

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



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

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May 2016

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

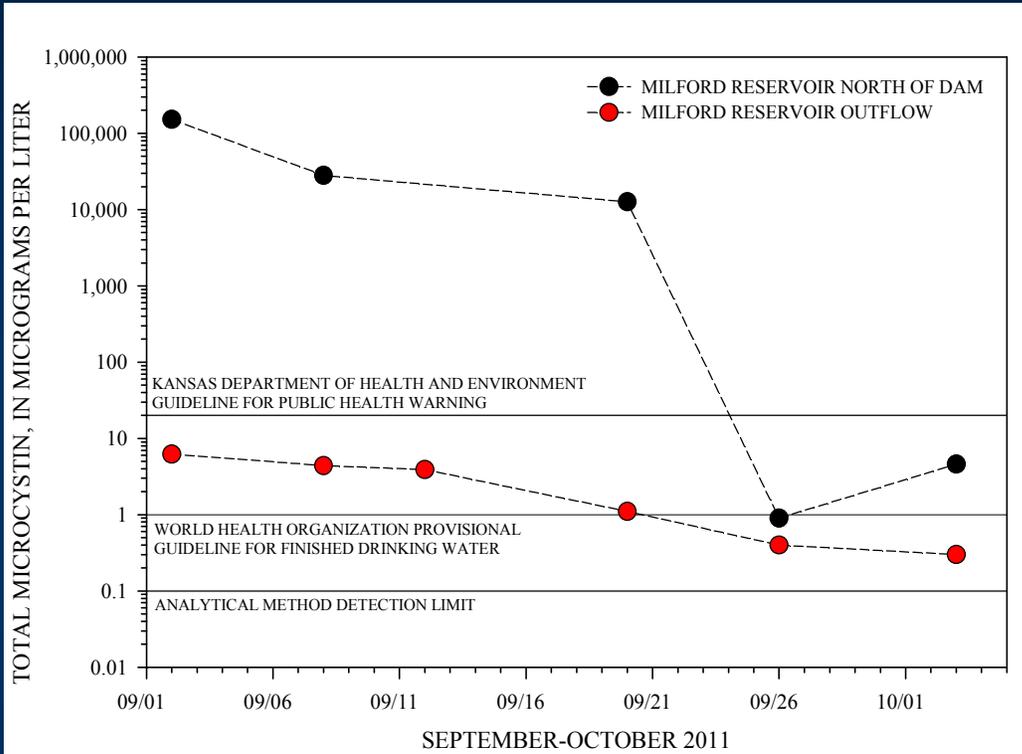
Kansas River serves as a drinking water supply for 800,000 Kansans

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

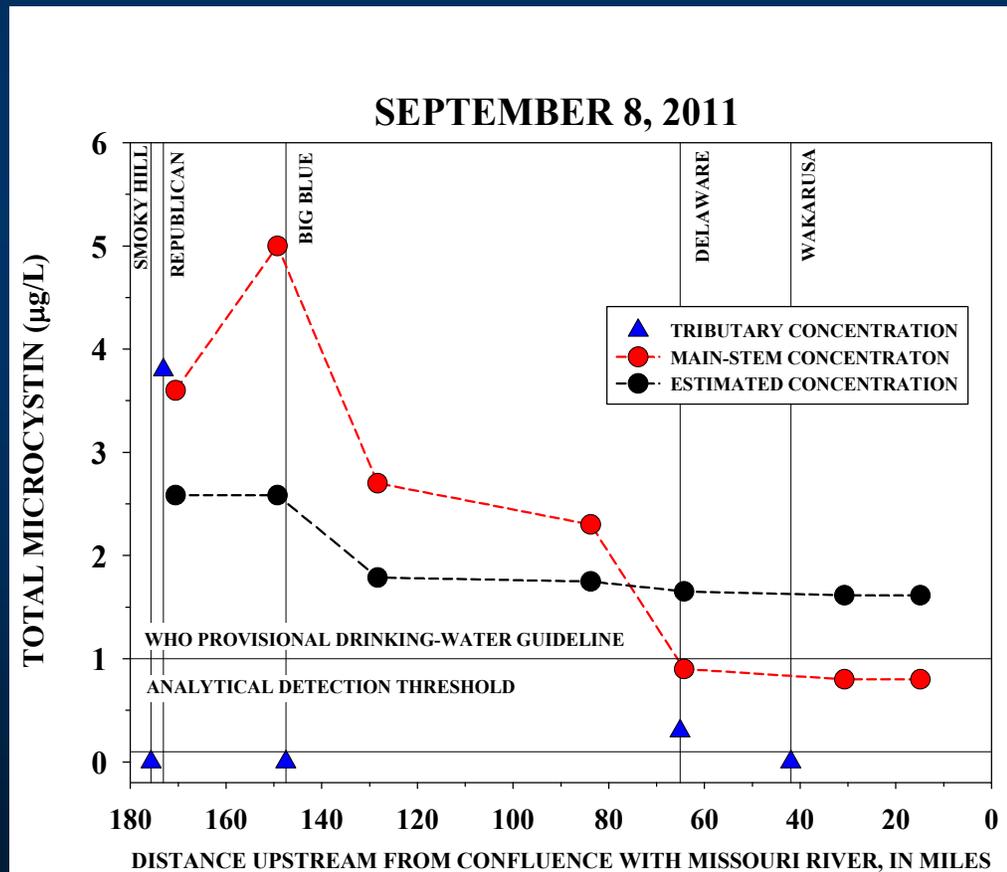
Cyanobacterial Toxins and Taste-and-Odor Compounds May Be Transported for Relatively Long Distances Downstream from Lakes and Reservoirs



