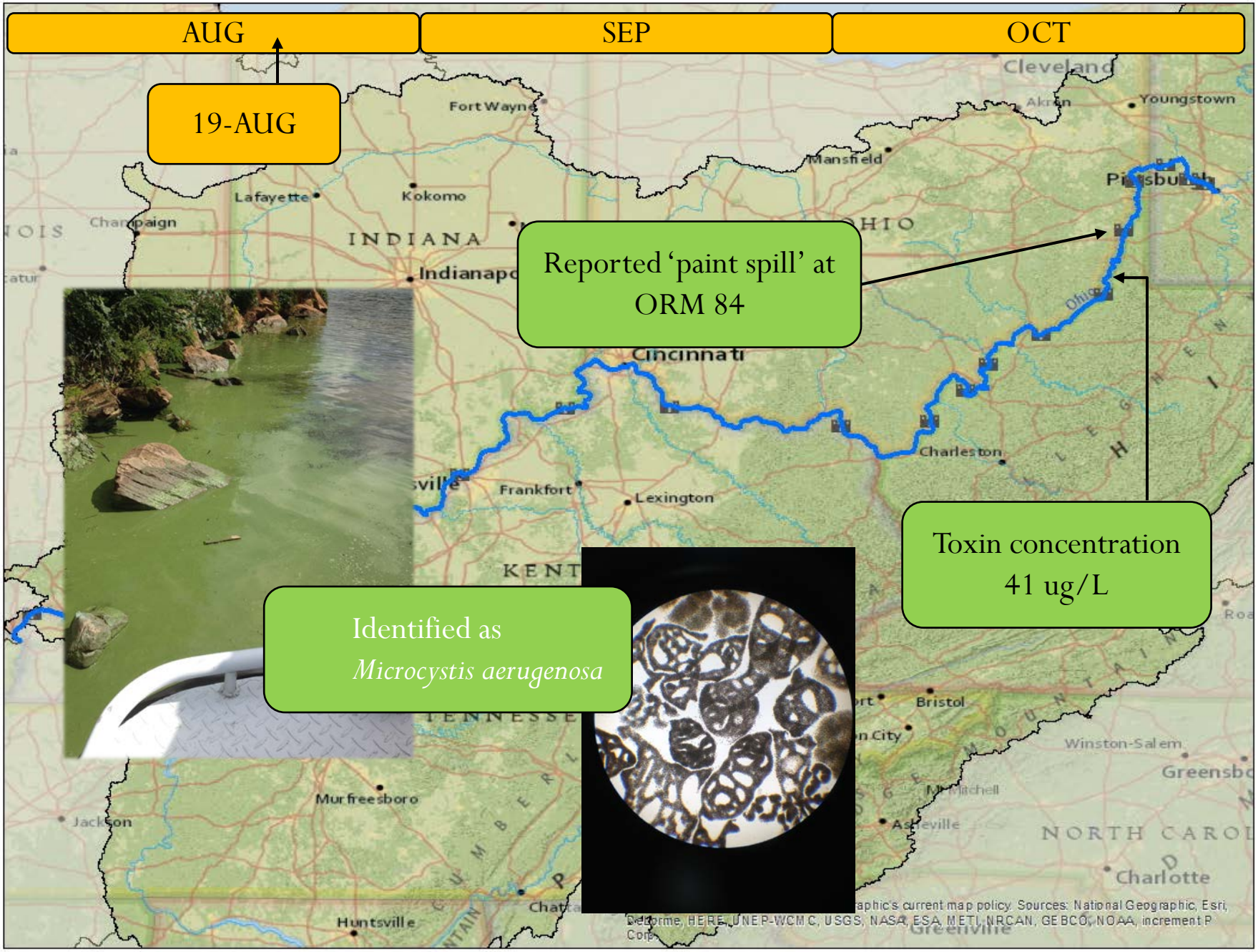
