Ohio EPA's Experience with Harmful Algal Blooms at Public Water Systems

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4-27-16

Ohio Environmental Protection Agency

Microcystins Occurrence

- **Over 3500 source water samples have been collected at Ohio public water systems**
  - Sampled 60% of all surface water systems
  - 75% of sampled systems (n=72) detected microcystins in their source water.
  - 21% of total samples had microcystins > 1.6 ug/L
  - Maximum concentration >20,000 ug/L (scum sample)
- **<u>Finished water microcystins detections at 8 public water systems</u>**
  - Advisories in 2013 & 2014
  - 5 finished water detections in 2015: No advisories
- **New Compliance Monitoring in 2016**

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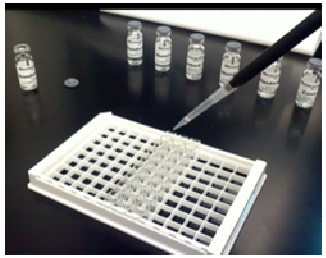

Other Cyanotoxin Occurrence

- Saxitoxins were detected in 38% of public water system source water samples.
- Finished water saxitoxins detections at 3 public water systems.
- Cylindrospermopsin was detected in less than 1% of public water system source water samples (maximum concentration 0.11 ug/L).
- Anatoxin-a has not been detected in source water intake samples. Some anatoxin-a detections at beaches, but at concentrations less than drinking water threshold.
- No finished water cylindrospermopsin or anatoxin-a detections.

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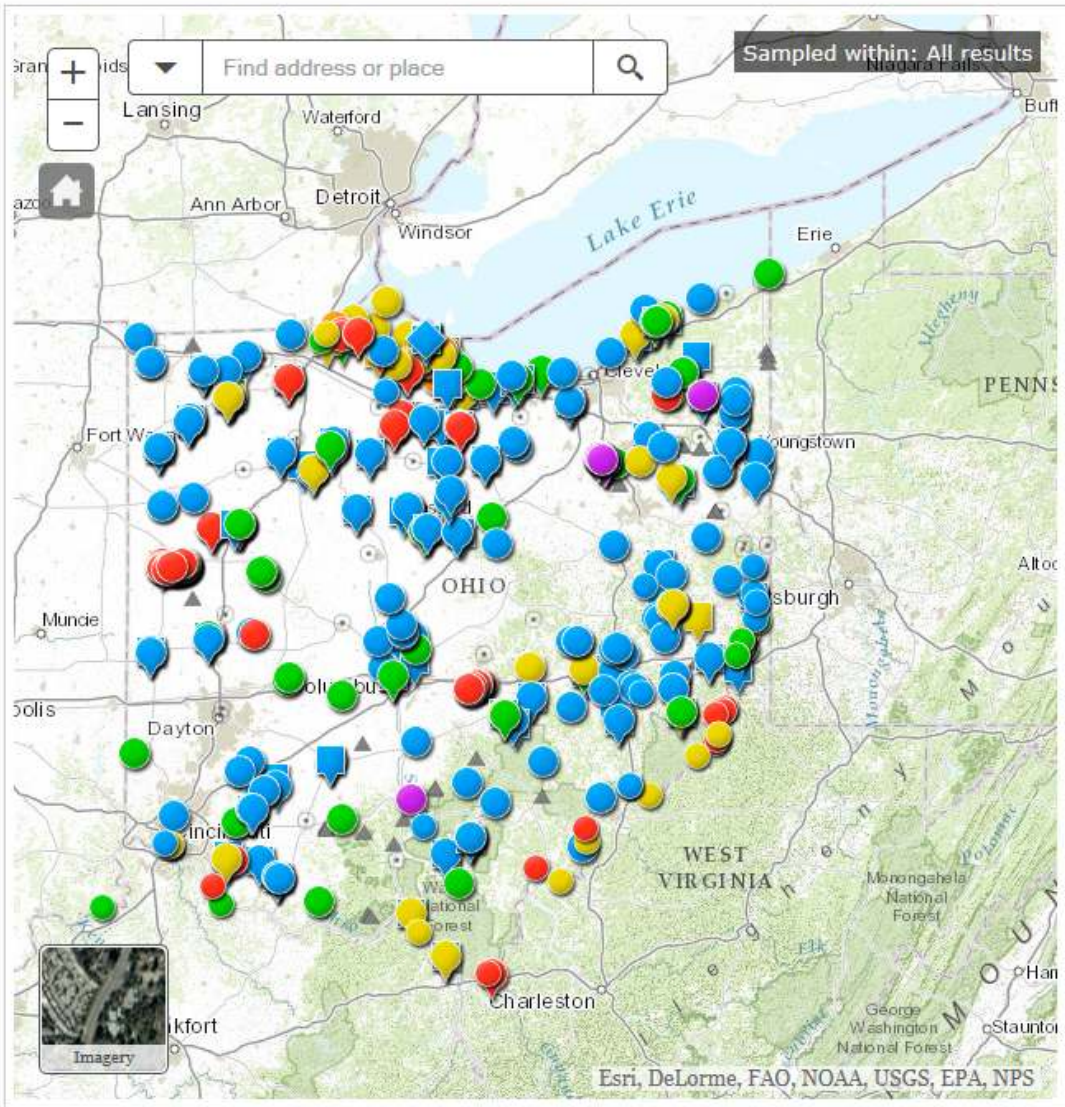
Ohio.gov State Agencies | Online Services

http://wwwapp.epa.ohio.gov/gis/mapportal/HAB_Monitoring.html

Harmful Algal Blooms: Cyanotoxin Monitoring in Ohio



Legend | Toxin Results | About this site

Filter the sampling sites by time period or type.

Sites sampled within:
○ 7 days ○ 14 days ○ 30 days ○ 90 days ○ 1 year ◉ All

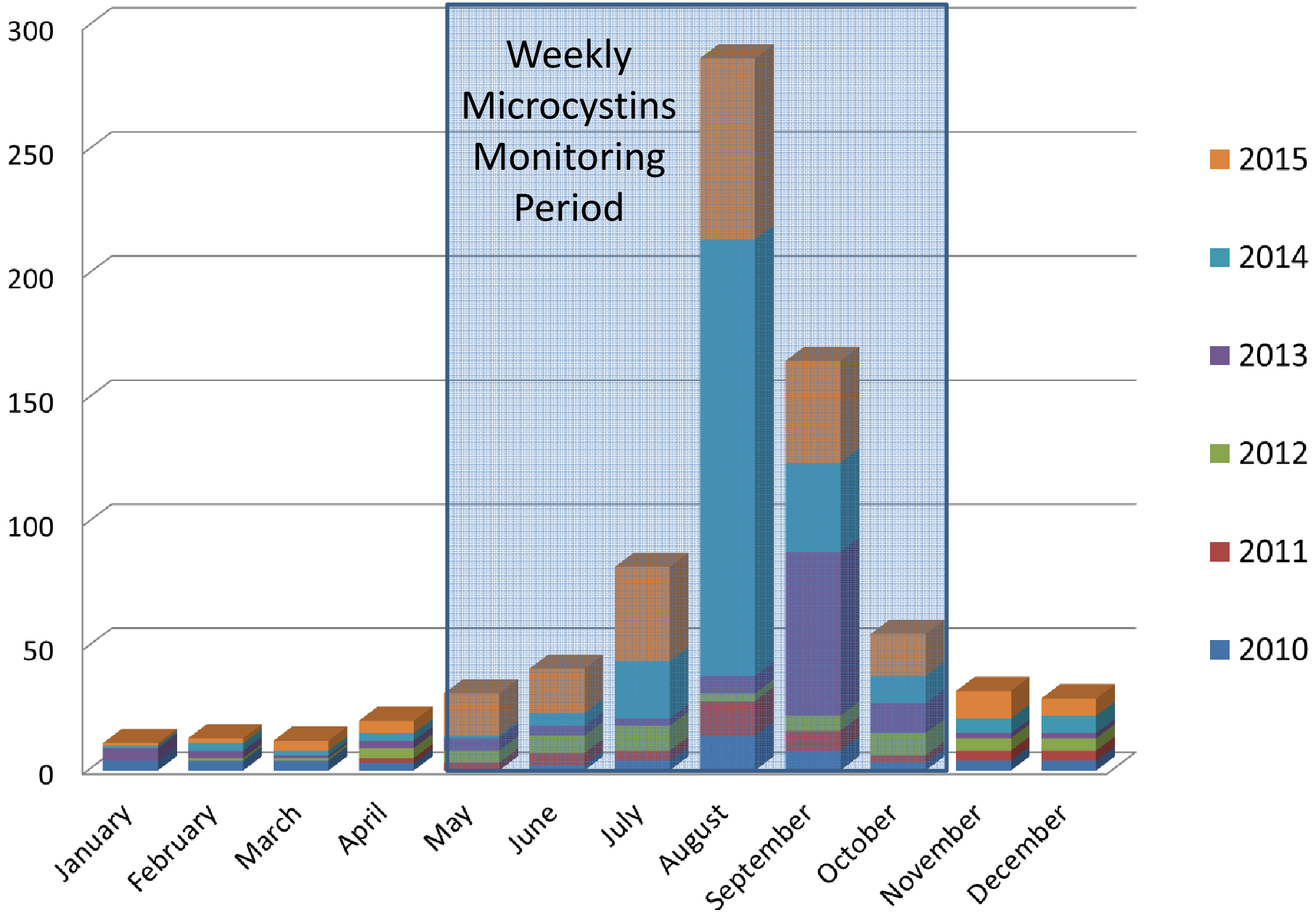
Type of Sampling Sites:
○ Lakes ○ Rivers ○ Groundwater ○ PWS Reservoirs/Intakes
○ Finished Drinking Water ○ ODNR Beaches ◉ All sites