Milford Lake release sends algae to Kansas River

MARIA SUDEKUM FISHER, Associated Press

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

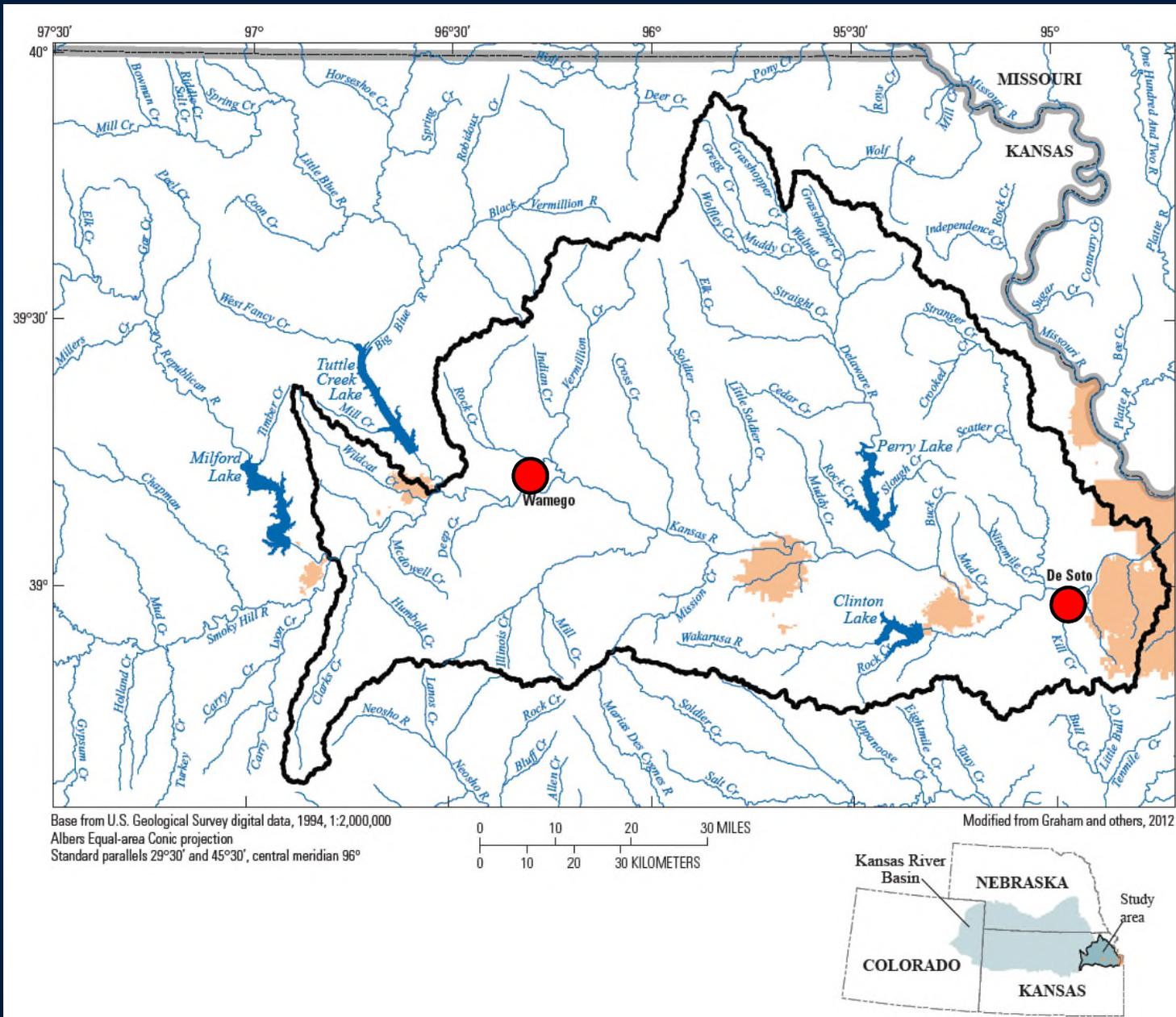


5 Year Study in the Kansas River - Objectives

- 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.

