Cyanobacteria and Associated Toxins and Taste-and-Odor Compounds in the Kansas River, Kansas

Jennifer L. Graham and Guy M. Foster

10th National Monitoring Conference

May 4, 2016

Tampa, FL

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

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 =

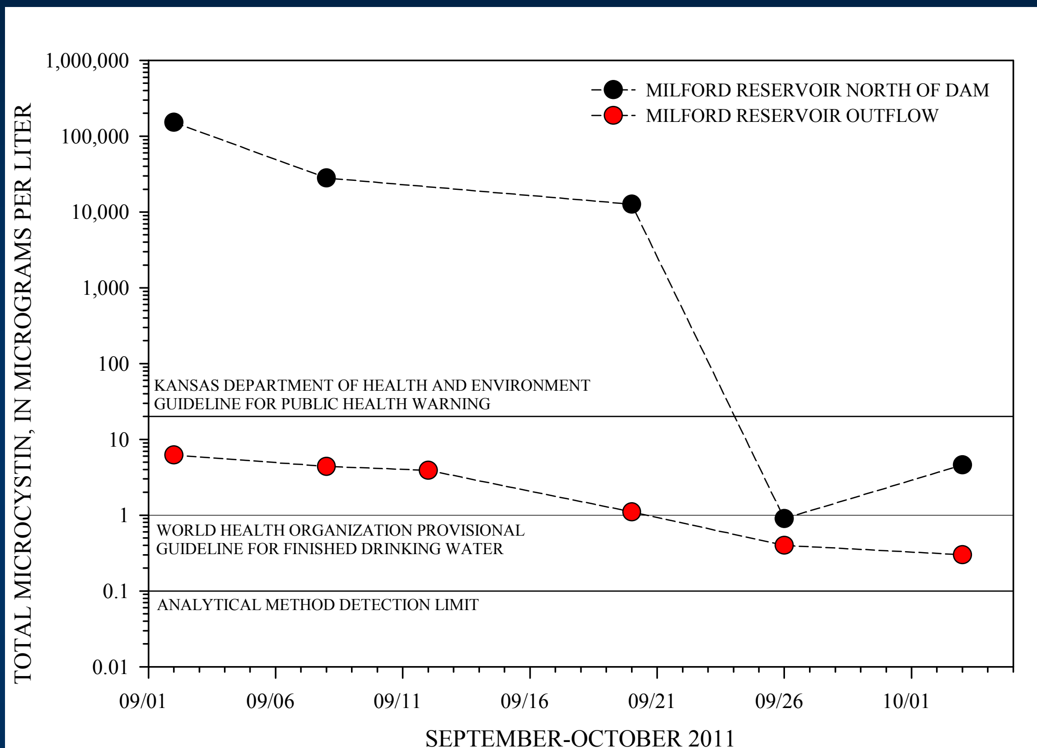
Concerns About Transport of Cyanotoxins and Taste-and-Odor Compounds Potentially Affecting Drinking Water Supplies

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

USGS science for a changing world

Kansas Water Office

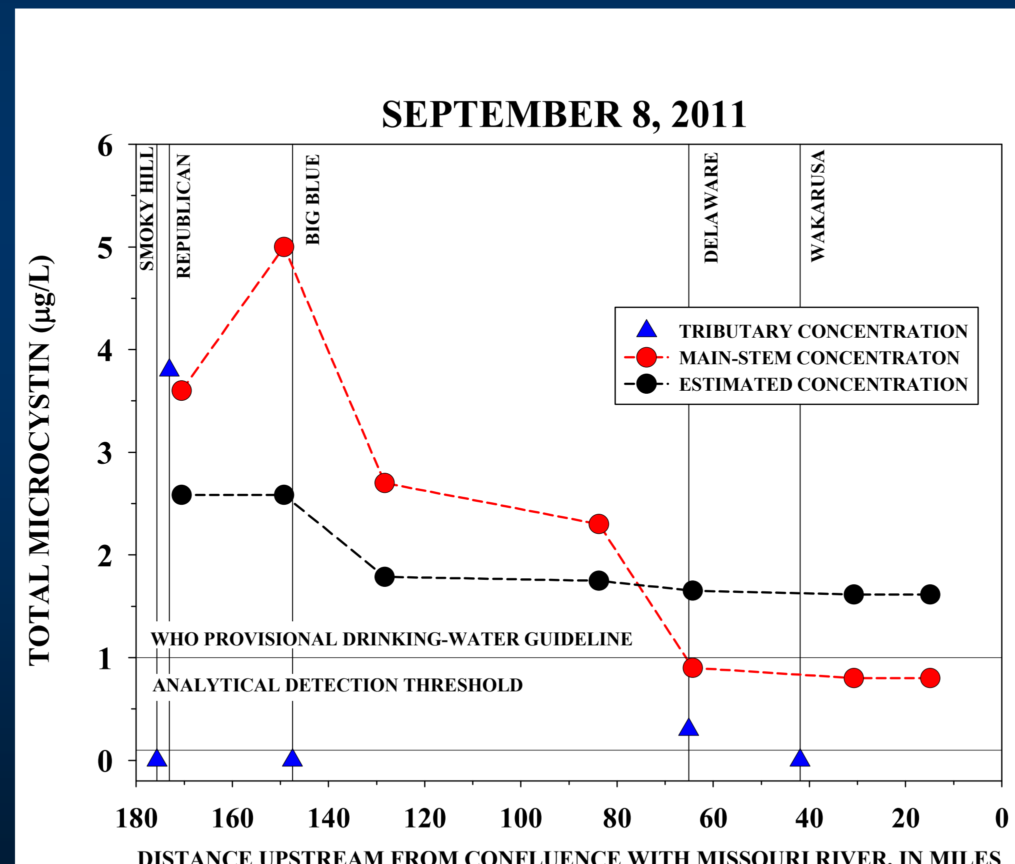
Cyanobacterial Toxins and Taste-and-Odor Compounds May Be Transported for Relatively Long Distances Downstream from Lakes and Reservoirs