Download all results (excel file).

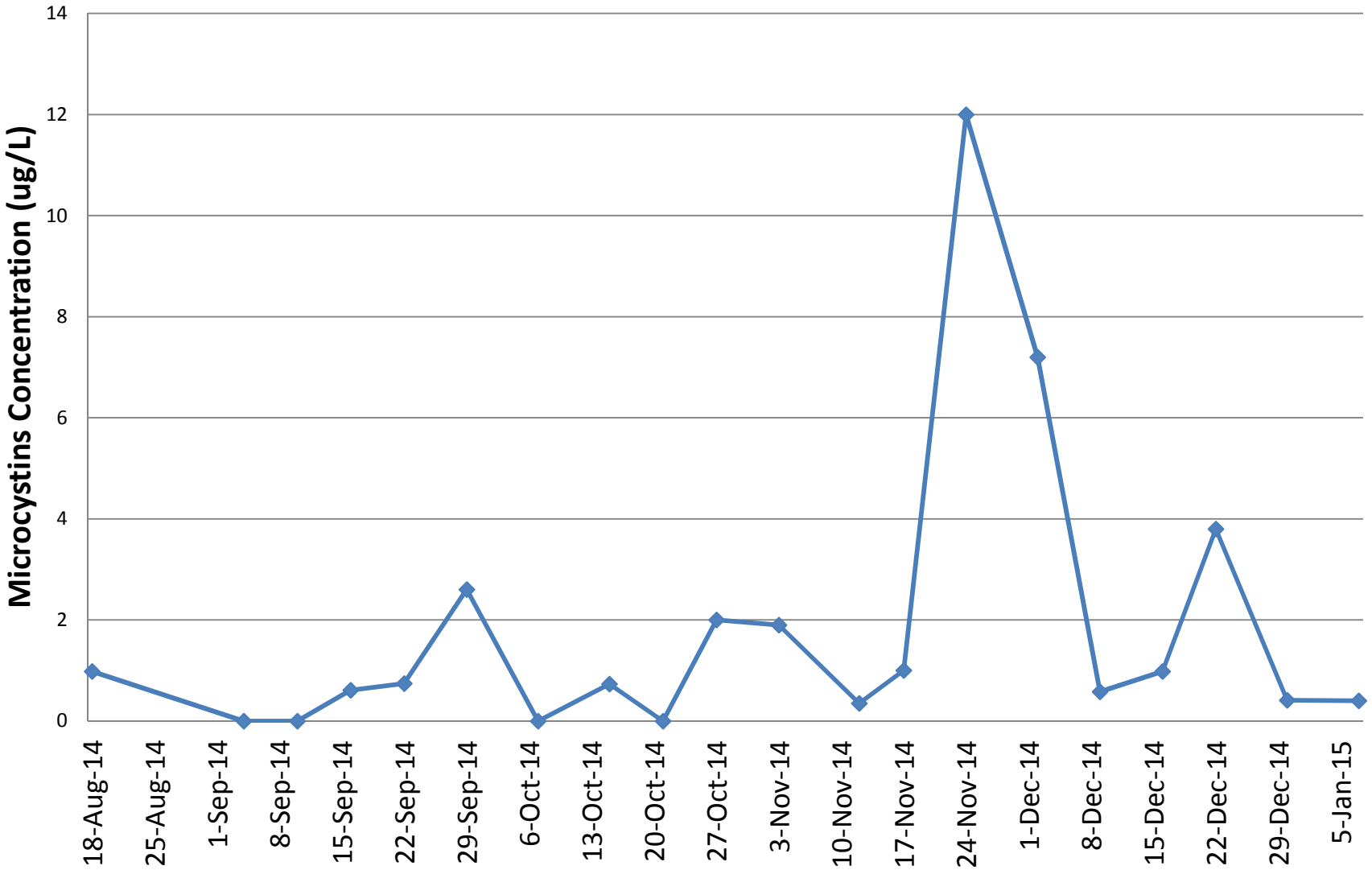
Microcystins Concentration	Site Type
Below detection (<0.30 µg/l)	Public Water System (PWS) Finished Water
Between 0.30 - 1.6 µg/l	Reservoirs/Intakes (PWS)
Between 1.6 - 6 µg/l	Lakes & Rivers
Between 6 - 20 µg/l	Groundwater
Greater than 20 µg/l	PWS (no data)
Saxitoxin, Cylindrospermopsin, Anatoxin-a	ODNR State Park Beach (no data) Non-ODNR Beach (no data)

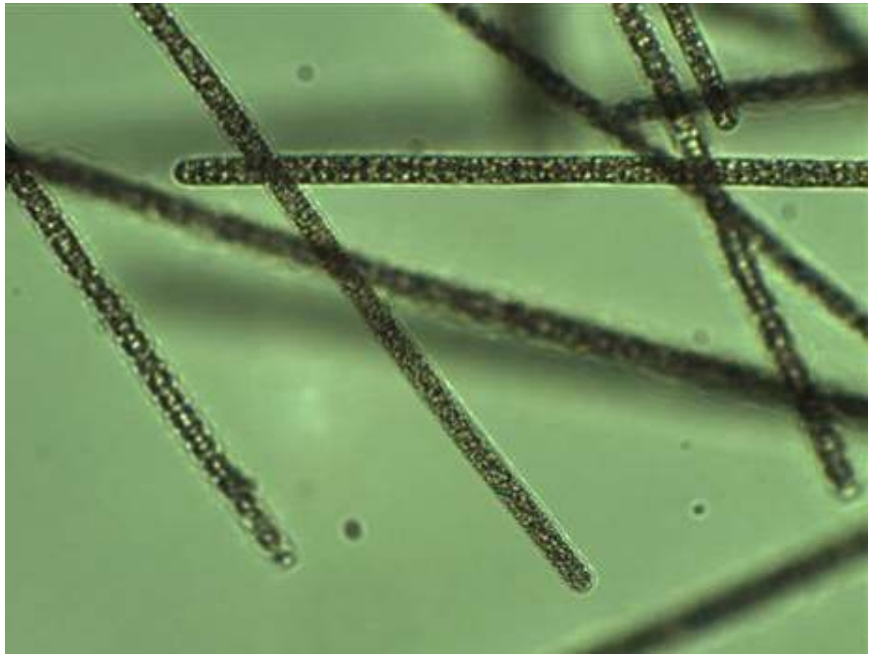
Markers on the map show sites sampled for microcystins during the selected time period. Marker color indicates that one or more results for that time period were within the range indicated by the marker color. Marker shape indicates the type of sampling site.
Concentration Units µg/l - micrograms per liter

