Ohio EPA
Reservoir Management Assistance

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Ohio EPA PWS HAB Coordinator
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Ohio Environmental Protection Agency

Overview

- Ohio EPA Inland Lakes Monitoring Program
- DataSonde Utility and Data Interpretation
- HAB Detection by Remote Sensing
- Algaecide Application and Case Studies
- Upcoming Research Projects
- Nutrient Management

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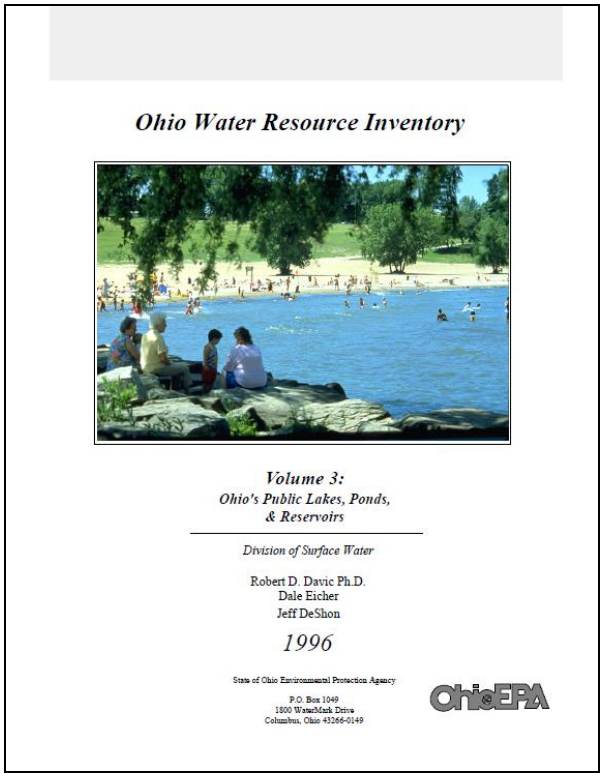
Ohio EPA Inland Lakes Monitoring Program Overview

- In 1996 reported status of 447 public lakes in Clean Water Act 305(b) report
- Participated in U.S. EPA Sponsored National Lakes Survey (19 Lakes in 2007)
- In 2008 DSW renewed focus on Inland Lakes
  - Monitor up to 16 lakes per year (over 2 years)
  - Over 60 Lakes monitored since 2008