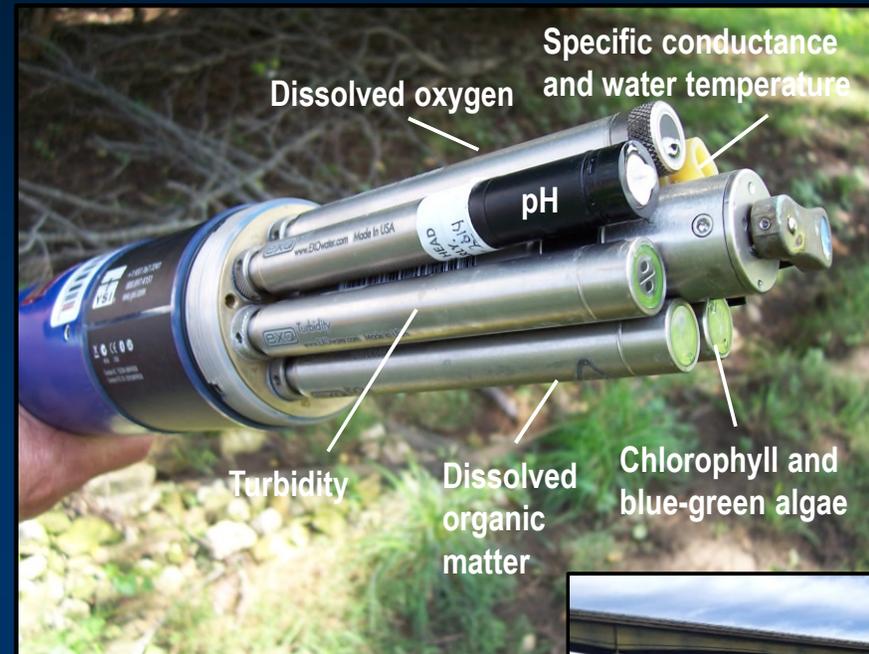


Kansas River Study Sites

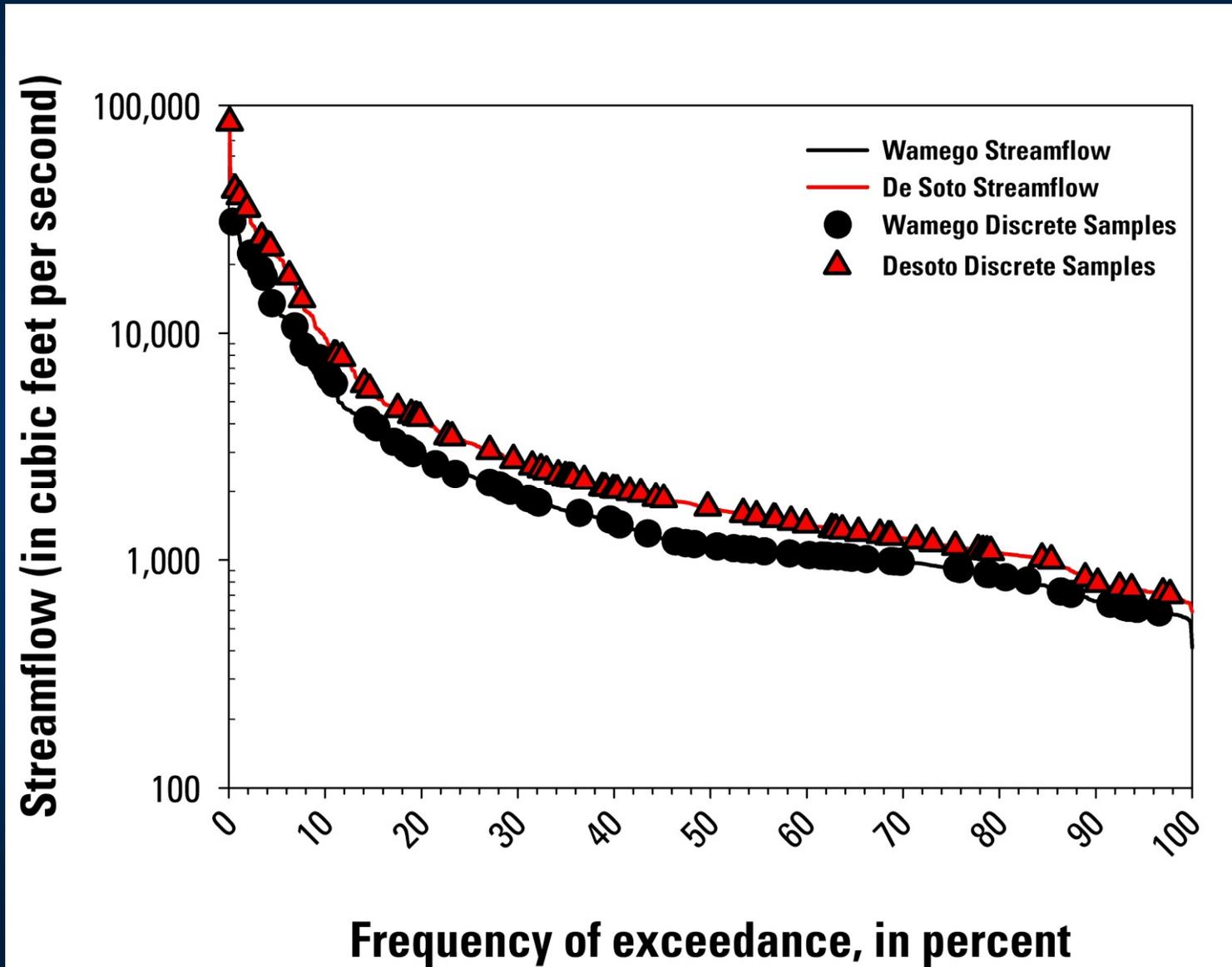


5 Year Study in the Kansas River - Approach

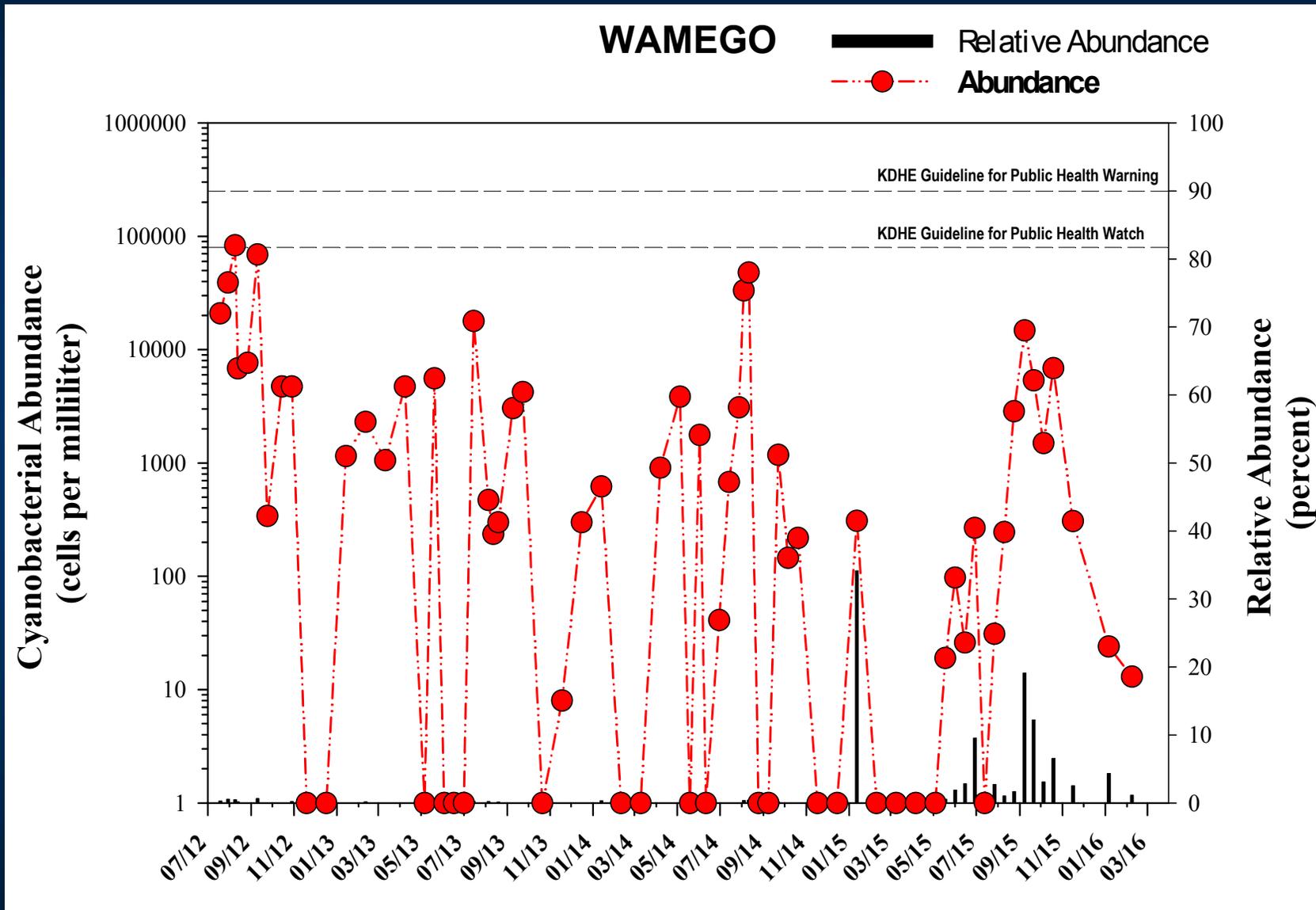
- Real-time water-quality monitors at USGS streamgages at Wamego and De Soto.
- Routine sample collection at these 2 sites about 18 times per year; reservoir outflows sampled during releases and cyanobacterial blooms.