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

5 Year Study in the Kansas River - Objectives

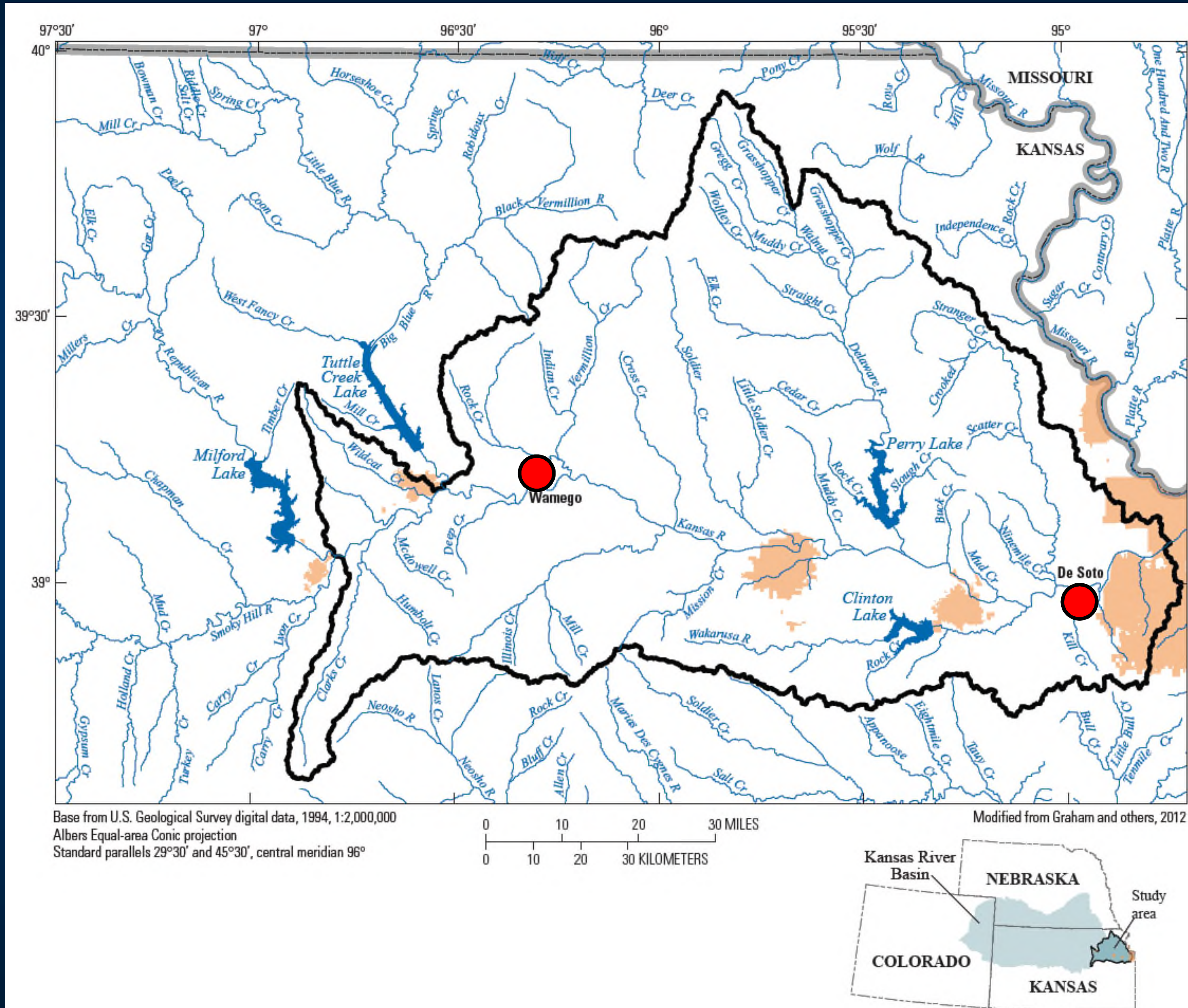
- Characterize sources, frequency of occurrence, and potential causes of cyanobacteria and associated compounds in the Kansas River.

- Develop models to provide real-time estimates for a number of constituents, including cyanotoxins and taste-and-odor compounds.