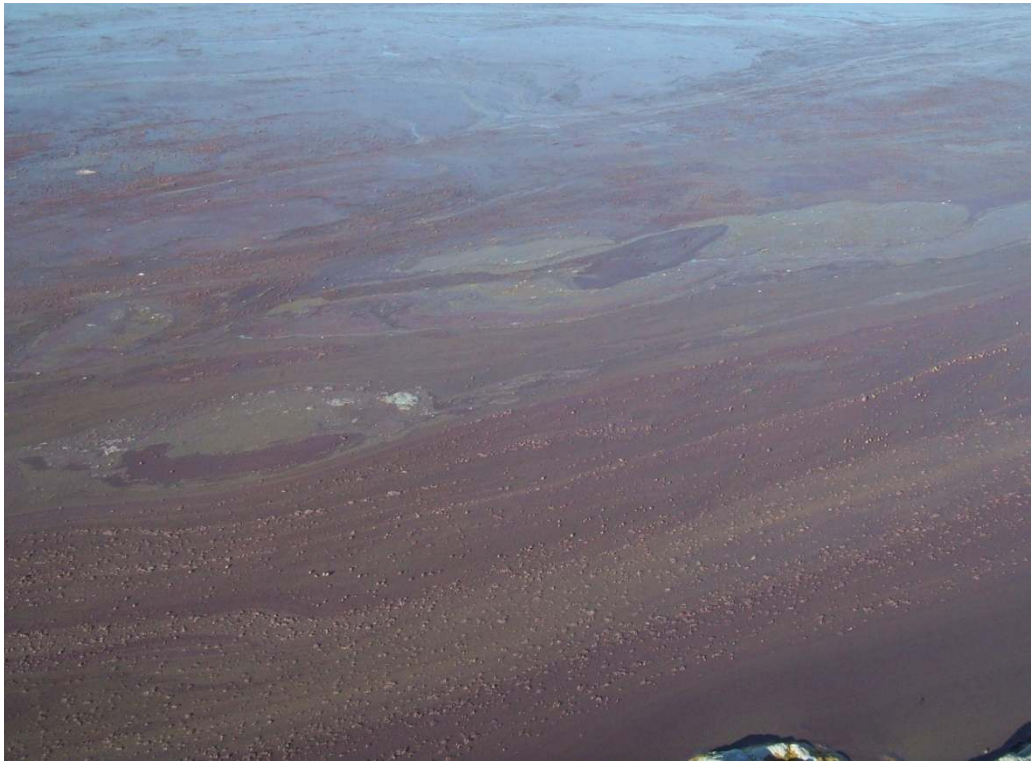
Frequency of Source Water Microcystins Detections > 1.6 ug/L in Ohio



Microcyctins Concentrations at Cadiz Intake on Tappan Lake (Raw Water)







William's Reservoir
November, 2012

Microcystin
Concentration: 1400 ug/L

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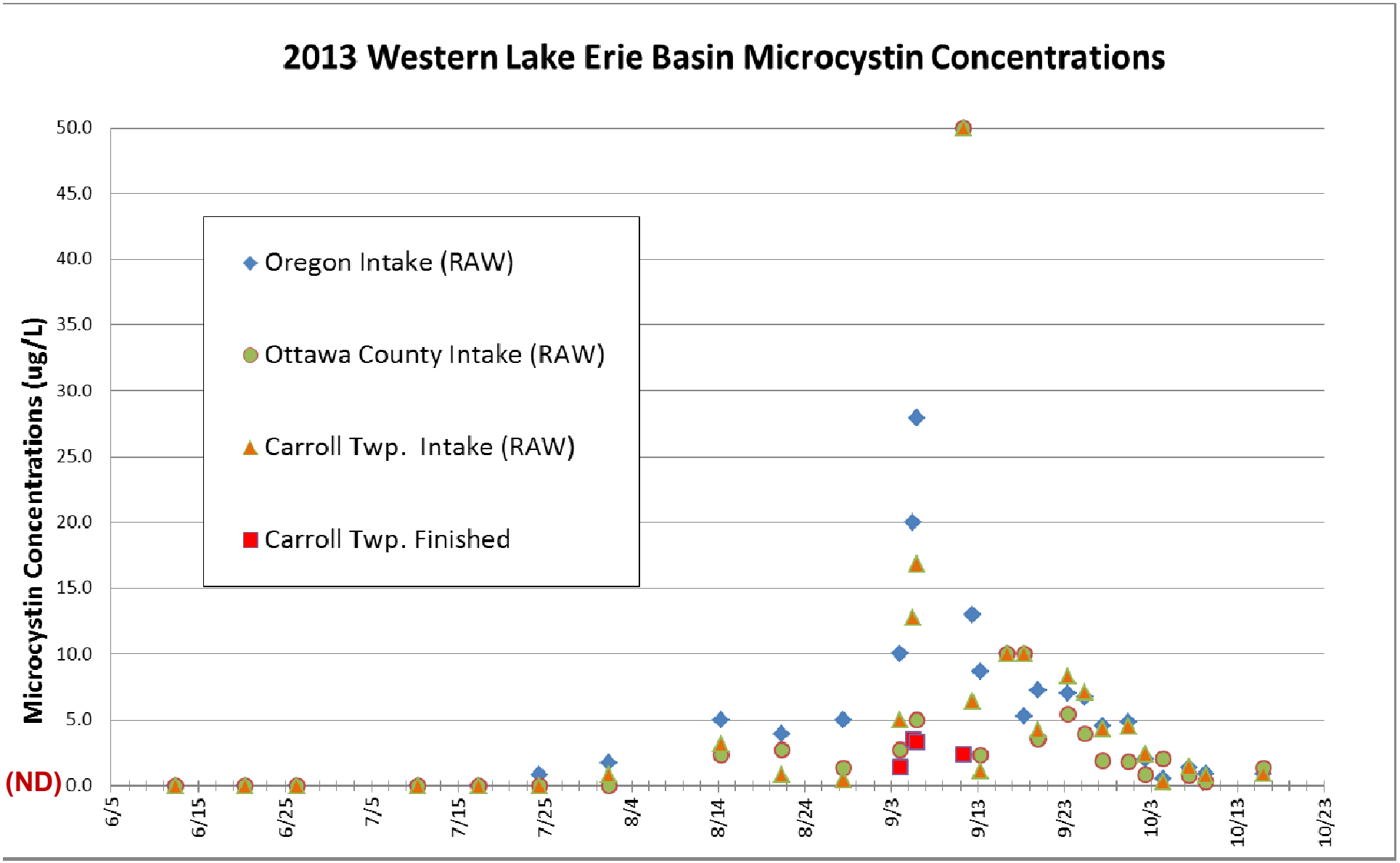
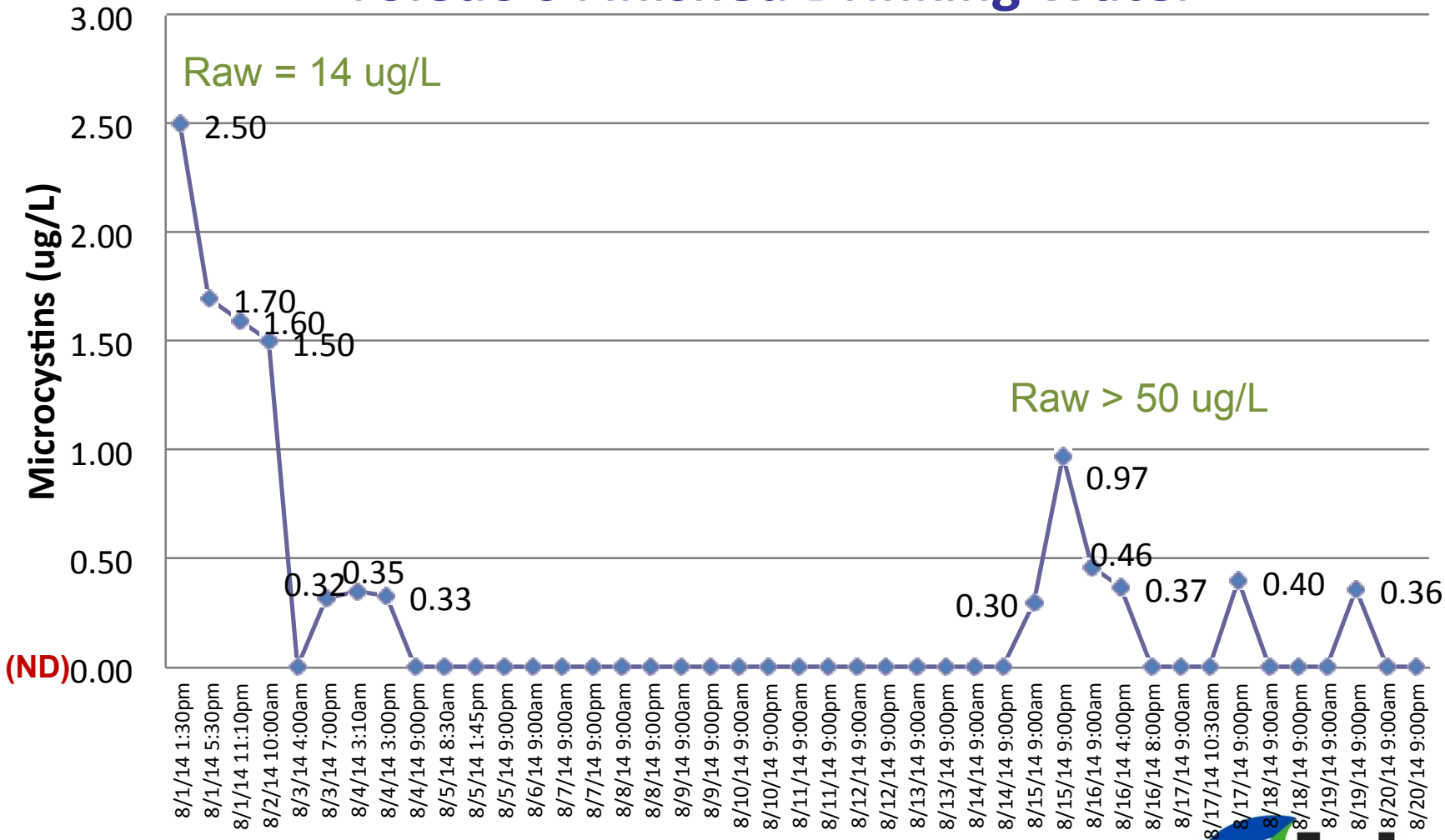