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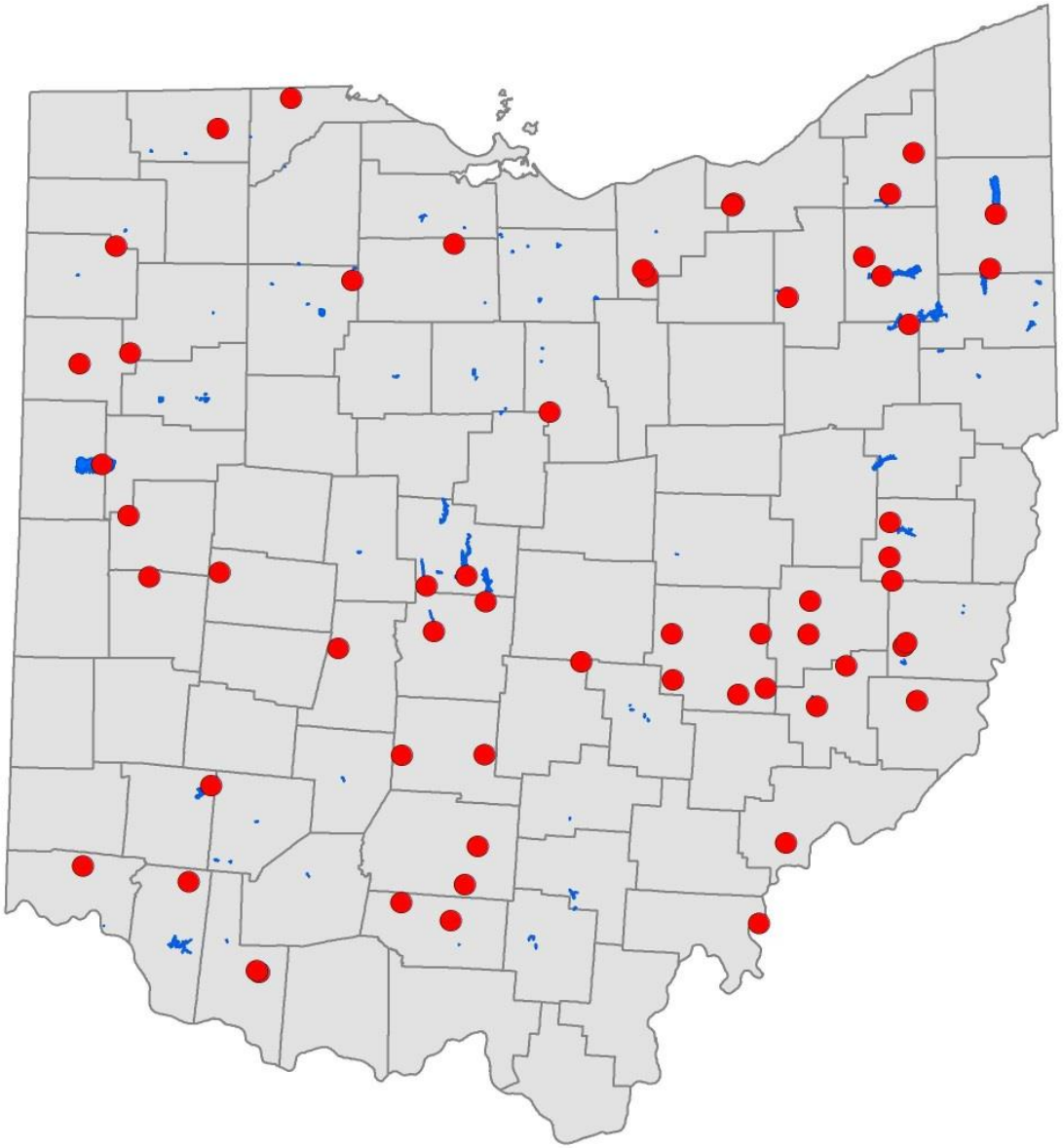
Inland Lakes Studied Since 2008 (Division of Surface Water)



Objectives

- Track status and trends
- Determine attainment status
- Identify causes and sources of impairment
- Recommend actions for improving water quality

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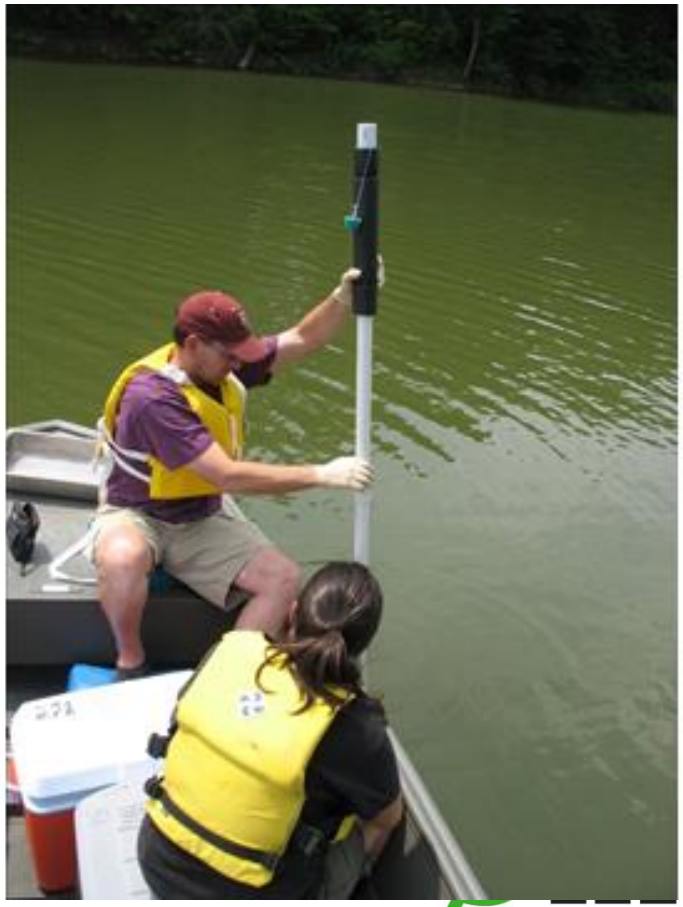
What is Monitored?