USGS
science for a changing world

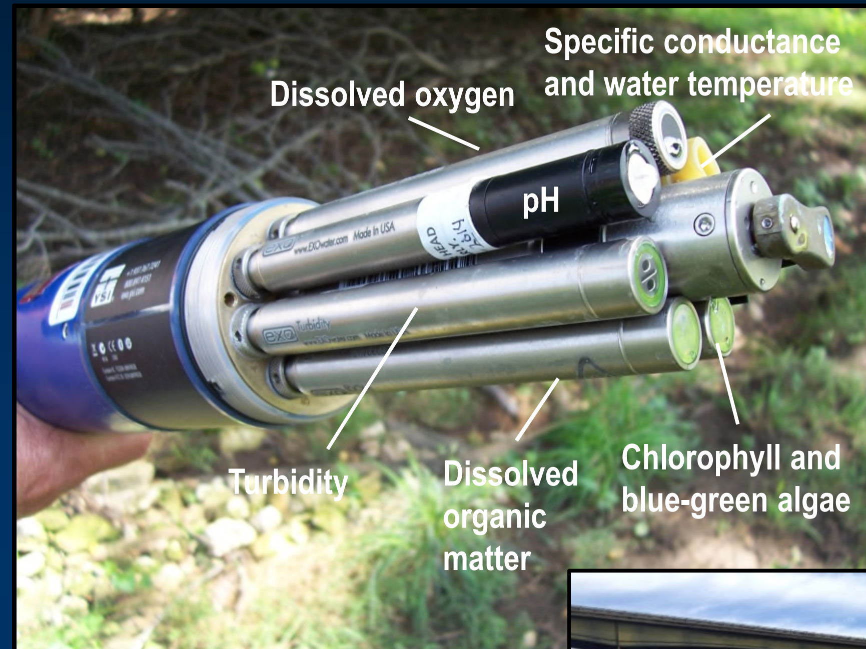
Kansas Water Office

Kansas River Study Sites

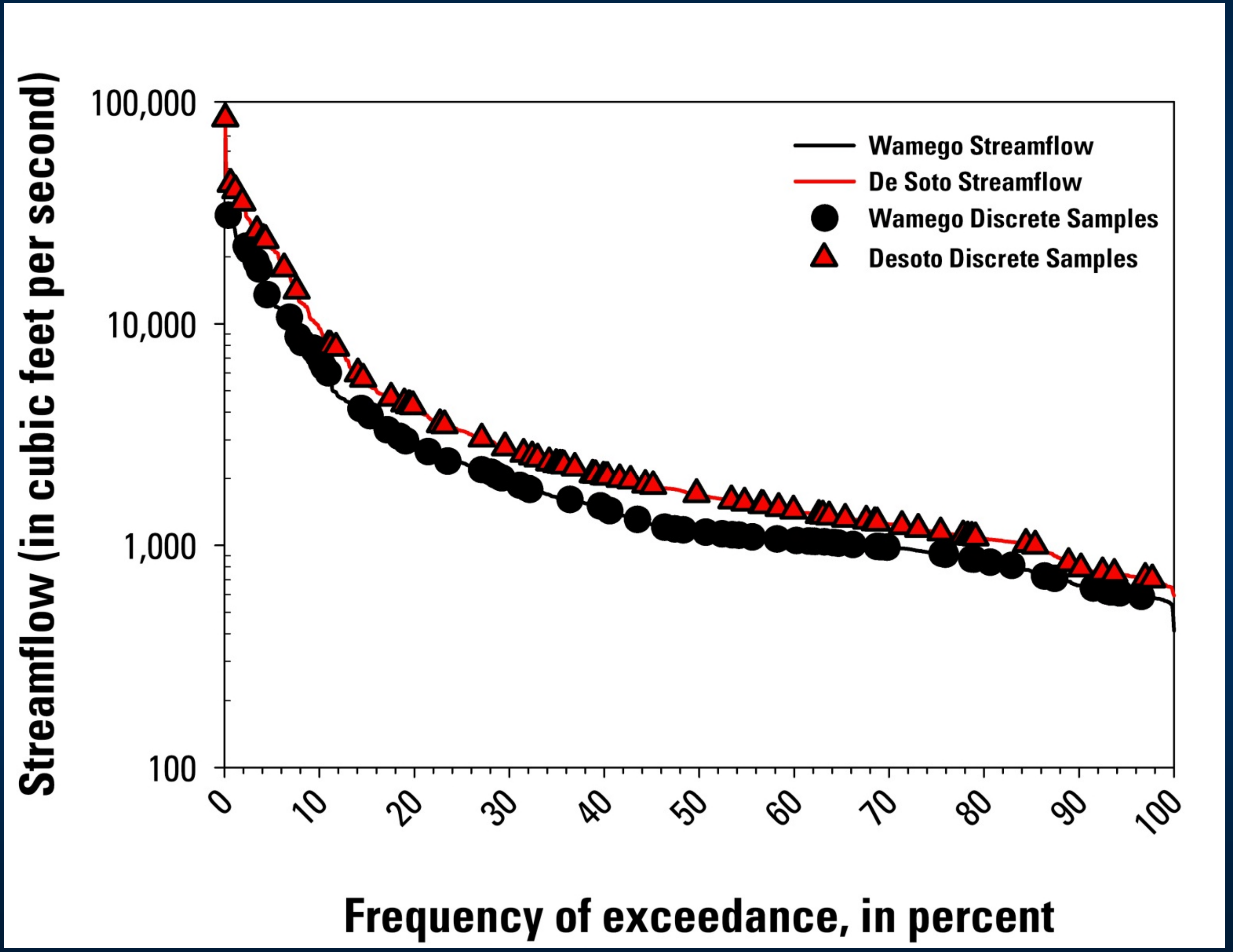


5 Year Study in the Kansas River - Approach

- 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.



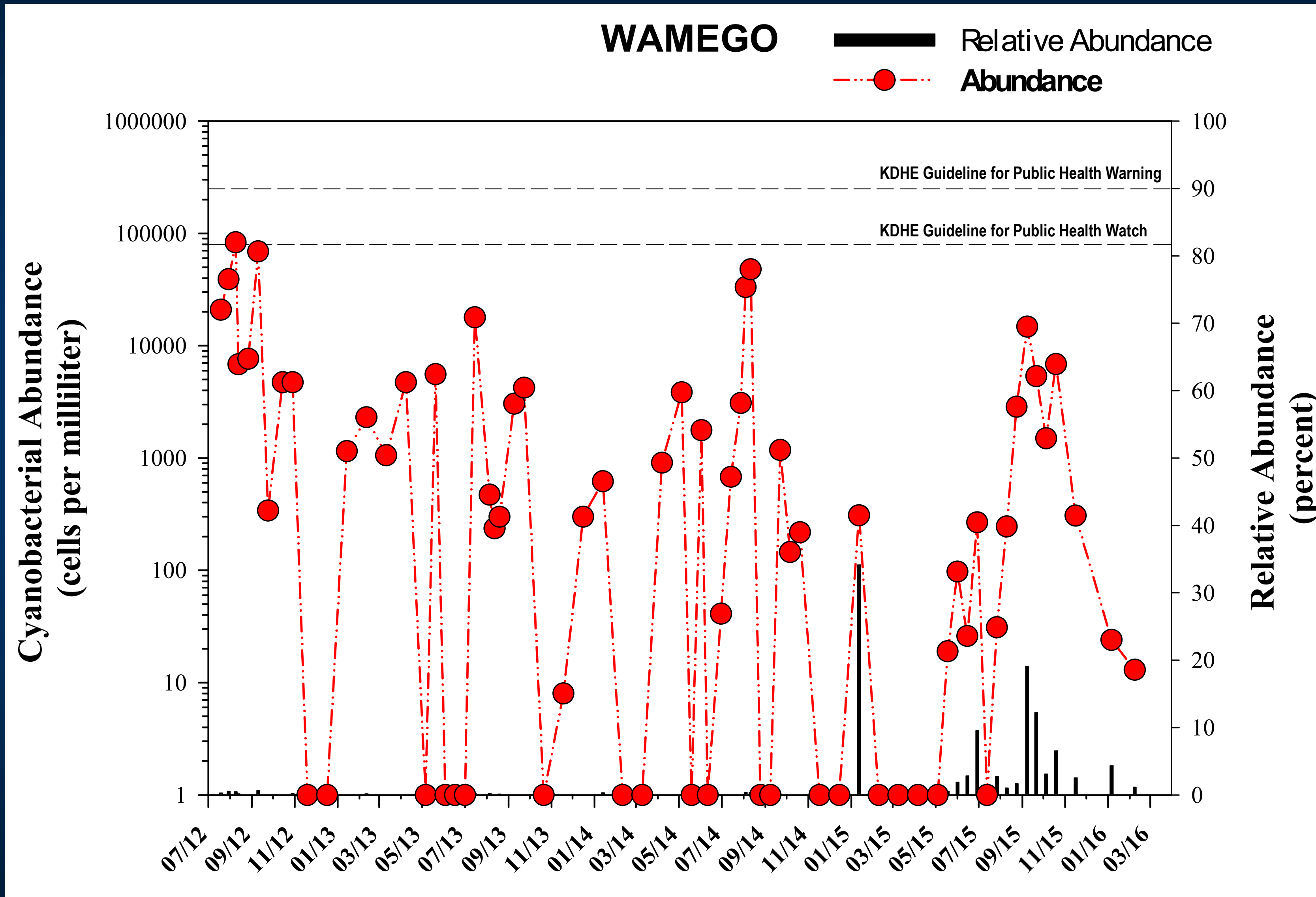
Discrete Samples Have Been Collected Over a Range of Streamflow Conditions, Including Reservoir Releases