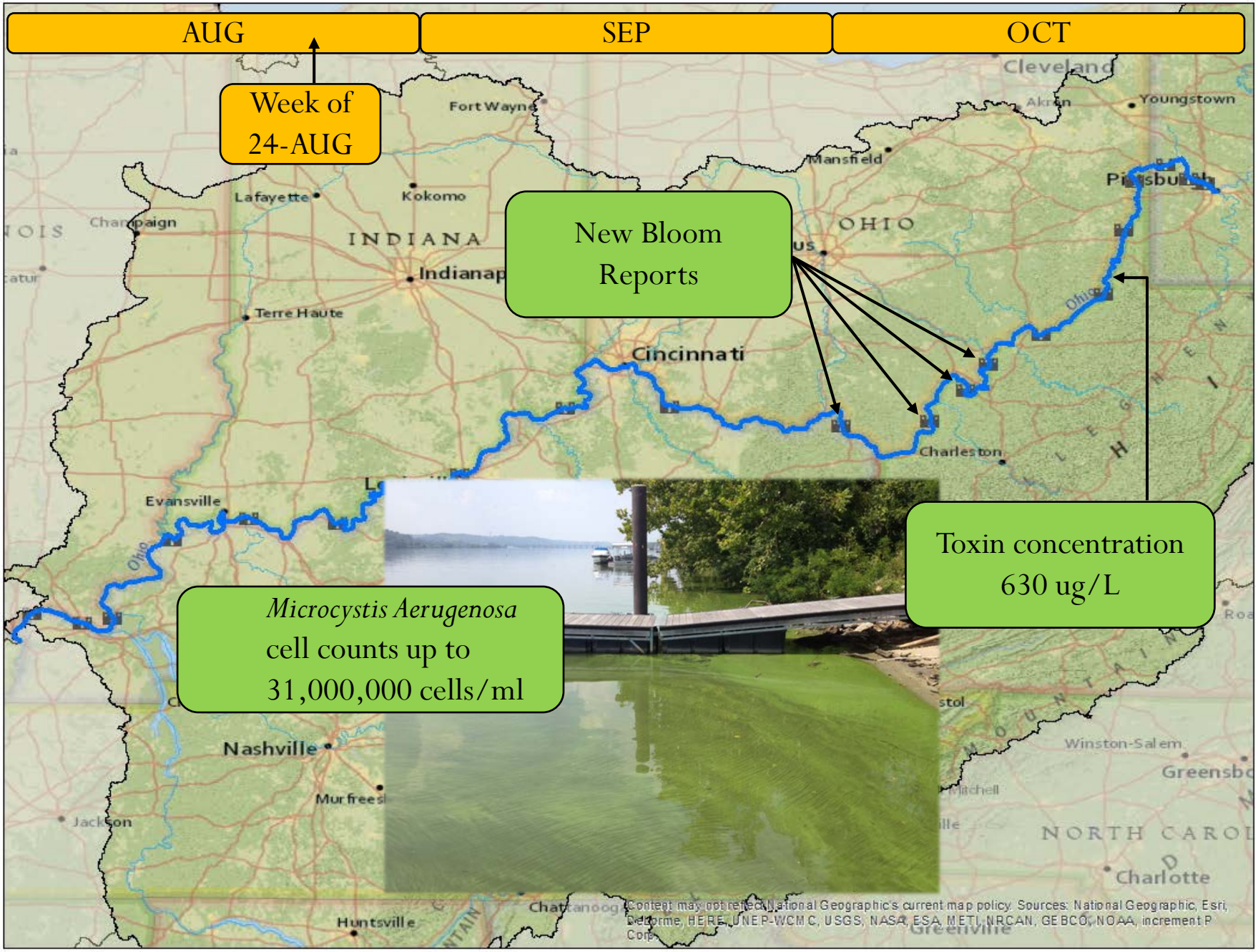
2015 Ohio River HAB Event