- Lake Profiles
- Secchi Depth
- Nutrients
- Metals
- Algal Toxins
- Phytoplankton
- Zooplankton
- Bacteria
- Organics (atrazine)
- Sediment



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Ohio EPA Division of Surface Water Inland Lakes Contacts

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Remote Sensing Data

High

Med

Low

0

Experimental
Lake Erie Harmful Algal Bloom Bulletin
2011-014
08 September 2011
National Ocean Service
Great Lakes Environmental Research Laboratory
Last bulletin: 01 September 2011

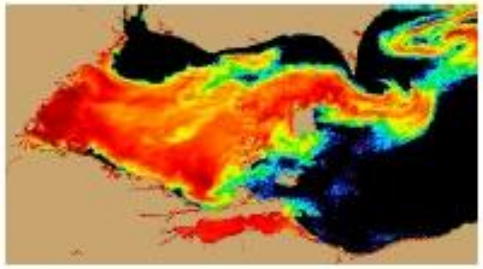

Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from September 03, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low) , + (very low) and X (not present).

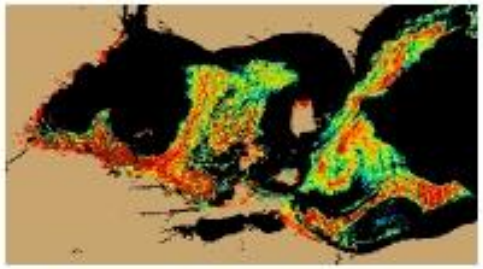

Figure 2. Nowcast position of *Microcystis* spp. bloom for September 08 using GLCFS modeled currents to move the bloom from the September 03 image.

Conditions: A massive *Microcystis* bloom persists throughout most of Lake Erie's Western Basin.

Analysis: As indicated in satellite imagery from Saturday (9/3/2011), an enormous *Microcystis* bloom was present in western Lake Erie. The southern extent of the bloom was remotely observed along the coast of Ohio from Maumee Bay to Catawba Island. The northern extent of the bloom was observed to be consistent along the Michigan coast from Northern Maumee Bay to the mouth of the Detroit River. The eastern-most portion of the bloom was observed past Point Pelee and to the northeast up in to Rondeau Provincial Park.

At the mouth of the Detroit River, a five day nowcast shows a southward suppression of the western-most portions of the bloom. However, the bloom is likely to still persist in much of the Western Basin. The nowcast also suggest the bloom has spread to the east of Sandusky and into the Cleveland area. **(Note: Due to a lack of clear imagery the bloom has not been remotely observed in the Cleveland area.)** A three day forecast also suggests that the bloom will persist to the north of Cleveland through the weekend. Water temperatures remain above 20 degrees Celsius and are forecast to decrease into the weekend; however, conditions remain favorable for bloom growth.

Briggs, Wynne

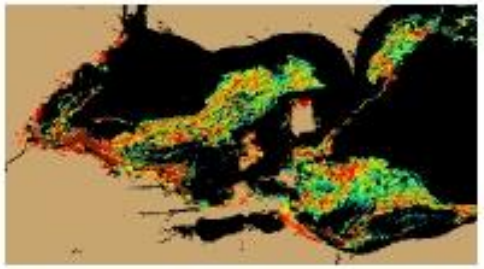

Figure 3. Forecast position of *Microcystis* spp. for September 11 using GLCFS modeled currents to move the bloom from September 03 image.