USGS
science for a changing world

Kansas Water Office

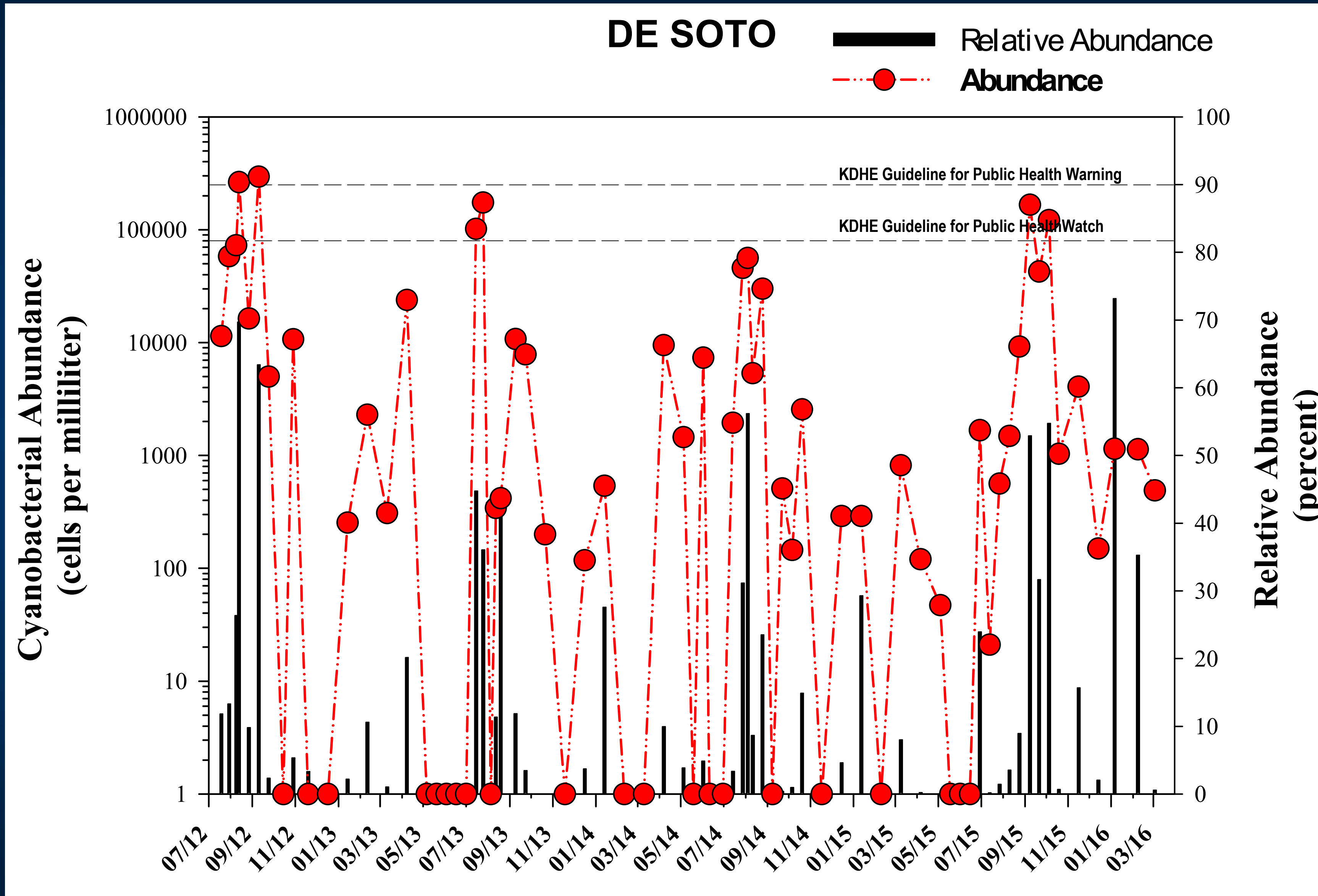
Cyanobacteria Rarely Dominated the Phytoplankton Community at Wamego During July 2012-March 2016



USGS
science for a changing world

Kansas Water Office

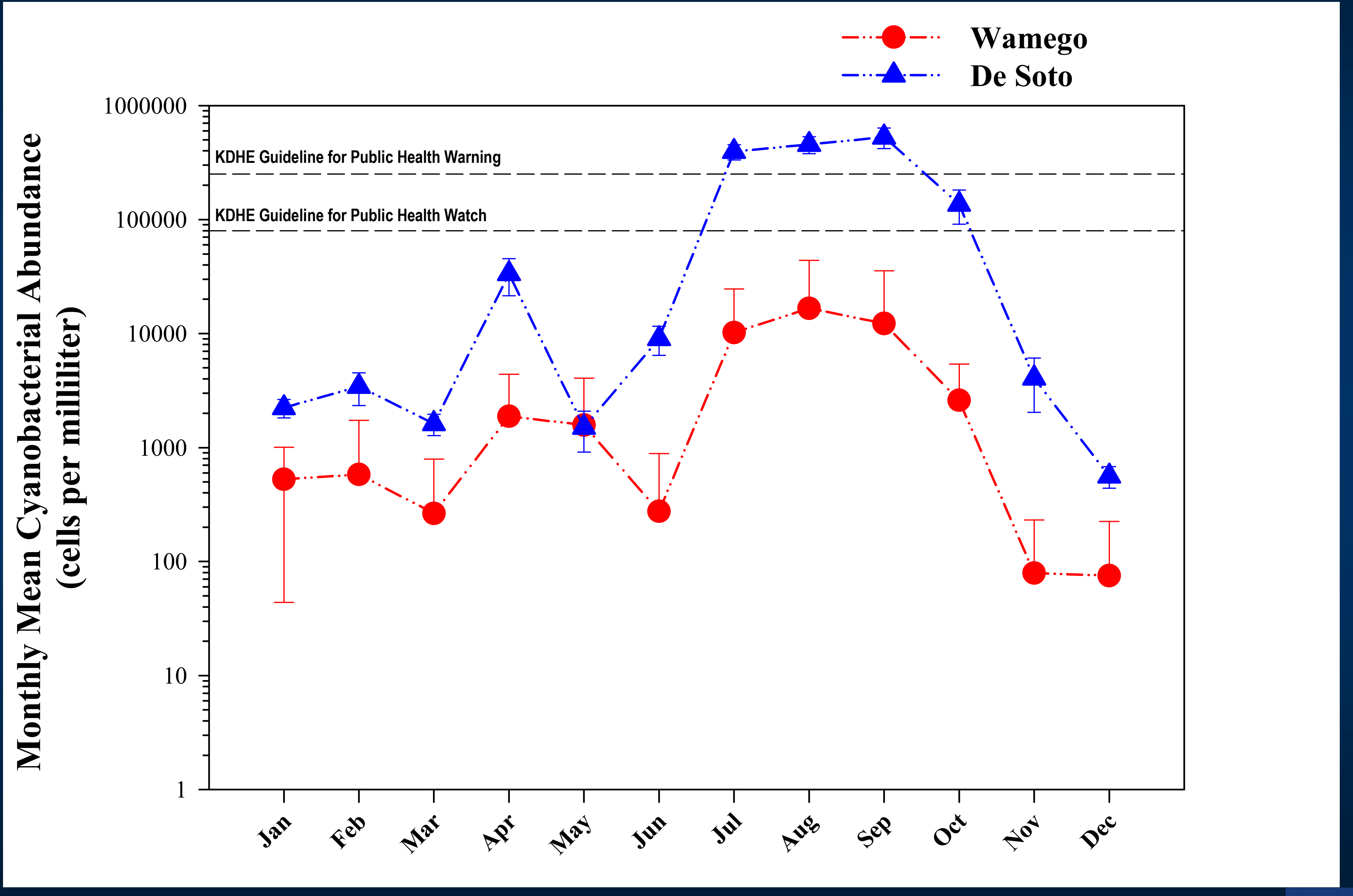
Cyanobacteria Were More Abundant at De Soto than Wamego, But Rarely Dominated the Phytoplankton Community During July 2012-March 2016