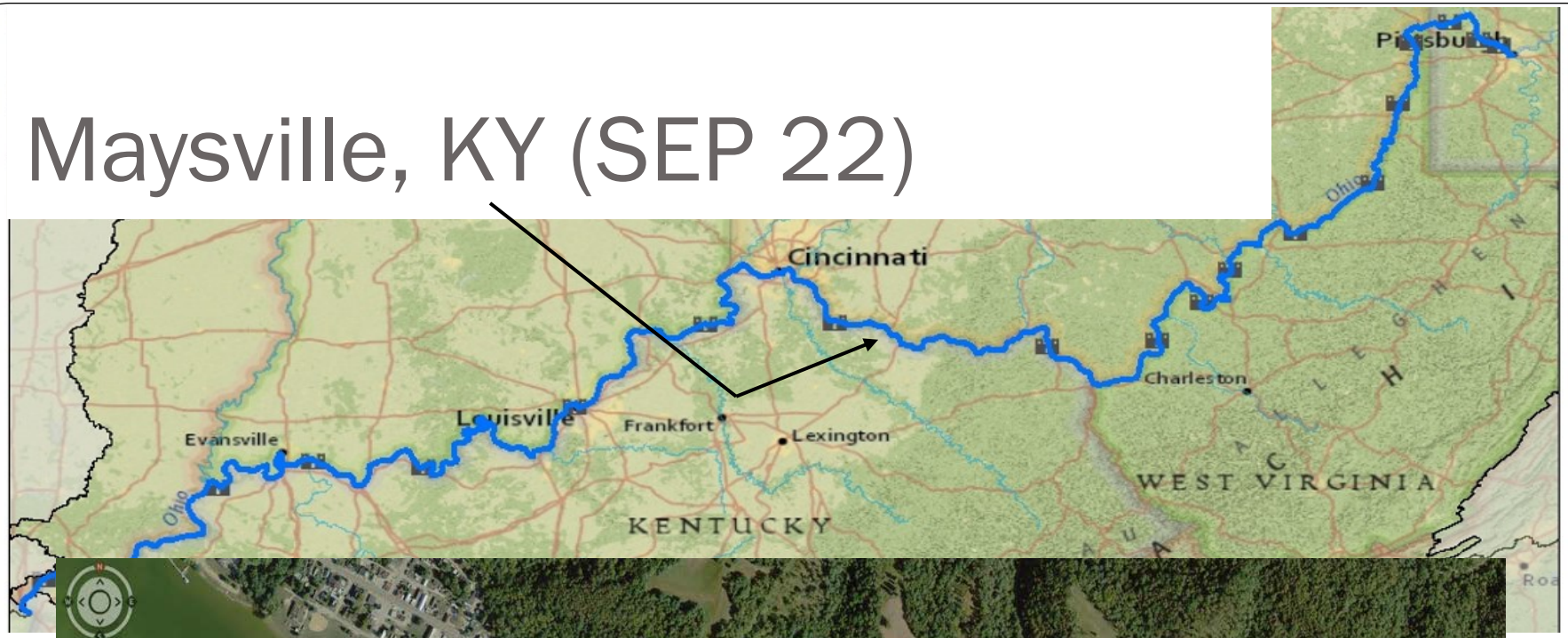
Greg Youngstrom
Environmental Scientist
ORSANCO