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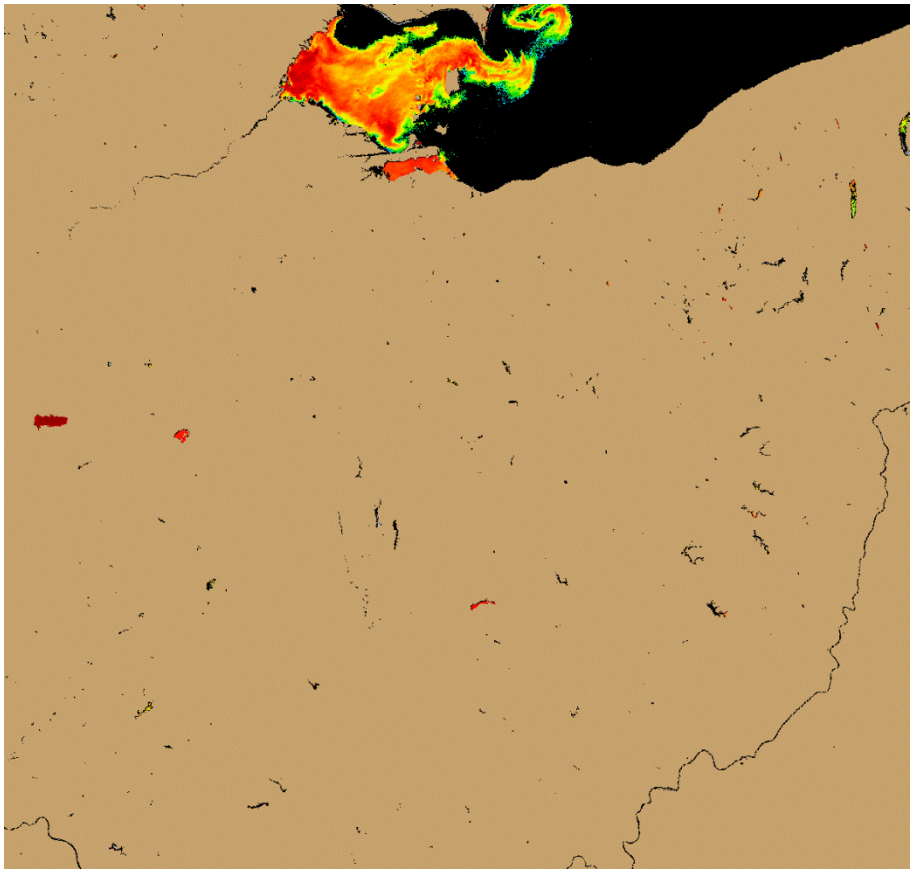
Cyanobacteria Assessment Network (CyAN) Project – Inland Lakes