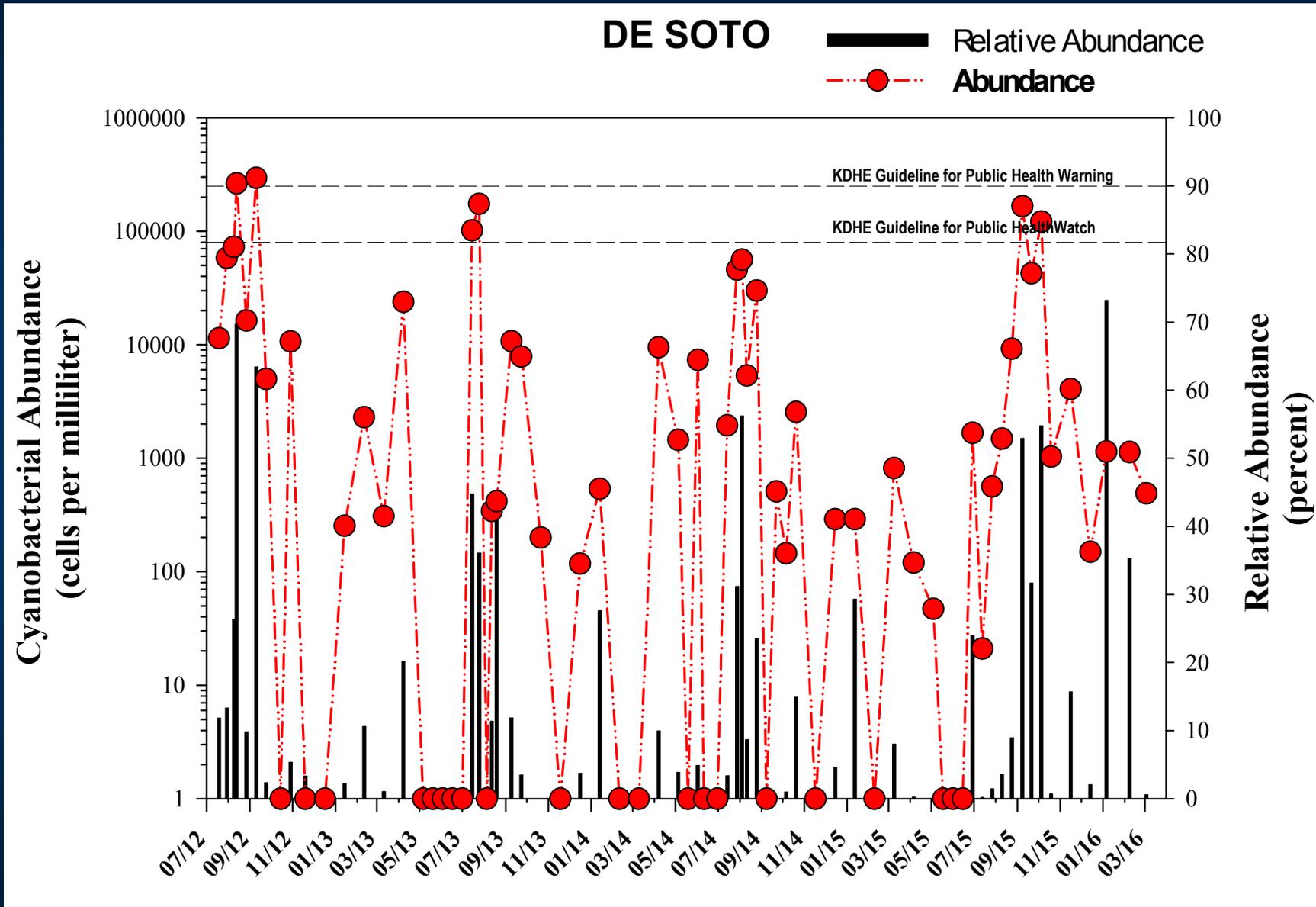
Discrete Samples Have Been Collected Over a Range of Streamflow Conditions, Including Reservoir Releases