ND= Not Detected (Concentration <0.25)

Data Source: Oregon

2014 Microcystins Concentrations in Toledo's Finished Drinking Water



Microcystins also detected at 31 distribution sites

ND= Not Detected (Concentration <0.30)

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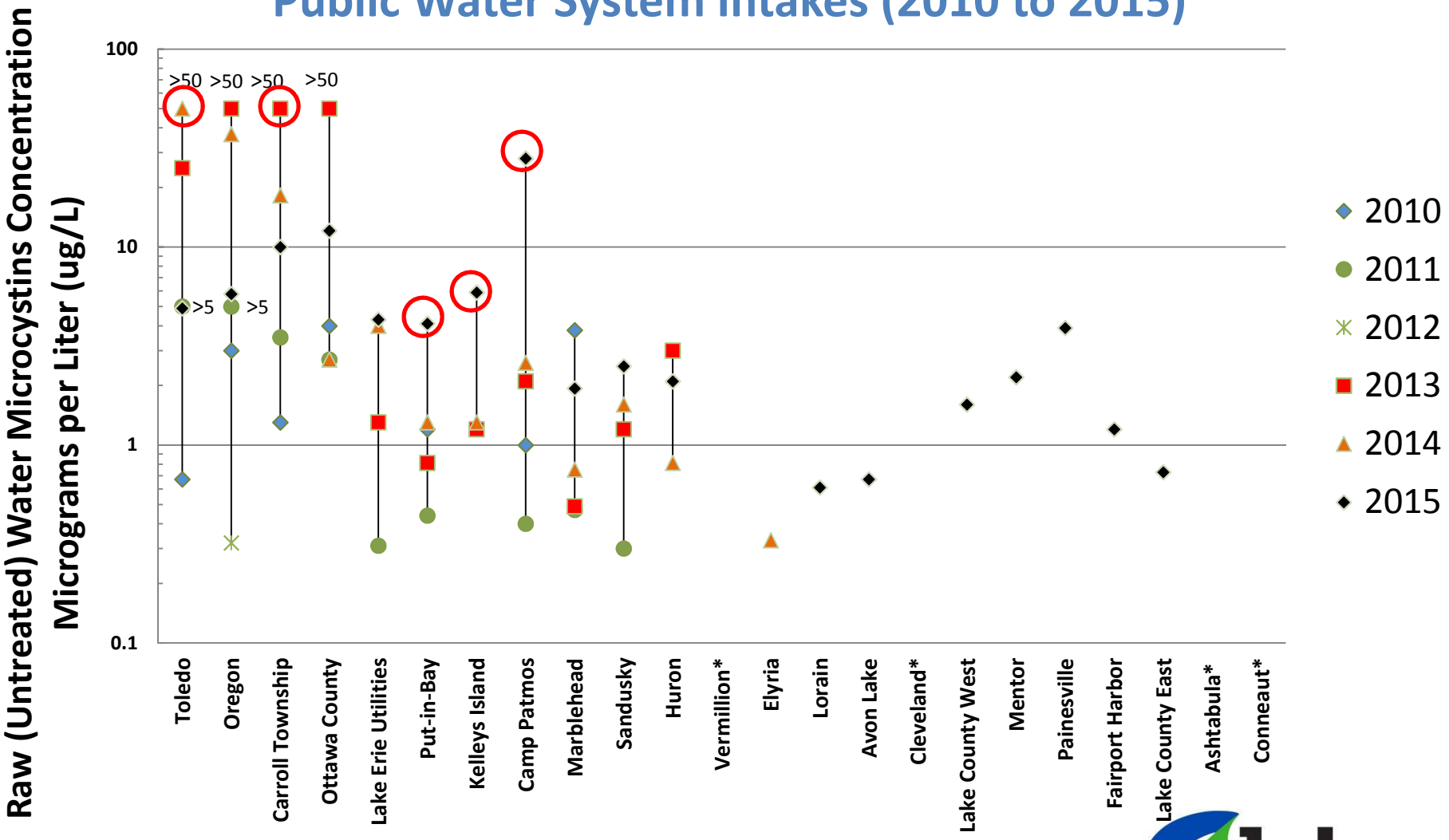
Data Source: Toledo PWS

Maximum Microcystin Concentrations at Lake Erie Public Water System Intakes (2010 to 2015)



*microcystins were not detected above reporting level of 0.30 ug/L at these locations

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Utilization of NOAA Remote Sensing Data