Erich Emery
Water Quality Specialist / Biologist
U.S. Army Corps of Engineers
Great Lakes & Ohio River Division


AUG
SEP
OCT
19-AUG
Reported 'paint spill' at ORM 84
Toxin concentration 41 ug/L
Identified as *Microcystis aerugenosa*
Cleveland
Akron
Youngstown
Fort Wayne
Mansfield
Lafayette
Kokomo
Champaign
INDIANA
OHIO
Indianapolis
Cincinnati
Ohio
Charleston
Frankfort
Lexington
KENTUCKY
TENNESSEE
Bristol
Winston-Salem
Murfreesboro
Jackson
Asheville
NORTH CAROLINA
Charlotte
Huntsville
Greenville


AUG
SEP
OCT
Week of 24-AUG
New Bloom Reports
Toxin concentration 630 ug/L
Microcystis Aerugenosa cell counts up to 31,000,000 cells/ml
Cleveland
Akron
Youngstown
Fort Wayne
Mansfield
Lafayette
Kokomo
Champaign
INDIANA
OHIO
Indianapolis
Terre Haute
Cincinnati
Charleston
Evansville
Ohio
Nashville
Murfreesboro
Jackson
Huntsville
Chattanooga
Winston-Salem
Greensboro
NORTH CAROLINA
Charlotte
Greenville
Mitchell
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Maysville, KY (SEP 22)