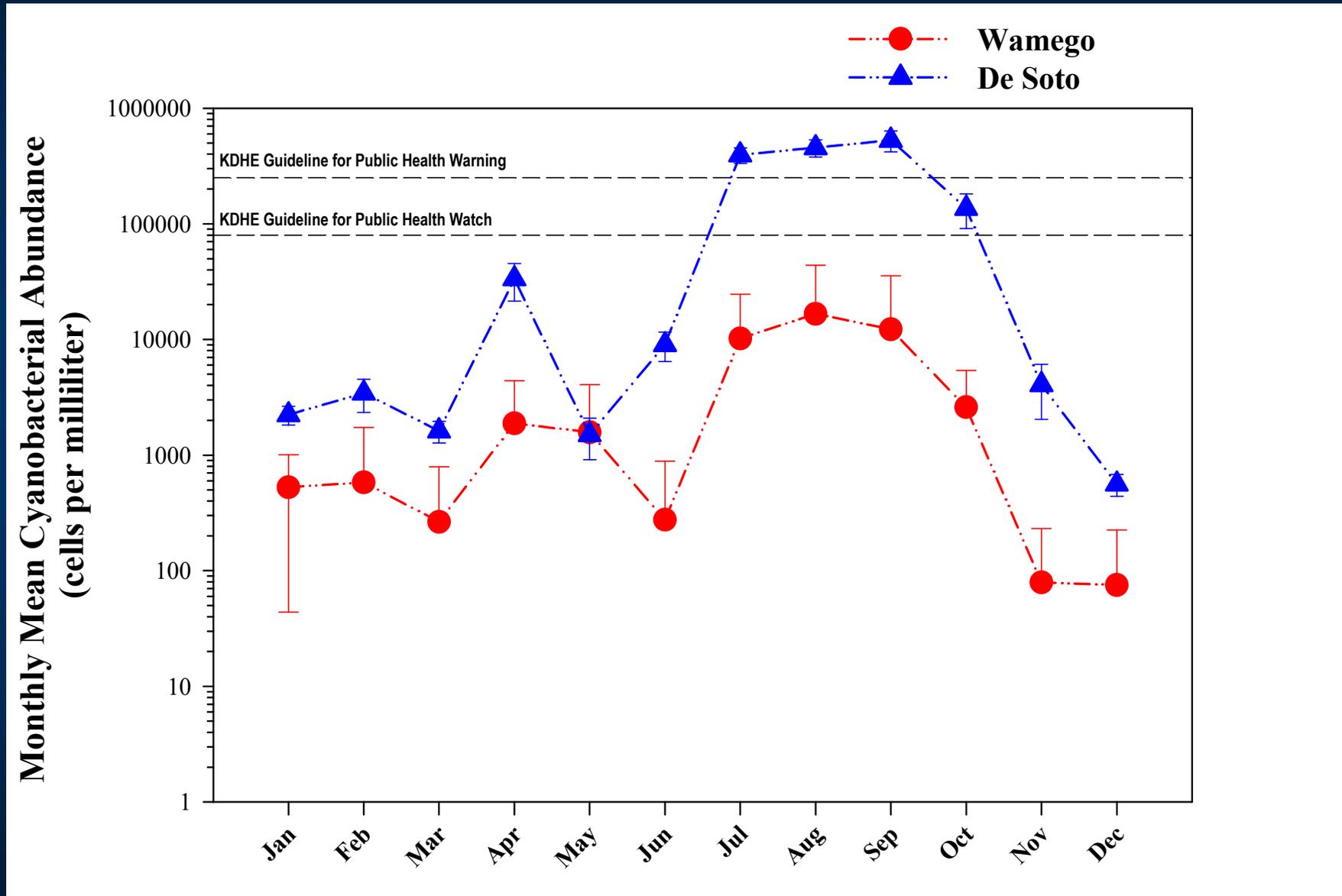
Cyanobacteria Rarely Dominated the Phytoplankton Community at Wamego During July 2012-March 2016



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



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



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

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 |

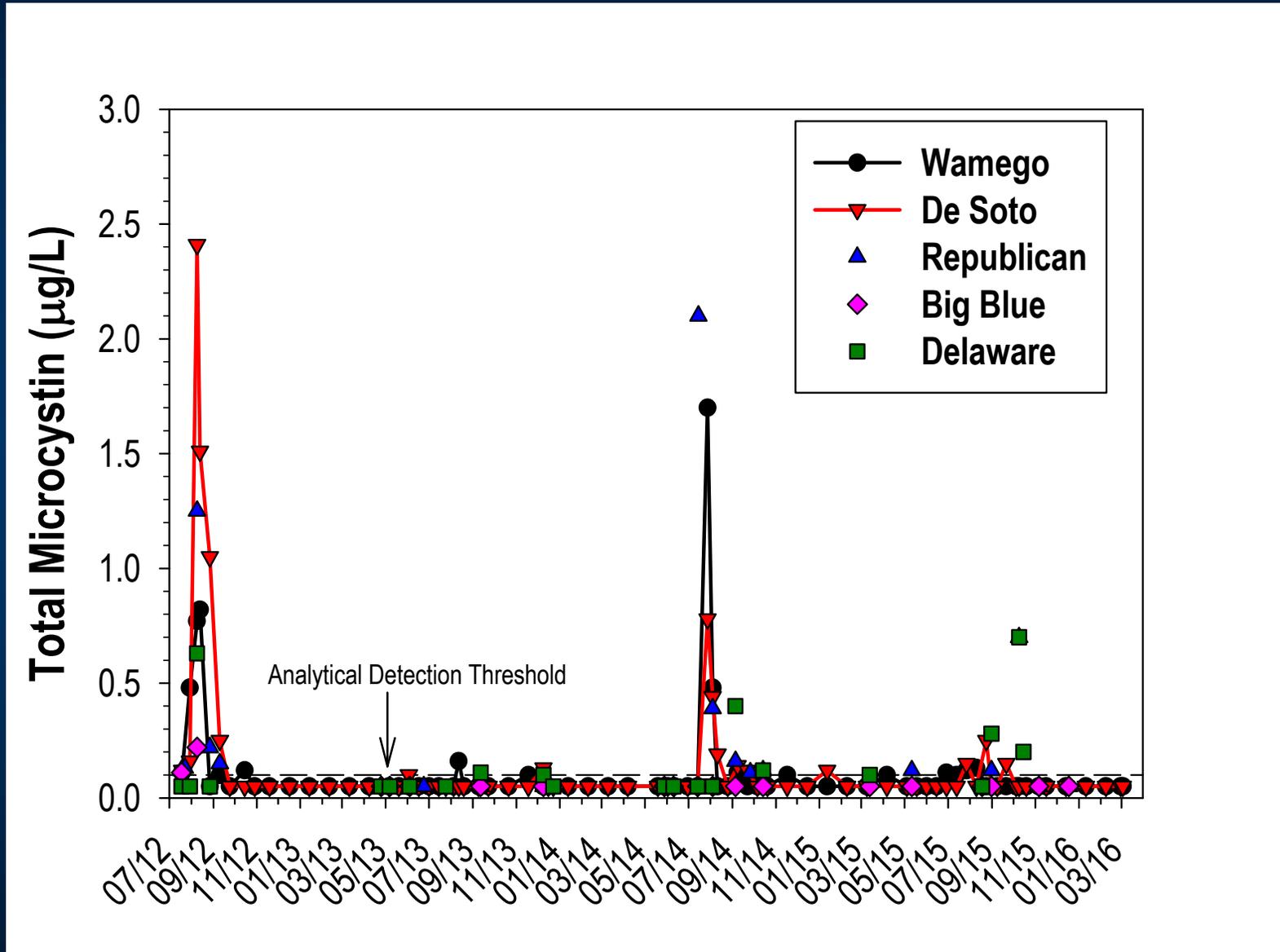
¹Microcystin was analyzed by –adda specific ELISA with an analytical detection threshold of 0.1 µg/L