- **Lake Erie NOAA Interpreted Satellite Imagery (HAB Bulletins)**
  - Target response monitoring at PWSs and beaches
  - Predict Bloom Movement- provide early warning to water systems
  - Utilized by water systems to optimize treatment and plan avoidance strategies
- **Lake Erie Forecasts**
  - Assist Ohio EPA and water systems in response planning. Helpful for water systems to estimate treatment chemicals needed for season.
- **Inland Lake/River Satellite Imagery**
  - Ohio EPA assisted in collecting field data to ground truth inland lake satellite data
  - Used imagery to start targeting inland lake response sampling – Very helpful for non-scum forming, not “visually apparent” blooms
  - Pilot state on CyAN project and use of new inland lake mixing models

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Use of NOAA Remote Sensing Data- Predict Bloom Movement

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2011-019
13 October 2011
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 29 September 2011

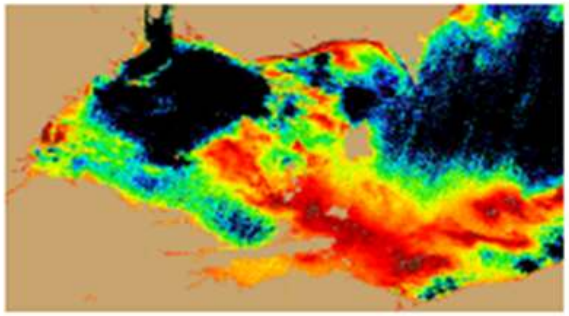


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from October 11, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low), + (very low) and X (not present).

Conditions: A large *Microcystis* bloom persists in Lake Erie, extending well past Cleveland to the east.

Analysis: Satellite imagery from Tuesday (10/11) indicates that the *Microcystis* bloom has now extended well past Cleveland to the east, and remains offshore. The eastern extent is just past Fairport Harbor. The bloom also hugs the northen shore in Ontario, to the Rondeau Provincial Park region. The forecast over the next three days indicates that the bloom will continue moving eastward as far as Geneva on the Lake, but will remain offshore. However, the northern portion of the bloom will dissipate. The wind stress is expected to increase dramatically on Oct 14, and will likely cause the surface bloom to decrease as mixing occurs. Water temperatures continue to remain stable.

NOTE: Please see pages 3 and 4 of this bulletin, as they show the MERIS image from 10/11/2011 (page 3) for the whole lake and the forecast for 10/16/2011 (page 4).

-Tomlinson, Wynne

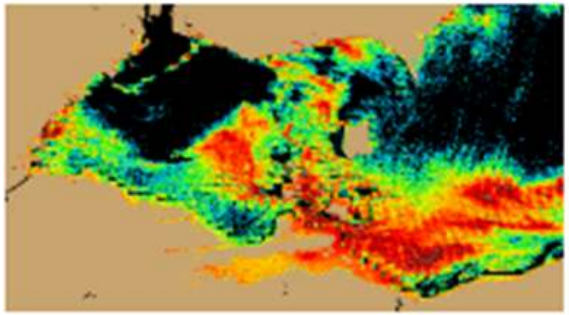


Figure 2. Nowcast position of *Microcystis* spp. bloom for October 13 using GLCFS modeled currents to move the bloom from the October 11 image.

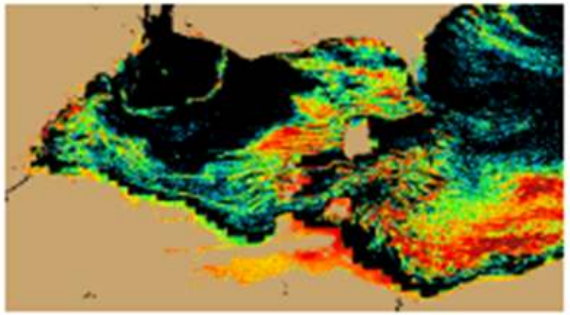
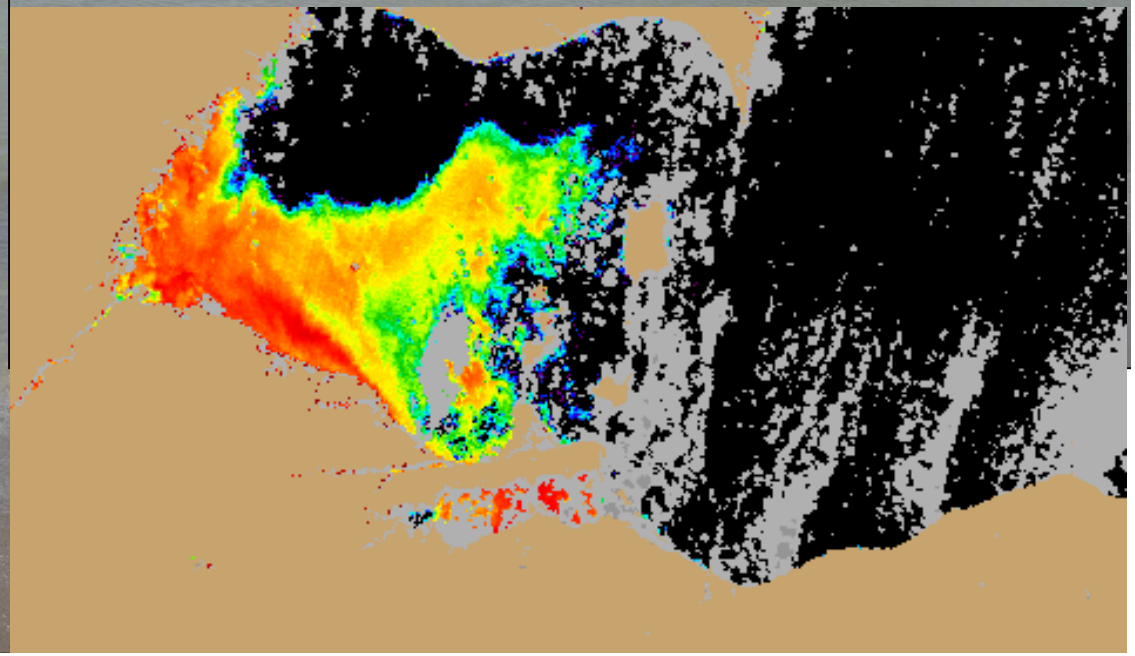
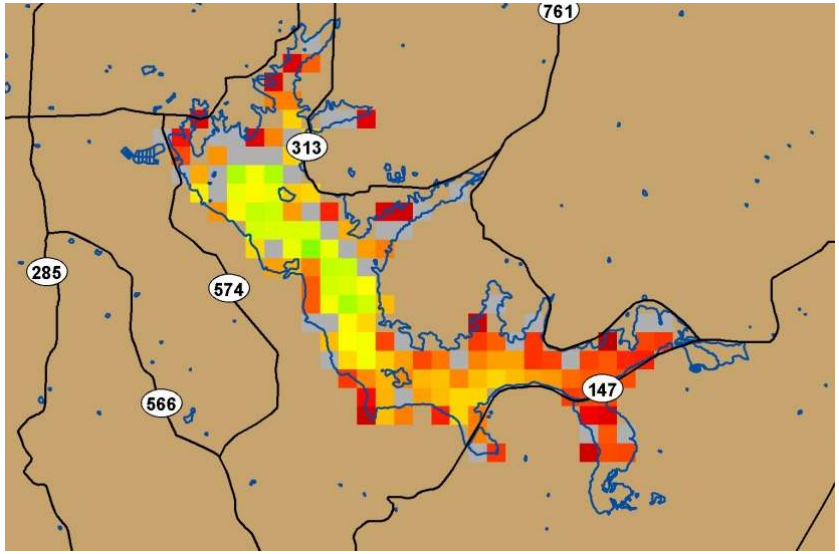


Figure 3. Forecast position of *Microcystis* spp. for October 16 using GLCFS modeled currents to move the bloom from October 11 image.