USGS science for a changing world

Kansas Water Office

During July 2012-March 2016 Cyanobacterial Dynamics Were Similar Between Sites and Among Years, With Peak Abundances During July Through October



USGS
science for a changing world

Kansas Water Office
AD ASTRA PER ASPERA

Potential Microcystin and Taste-and-Odor Producers in the Kansas River July 2012-March 2016

Potential Taste-and-Odor Producers

- *Anabaena*, *Aphanizomenon*, *Oscillatoria*, *Phormidium*, *Planktolyngbya*, *Pseudanabaena*
- Present in 59% of samples (n=138) collected during July 2012-March 2016

Potential Microcystin Producers

- *Anabaena*, *Anabaenopsis*, *Aphanocapsa*, *Microcystis*, *Oscillatoria*, *Phormidium*, *Planktolyngbya*, *Pseudanabaena*
- Present in 48% of samples (n=138) collected during July 2012-March 2016

USGS
science for a changing world

Kansas
Water Office

Geosmin was Detected More Frequently at the Kansas River Study Sites than Microcystin or MIB during July 2012-March 2016

Site	n	% MC[1] Detection	% MIB[2] Detection	% GEOS[2] Detection
Wamego	76	22	42	72
De Soto	80	20	31	82
Republican	24	54	54	92
Big Blue	20	10	70	60
Delaware	23	35	61	96
Overall	**223**	**25**	**44**	**79**

[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

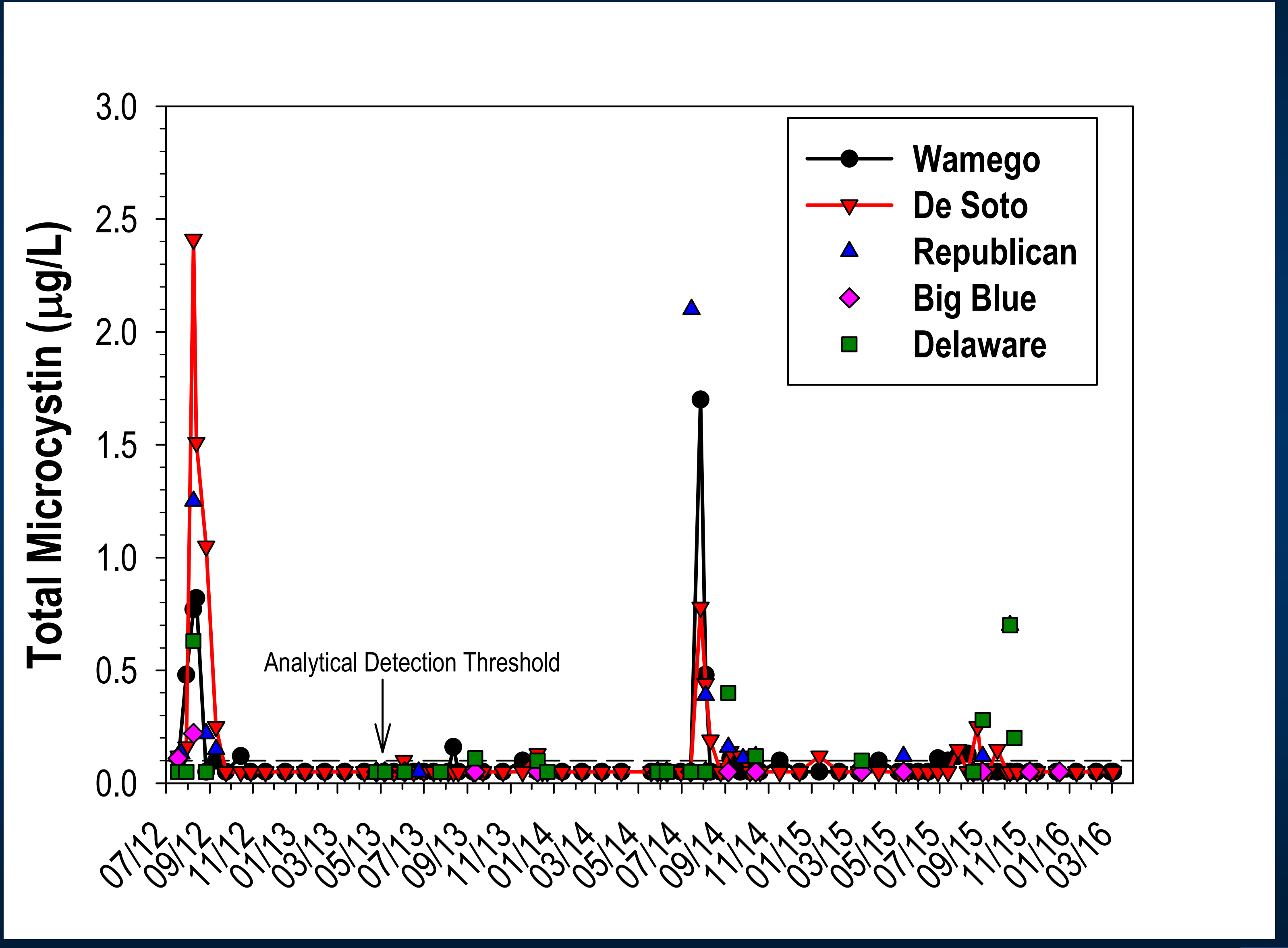
USGS science for a changing world

Kansas Water Office

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

Site	n	MC > 0.1 µg/L (n)	MC > 0.3 µg/L (n)	MC > 1.6 µg/L (n)
Wamego	76	17	5	1
De Soto	80	17	6	3
Overall	**156**	**34**	**11**	**4**