²Geosmin and MIB were analyzed by GC/MS with an analytical detection threshold of 1.0 ng/L

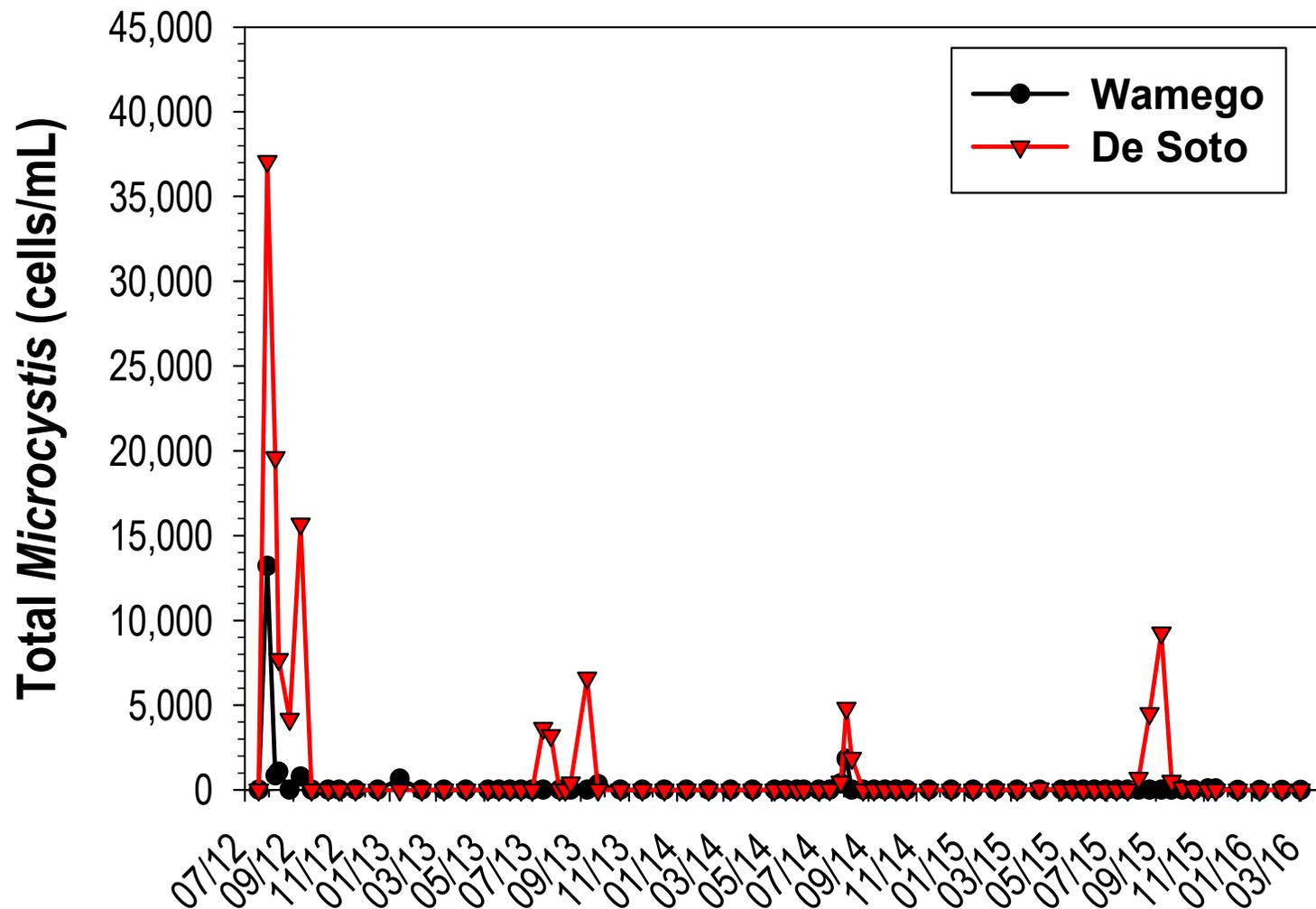
Microcystin was Detected in 27% of Samples Collected at the Kansas River Study Sites from July 2012 through March 2016