Use of NOAA Remote Sensing Data- detect “non-visible” blooms

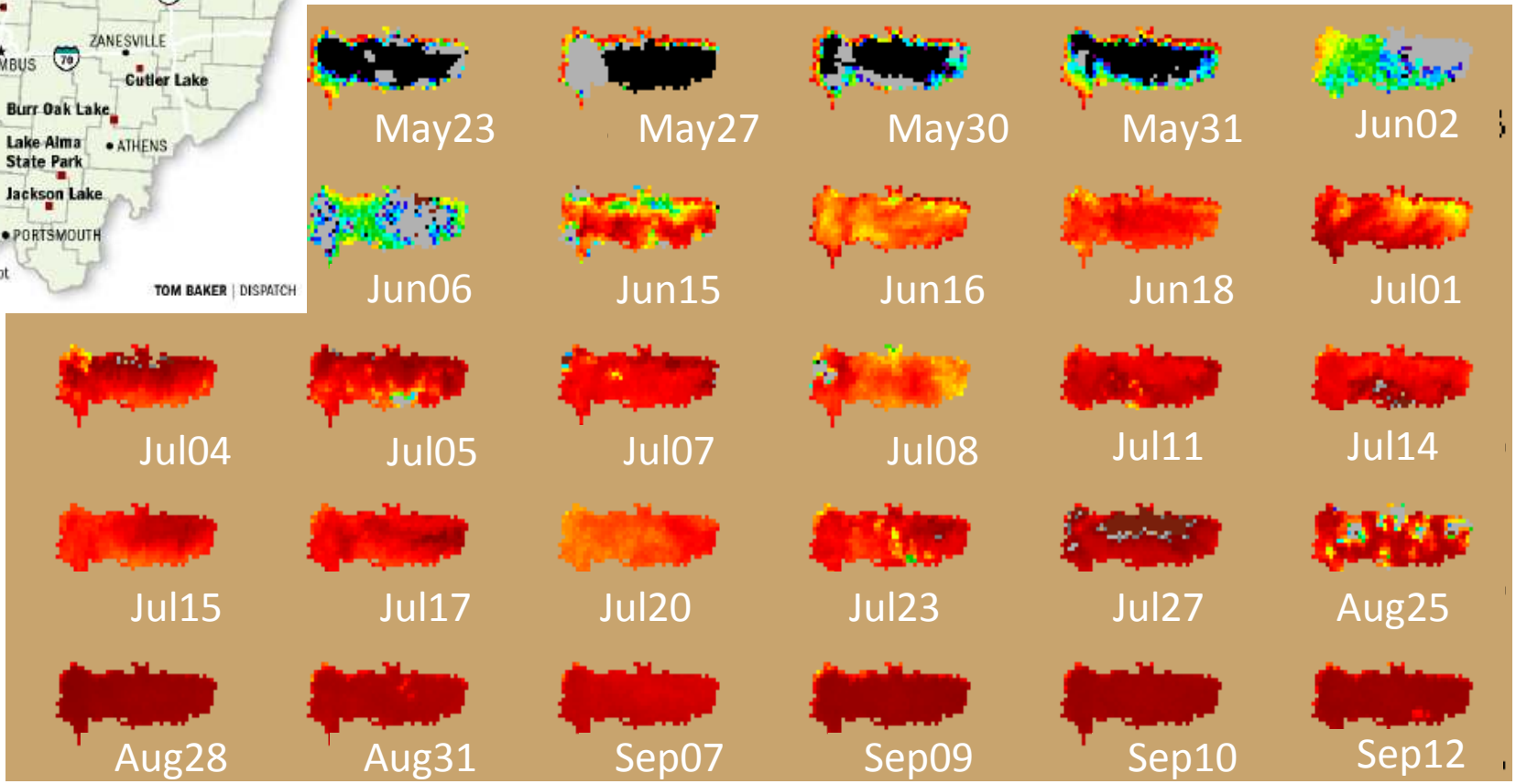


Application to Inland Lakes



Inland Lake Example

- Cyano index for 2010




Grand Lake Saint Mary 2010

Celina Intake on Grand Lake Saint Mary, September, 2015

Planktothrix Bloom, Microcystins 185 ug/L

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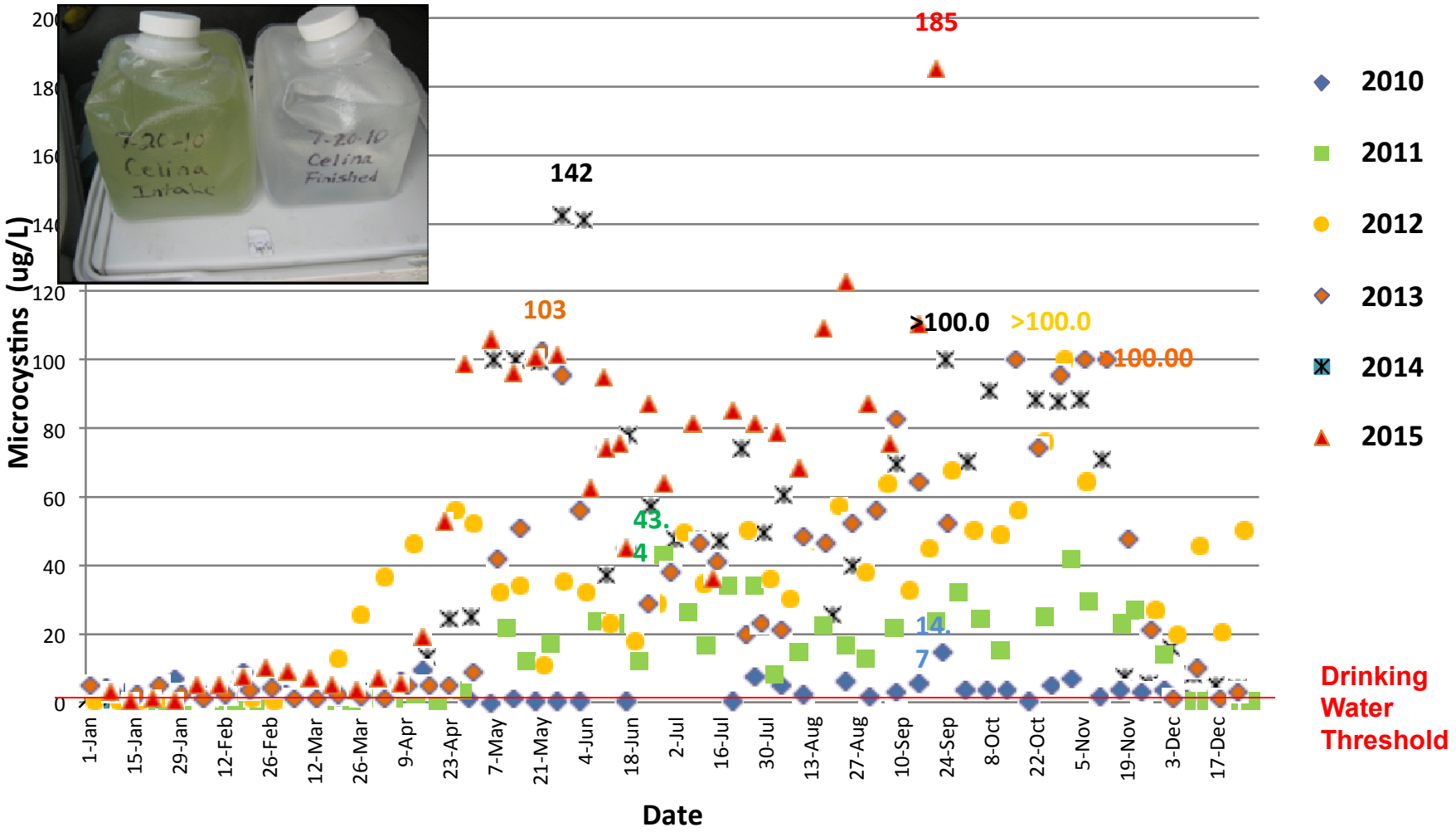
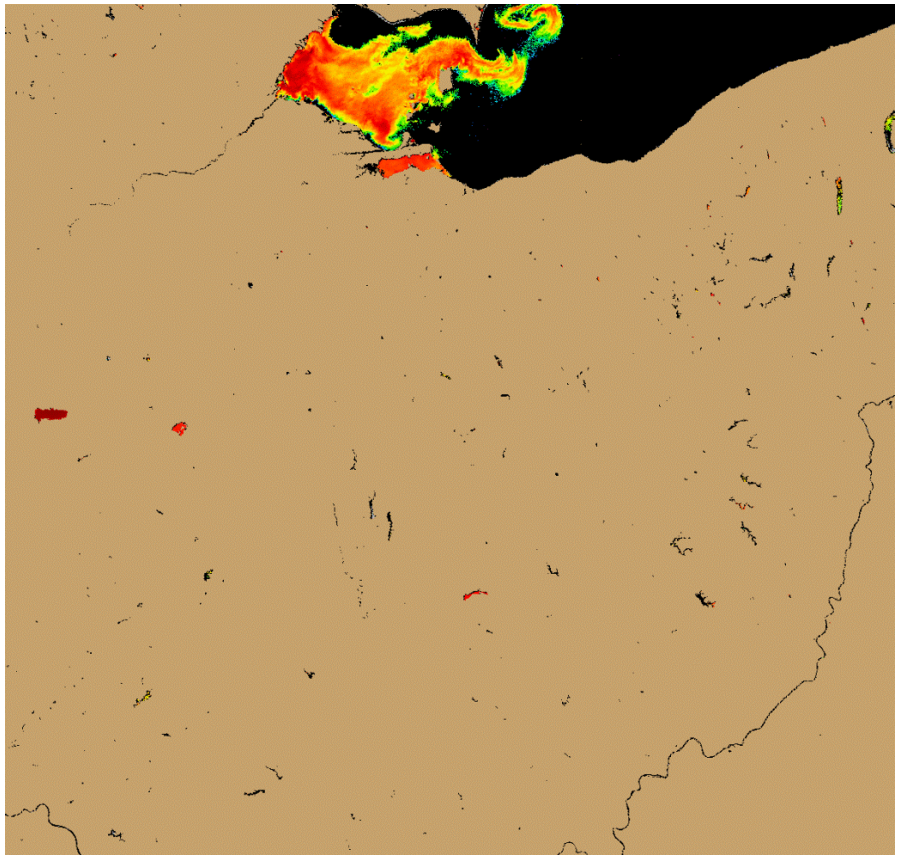
Grand Lake St. Marys Microcystin Concentrations at City of Celina Intake (Raw Water)