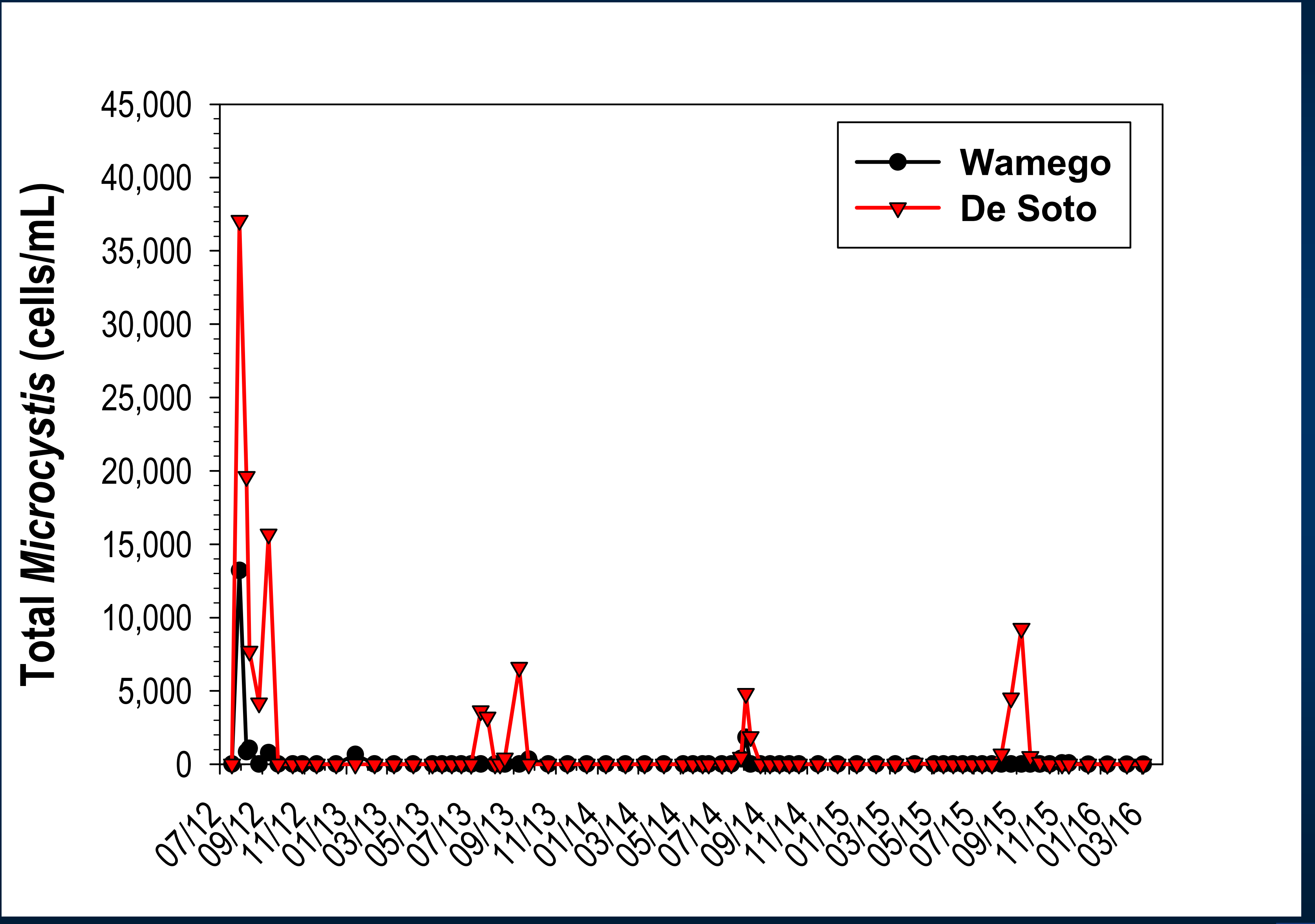
With the Exception of Late Summer 2011, 2012 and 2014, Microcystin Detections in the Kansas River Have Been Relatively Uncommon



USGS
science for a changing world

Kansas Water Office

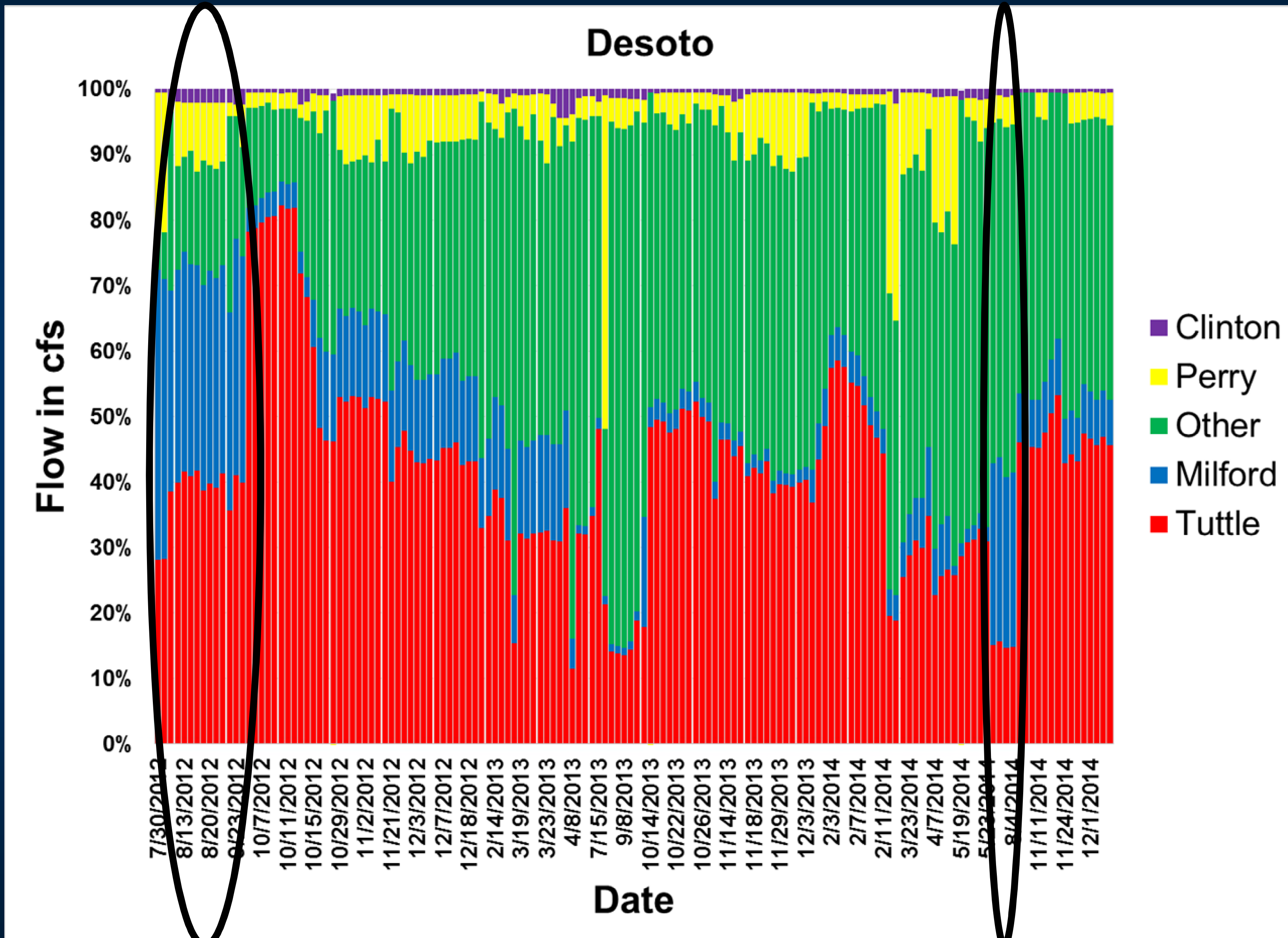
Microcystin Occurrence in the Kansas River is Associated with *Microcystis*