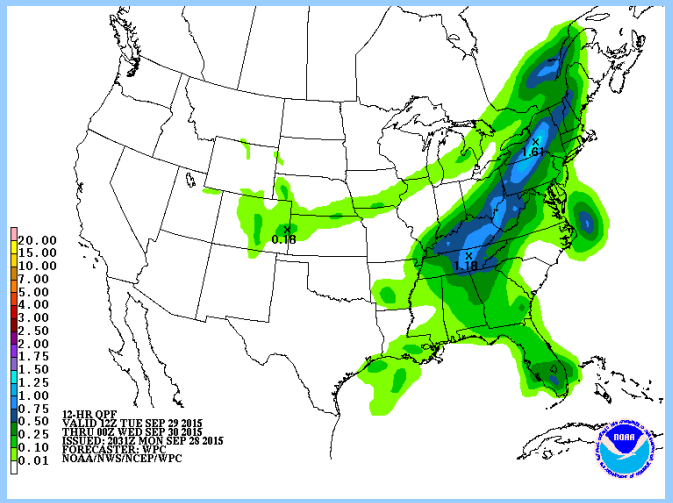


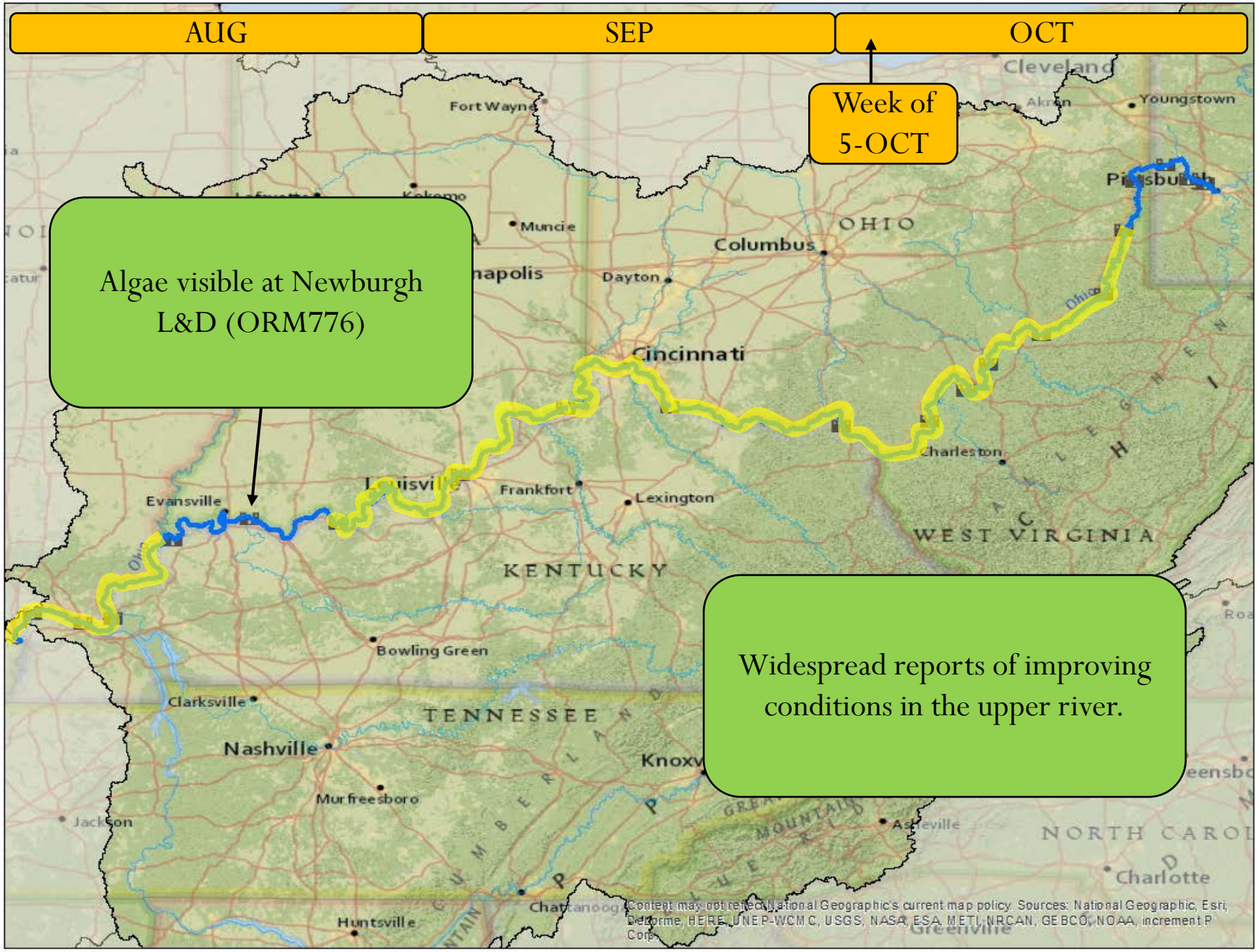
AUG | SEP | OCT

Week of 28-SEP

Report of localized algae near Evansville Water (ORM 791).

30-SEP RAIN!!!




AUG
SEP
OCT
Week of 5-OCT
Algae visible at Newburgh L&D (ORM776)
Widespread reports of improving conditions in the upper river.
Cleveland
Akron
Youngstown
Fort Wayne
Kokomo
Muncie
Columbus
OHIO
Dayton
Cincinnati
Ohio
Charleston
Evansville
Frankfort
Lexington
WEST VIRGINIA
KENTUCKY
Bowling Green
Clarksville
TENNESSEE
Nashville
Murfreesboro
Jackson
Asheville
NORTH CAROL
Charlotte
Huntsville
Greenville
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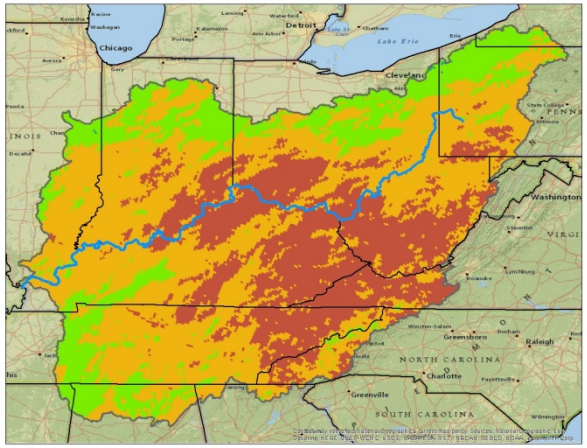
AUG
SEP
OCT
As of 29-OCT
Cleveland
Akron
Fort Wayne
Mansfield
Pittsburgh
Lafayette
Kokomo
Champaign
Muncie
INDIANA
OHIO
Columbus
Indianapolis
Dayton
Terre Haute
Ohio
Cincinnati
Charleston
Louisville
Frankfort
Evansville
KENTUCKY
Bowling Green
Clarksville
TENNESSEE
Kingsport
Bristol
Johnson City
Nashville
Knoxville
Winston-Salem
Murfreesboro
Jackson
Asheville
NORTH CAROL
Charlotte
Chattanooga
Huntsville
Greenville
Crews are gathering additional data to support lifting the remaining advisories.
(Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.)