Data Source: Celina PWS

Inland Lake Data: Statewide Satellite Data expected in 2016 (CyAN Project Collaboration)



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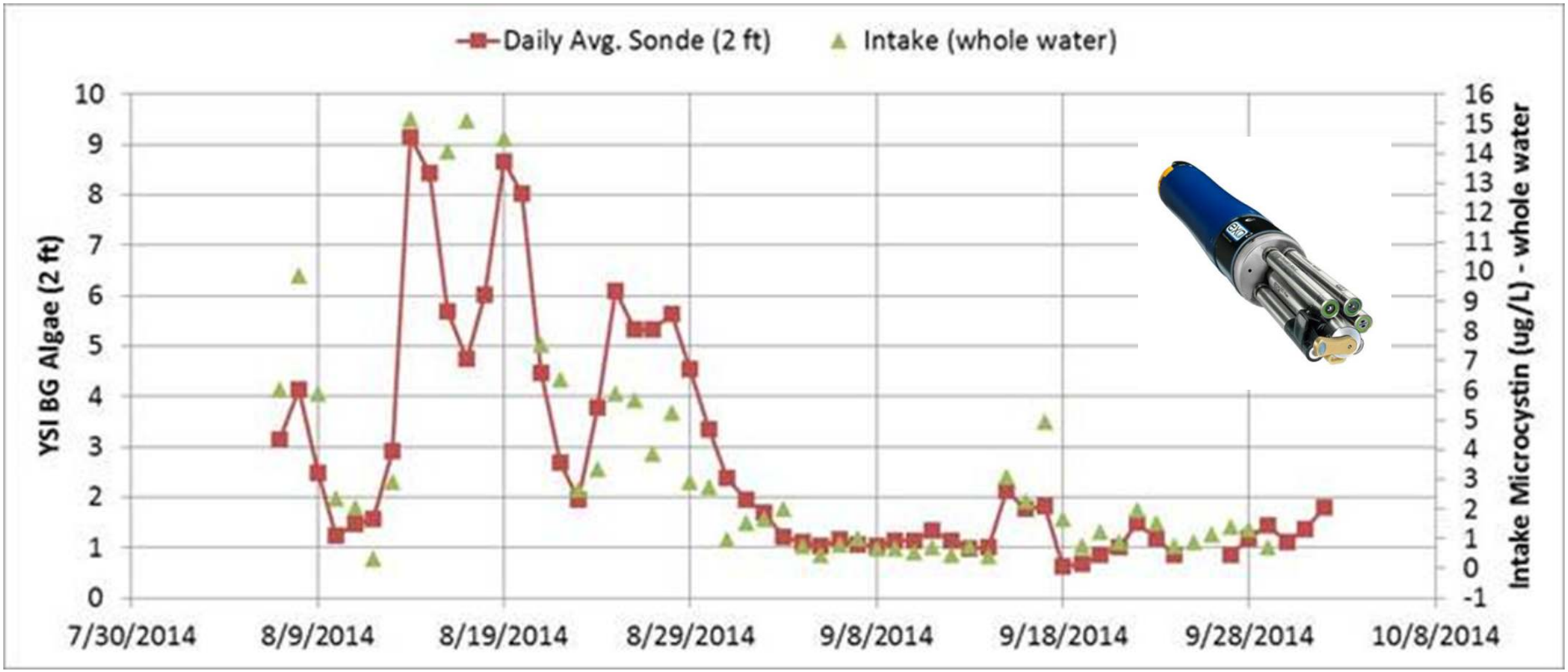
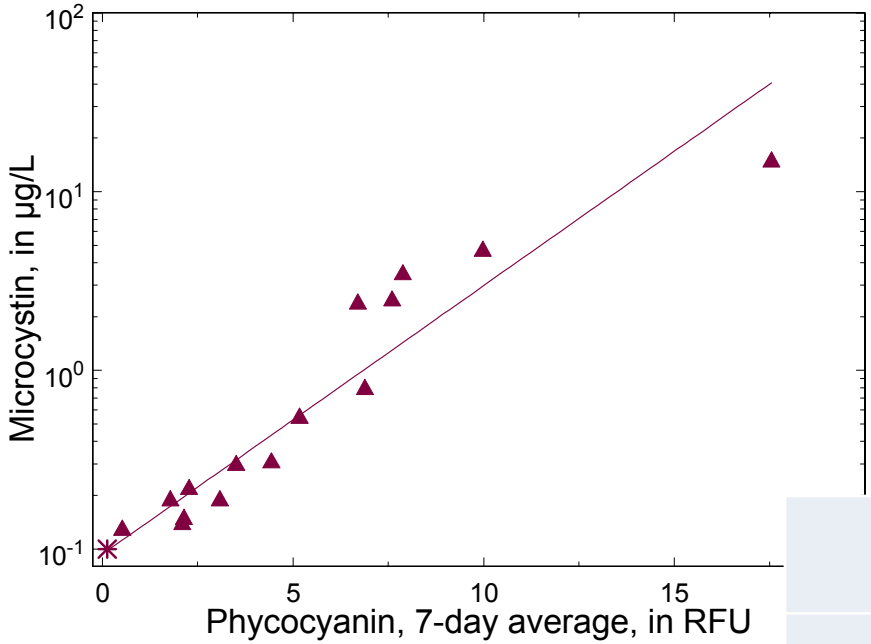
Ohio EPA Monitoring and Equipment Grants To Public Water Systems

- $1 million in grants, up to $30,000/water system
- Eligible items included water quality sensors, microscopes, ELISA-related analysis equipment and training



-Graph provided to Ohio EPA by Ed Verhamme, Limnotech.