USGS science for a changing world

Kansas Water Office

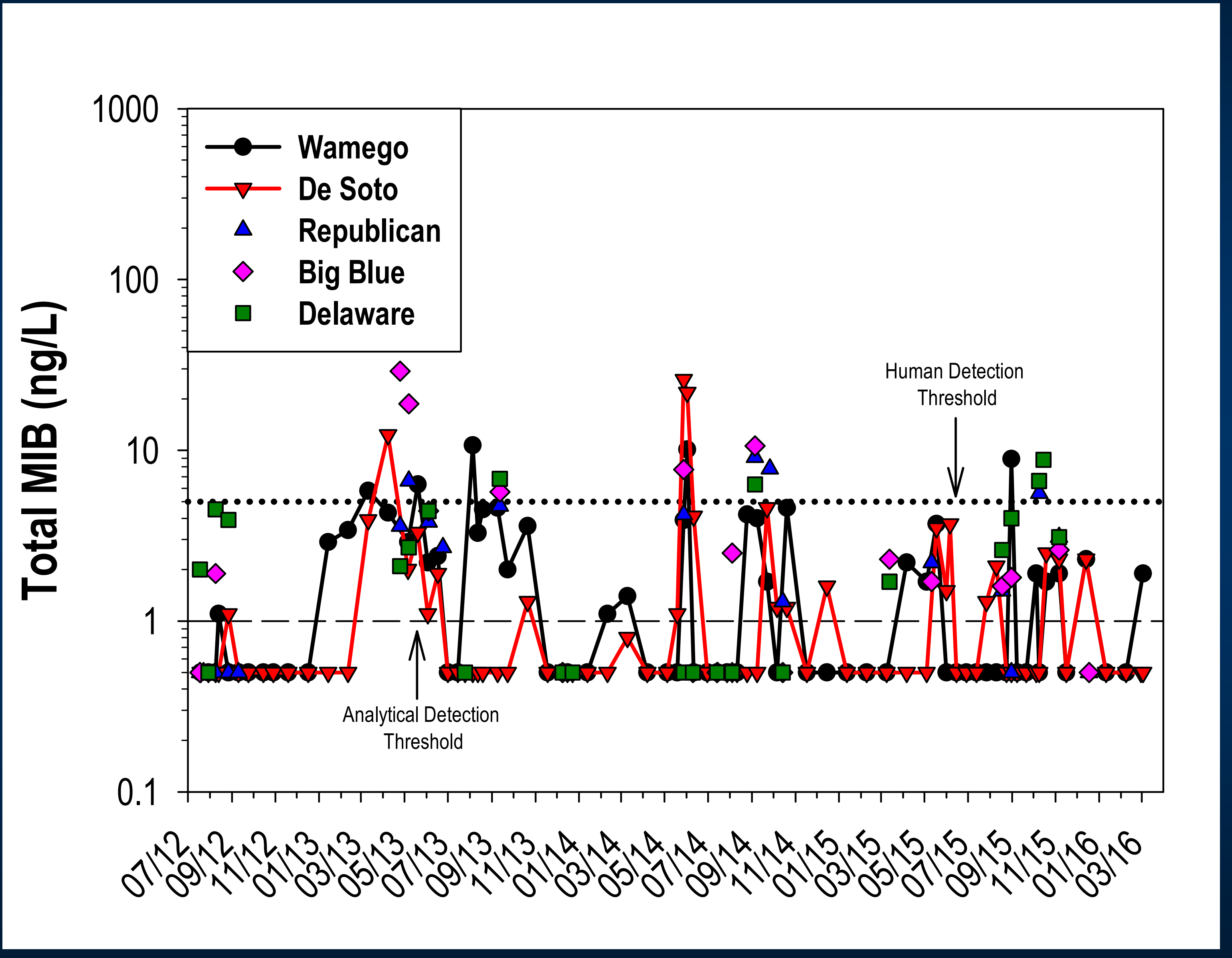
Microcystin Occurrence in the Kansas River is Associated with Flow Contributions from Milford Reservoir Greater than 30%



USGS
science for a changing world

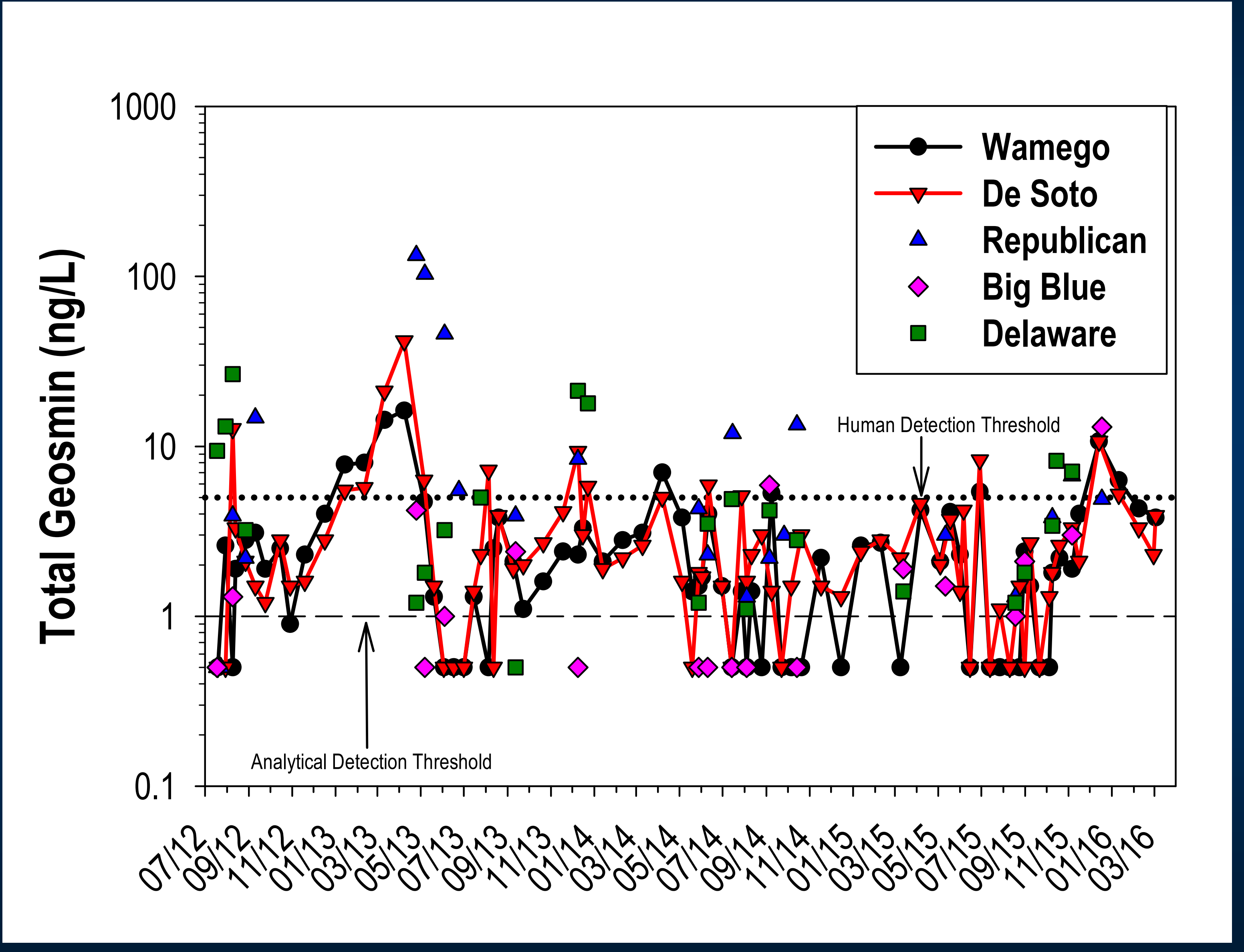
Kansas
Water Office

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



science for a changing world

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



USGS
science for a changing world

Kansas Water Office

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

- Logistic regression models for the Kansas River have been developed for cyanobacterial abundance, geosmin, and microcystin.