Where To Sample?

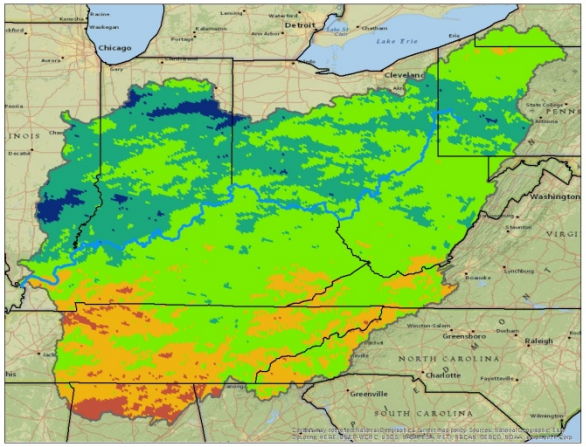
Where To Sample?

Summer 2015 Monthly Precipitation Relative to Normal

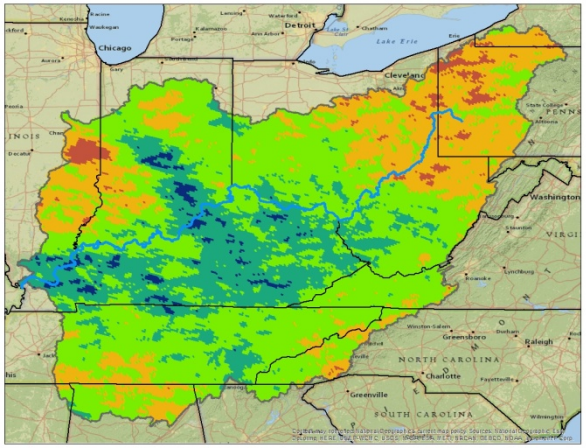
May



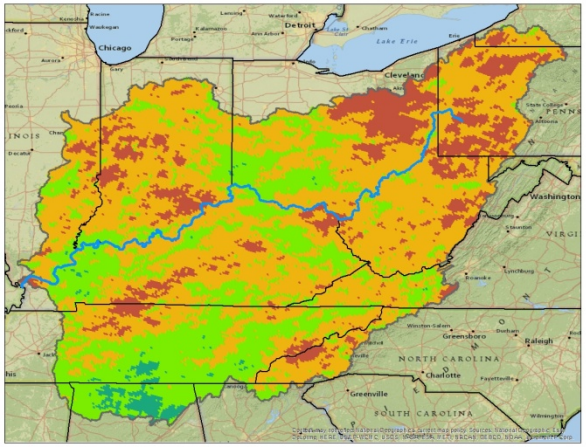
June



July



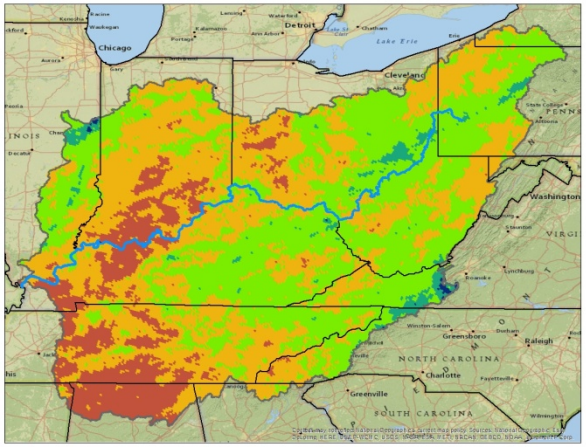
August



Percent of Normal Rainfal (2015)

- % **0.00 - 50.00**
- % **50.01 - 100.00**
- % **100.01 - 200.00**
- % **200.01 - 300.00**
- % **300.01 - 530.00**