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

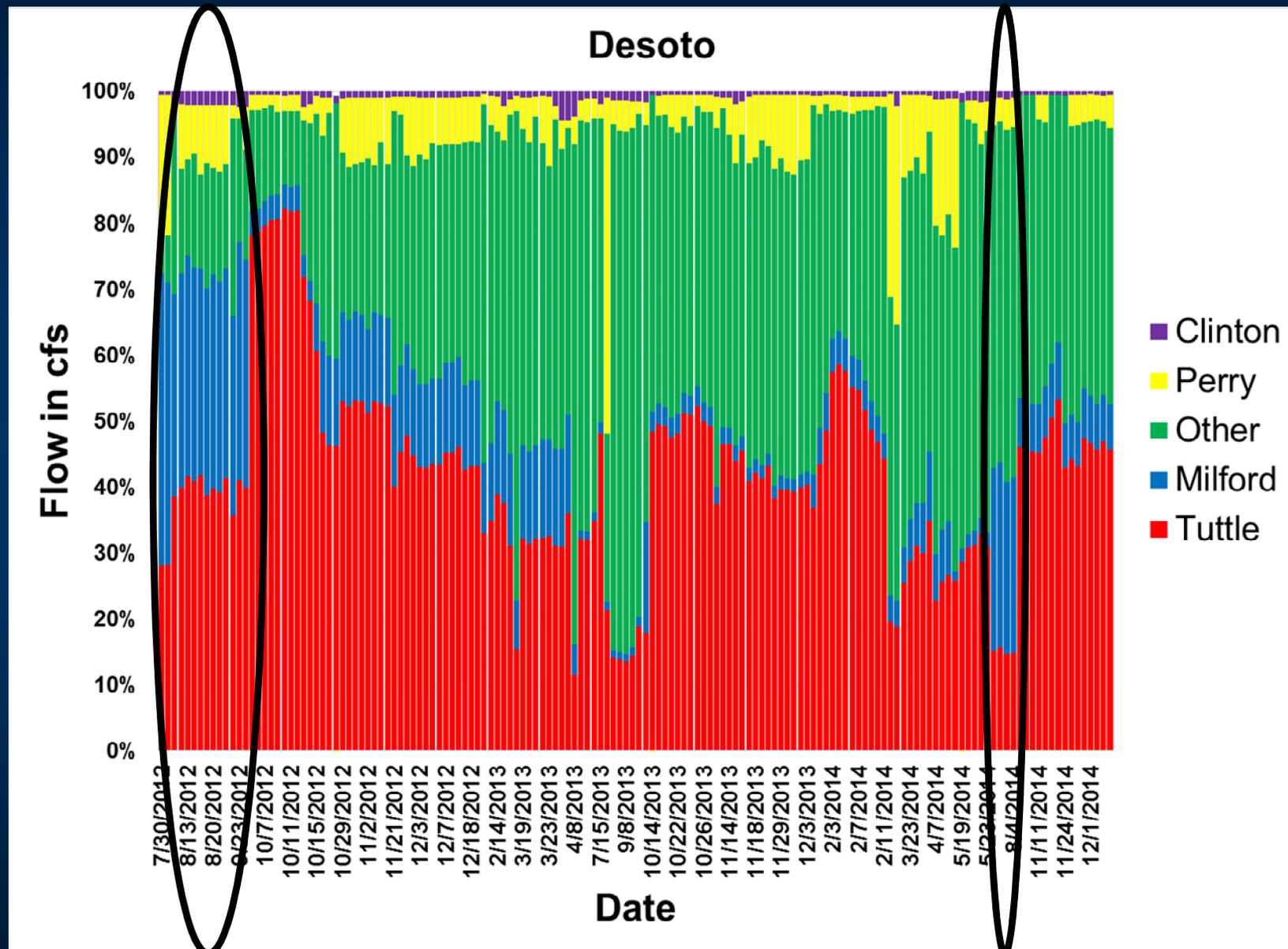
With the Exception of Late Summer 2011, 2012 and 2014, Microcystin Detections in the Kansas River Have Been Relatively Uncommon



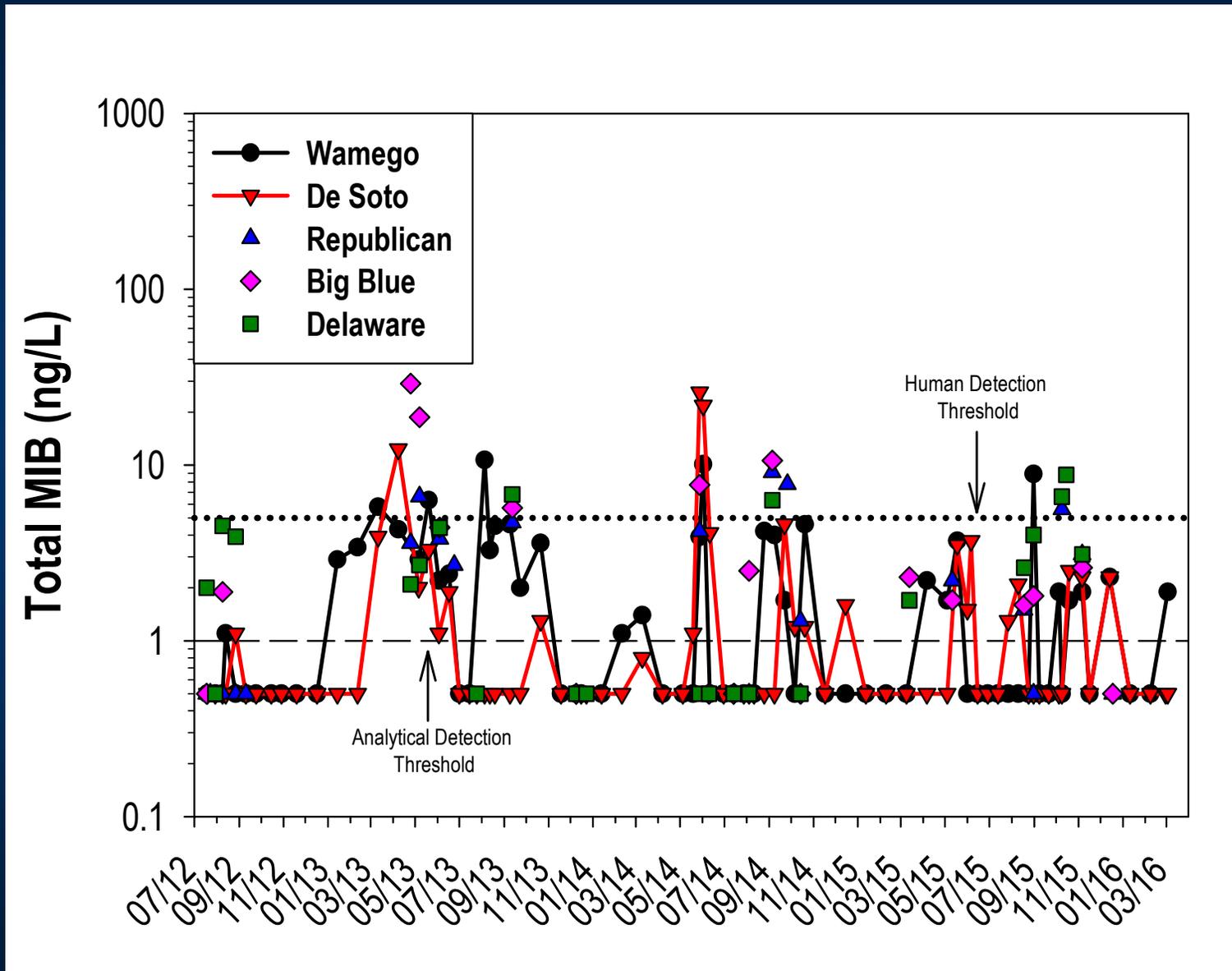
Microcystin Occurrence in the Kansas River is Associated with *Microcystis*