- Linear regression models for the Kansas River have been developed for several other water-quality constituents including major ions, nutrients, and sediment.

USGS
science for a changing world

Prepared in cooperation with the Kansas Water Office, the City of Lawrence, the City of Topeka, the City of Olathe, and Johnson County Water One

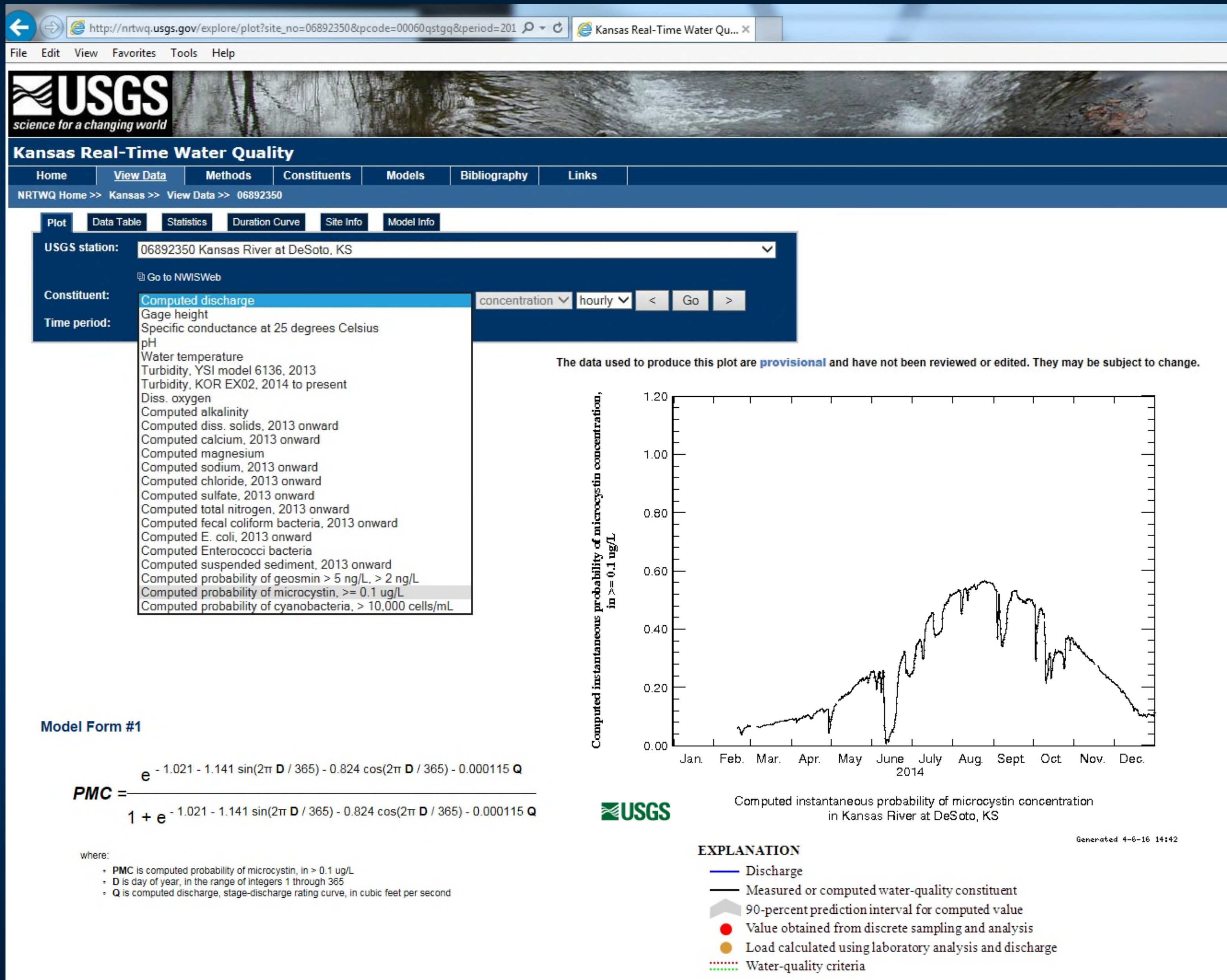
Logistic and Linear Regression Model Documentation for Statistical Relations Between Continuous Real-Time and Discrete Water-Quality Constituents in the Kansas River, Kansas, July 2012 through June 2015

Open-File Report 2016–1040

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

https://pubs.er.usgs.gov/publication/ofr20161040

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

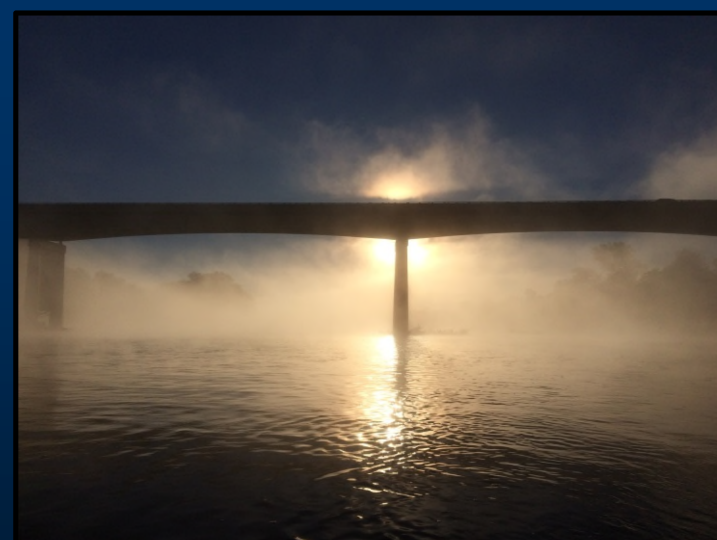


https://nrtwq.usgs.gov

Summary

- Cyanobacteria rarely dominate the algal community in the Kansas River.
- Taste-and-odor compounds occur year-round in the Kansas River, while microcystin typically occurs only during summer months.
- Relatively high concentrations of taste-and-odor compounds and microcystin in the Kansas River are associated with upstream reservoir releases.
- Continuous real-time water-quality data may serve as a notification system for cyanobacterial events in the Kansas River.

Kansas River at Wamego, September 22, 2014



Kansas River at De Soto, September 22, 2014

USGS
science for a changing world

Kansas Water Office

Contact Information:
jlgraham@usgs.gov
gfoster@usgs.gov

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

USGS
science for a changing world

Ad Astra Per Aspera
Kansas
Water Office