September



Comparison of Events in the Kansas and Ohio Rivers

Similarities

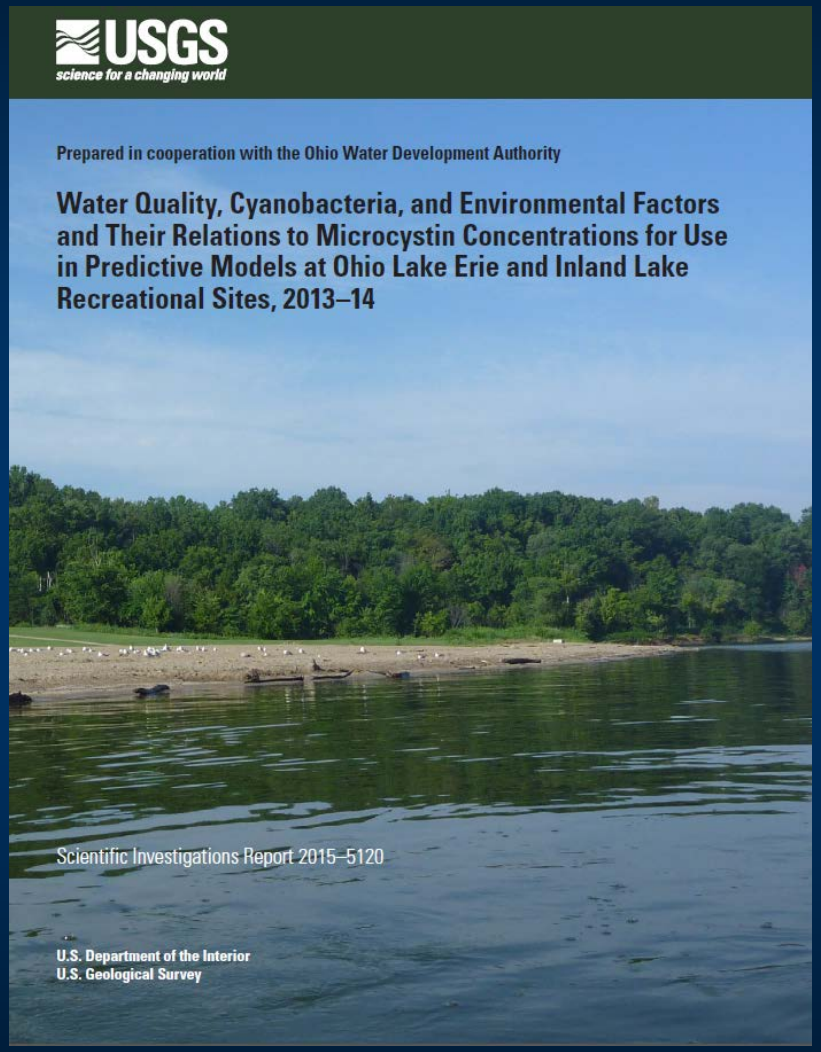
- Events that affect several hundred miles of river
- Microcystin produced by *Microcystis*
- Rainfall, runoff, and hydrology are important drivers

Differences

- Flow regulation by upstream reservoirs (Kansas) vs. locks and dams (Ohio)
- Development of persistent surface scums in the Ohio River
- Concentrations of microcystin and *Microcystis* orders of magnitude higher on the Ohio River

Unifying Themes in Harmful Algal Bloom Research

- Individual systems are unique.
- Spatial and temporal variability present challenges to data collection, analysis, and interpretation.
- Sensor technology and genetic approaches provide important information on spatiotemporal variability and environmental influences.
- A variety of tools for early warning and prediction are being developed and used.



http://pubs.er.usgs.gov/publication/sir20155120

Contact Information:

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Additional Information Available on the Web:

Kansas River Study – http://ks.water.usgs.gov/kansas-river-algal
Real-Time Water Quality – http://nrtwq.usgs.gov
Real-Time Data - http://waterdata.usgs.gov/ks/nwis

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