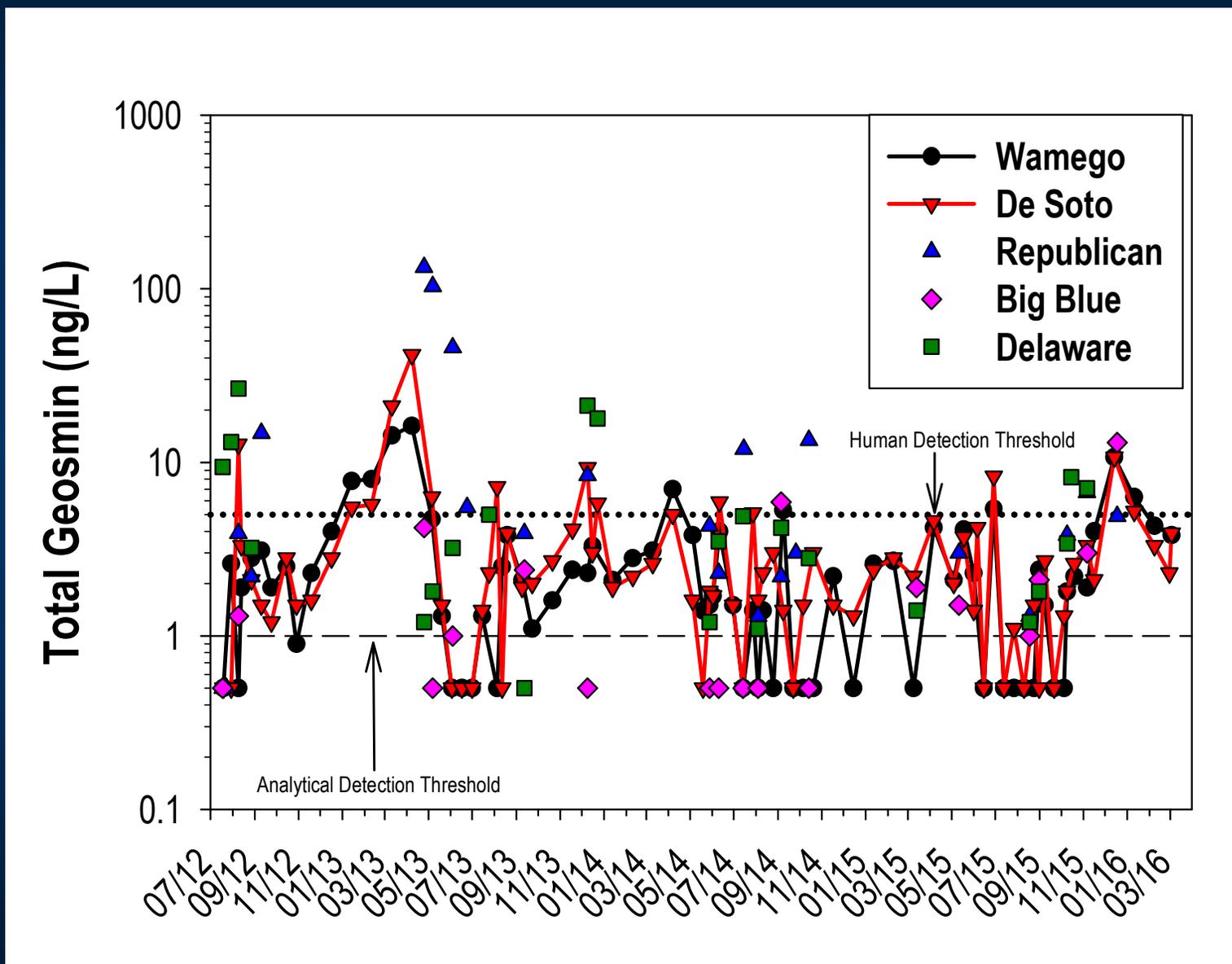
Microcystin Occurrence in the Kansas River is Associated with Flow Contributions from Milford Reservoir Greater than 30%



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



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



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.



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

The screenshot shows the USGS Real-Time Water Quality interface. The browser address bar displays the URL: http://nrtwq.usgs.gov/explore/plot?site_no=06892350&rcode=00060qstgq&period=2014. The page title is "Kansas Real-Time Water Quality".

The navigation menu includes: Home, View Data, Methods, Constituents, Models, Bibliography, Links. The breadcrumb trail is: NRTWQ Home >> Kansas >> View Data >> 06892350.

The main content area shows the USGS station: 06892350 Kansas River at DeSoto, KS. The constituent is set to "Computed discharge" with a concentration of "concentration" and a time period of "hourly". A dropdown menu lists various constituents, including "Computed probability of microcystin, >= 0.1 ug/L".

The plot displays the "Computed instantaneous probability of microcystin concentration, in >= 0.1 ug/L" for the year 2014. The y-axis ranges from 0.00 to 1.20, and the x-axis shows months from Jan. to Dec. The plot shows a peak in August and September, reaching approximately 0.60. A legend indicates that the blue line represents "Discharge", the black line represents "Measured or computed water-quality constituent", the grey shaded area represents the "90-percent prediction interval for computed value", the red dot represents "Value obtained from discrete sampling and analysis", the yellow dot represents "Load calculated using laboratory analysis and discharge", and the red dotted line represents "Water-quality criteria".

The model form #1 is given by the equation:

$$PMC = \frac{e^{-1.021 - 1.141 \sin(2\pi D / 365) - 0.824 \cos(2\pi D / 365) - 0.000115 Q}}{1 + e^{-1.021 - 1.141 \sin(2\pi D / 365) - 0.824 \cos(2\pi D / 365) - 0.000115 Q}}$$

where:

- PMC is computed probability of microcystin, in > 0.1 ug/L
- D is day of year, in the range of integers 1 through 365
- Q is computed discharge, stage-discharge rating curve, in cubic feet per second

The USGS logo is present at the bottom left of the plot area. The text "Generated 4-6-16 14:42" is located at the bottom right of the plot area.

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



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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>