Harsha Main 2014—
U.S. EPA Continuous Monitor



Spearman's correlation to microcystin concentrations	rho	p
Phycocyanin, 7-day average	0.98	<0.0001
Dissolved oxygen, 14-day average	0.88	<0.0001
pH, 7-day average	0.83	<0.0001
Temperature, instantaneous 10 a.m.	0.73	0.0031
Chlorophyll, 24-hour average	0.53	0.0358
Specific conductance, 3-day average	-0.20	0.4473

Data Courtesy:
Donna Francy, USGS

Phycocyanin Data Interpretation

- Phycocyanin concentrations vary based on type of cyanobacteria present, turbidity of the water and other factors.
- Relative/Raw Fluorescence Units (RFUs) better than Cell Counts.
  - Can calibrate to cell counts in source water, but this can change if cyanobacteria genera shift or turbidity changes.
- Evaluate trends, not absolute values.

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Public Drinking Water Supply Beneficial Use

Algae Impairment Criteria

2014 CWA Integrated Water Quality Monitoring and Assessment Report:

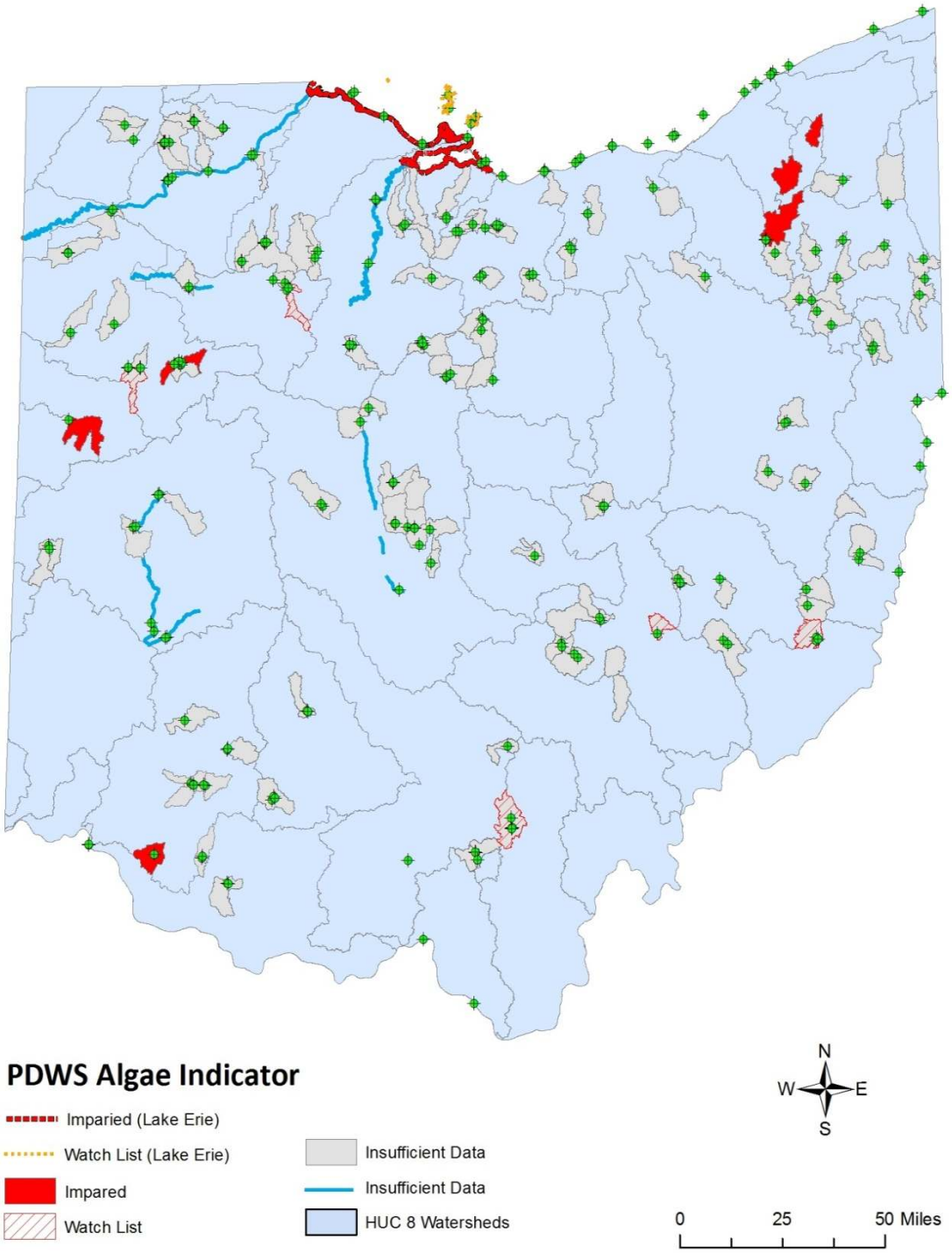
Impaired = at least 2 source water cyanotoxin detections above drinking water thresholds at least 30 days apart.

Nine Public Water Systems Triggered Impairment Listings: Toledo, Oregon, Carroll Township, Ottawa County, Marblehead, Lima, Akron, Clermont County, and Celina

The Western Lake Erie Basin Shoreline and Six Watersheds are Impaired

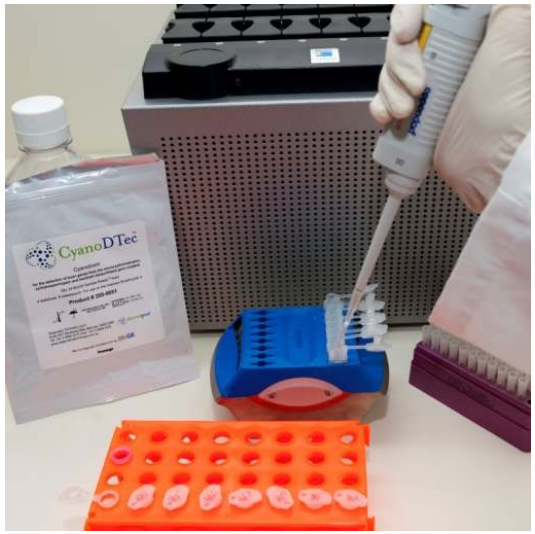
Six Additional Public Waters Systems are on a Watch List

2016 IR under development- Anticipate additional impairment listings



Cyanobacteria Screening: Multiplex qPCR

- Cyanobacteria screening
  - Quantitative polymerase chain reaction (qPCR) – identifies and quantifies the presence of genes unique to:
    - Cyanobacteria (16S rDNA, good correlation with cell counts)
    - Microcystin and Nodularin production (mcyE gene)
    - Cylindrospermopsin production (cyrA gene)
    - Saxitoxin production (sxtA gene)
  - Test completed within 2-3 hours (includes extraction)
  - Scalable
  - Cost-effective
  - Utilizes certified reference material
  - Specific: no gene, no toxin
- Method and certification beginning in 2017
- Until there is sufficient capacity at certified laboratories to perform this method, Ohio EPA's lab will conduct these analyses for Ohio PWSs
- www.phytoxigene.com/products/



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Using qPCR to Direct Reservoir Management

- Saxitoxins Detections in Finished Water from July 31, 2015 – September 21, 2015. Maximum concentration 0.039 ug/L. Maximum raw water concentration at intake 0.812 ug/L
- Extracellular saxitoxins predominated all samples.
- 10 different potential saxitoxin producing genera found in multiple habitat zones (pelagic, benthic, periphyton, etc.) in multiple locations.
- qPCR results indicated benthic source, data used to target algaecide application.

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Questions?
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http://epa.ohio.gov/ddagw/HAB.aspx
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Recreation Exposure: Is Common Sense Enough?

Will people use common sense and stay out of the water when it looks bad?

Not necessarily,
there is an assumption
that it is safe unless
told otherwise

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