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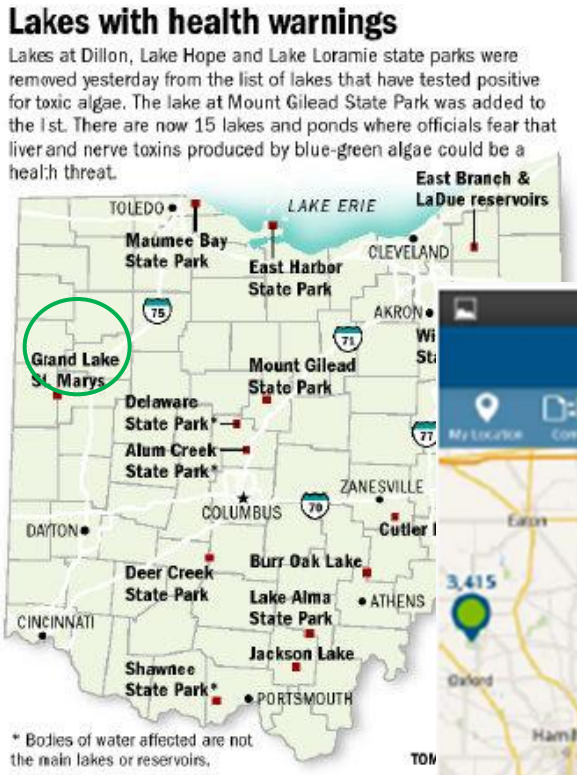
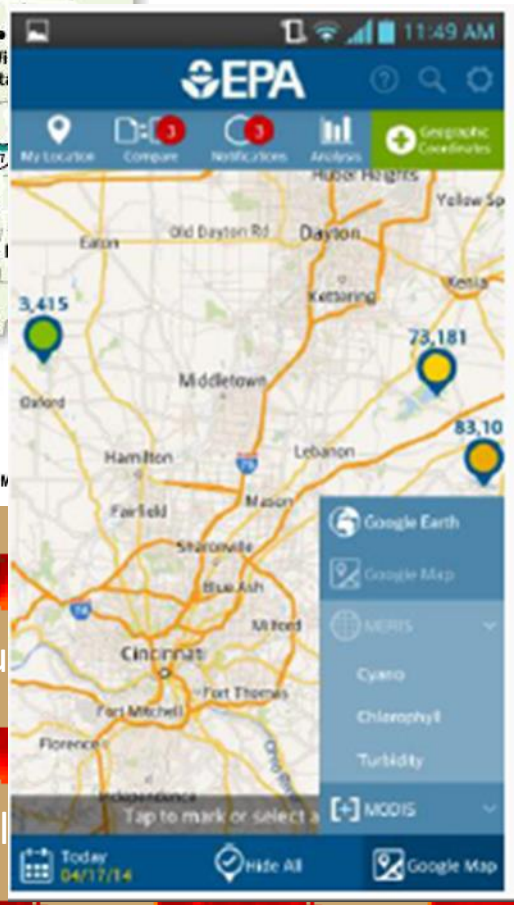
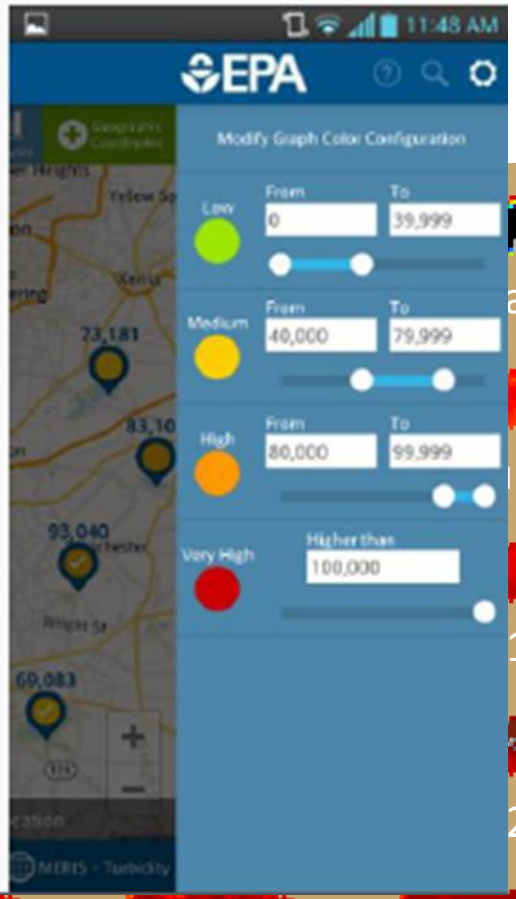
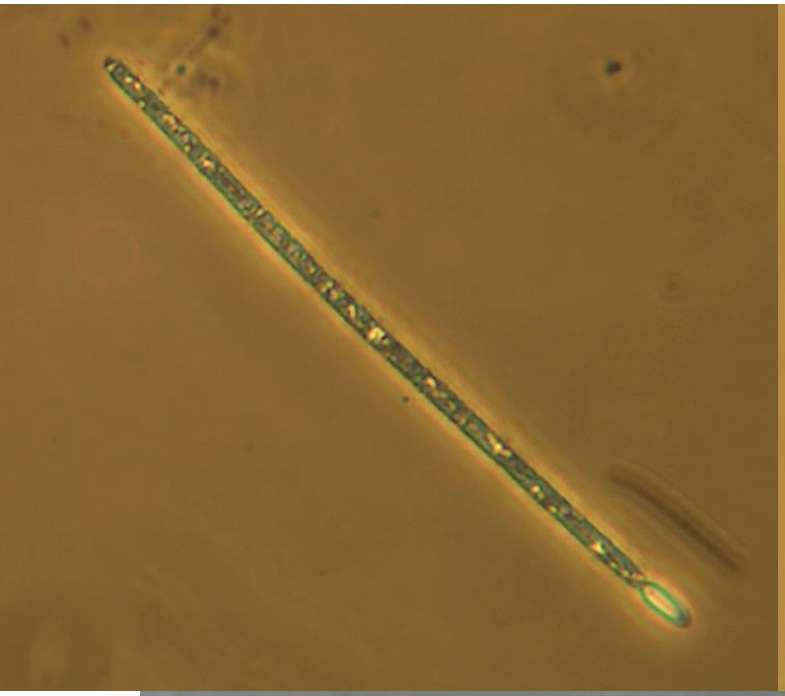
Inland Lake Example & Future Mobile Application

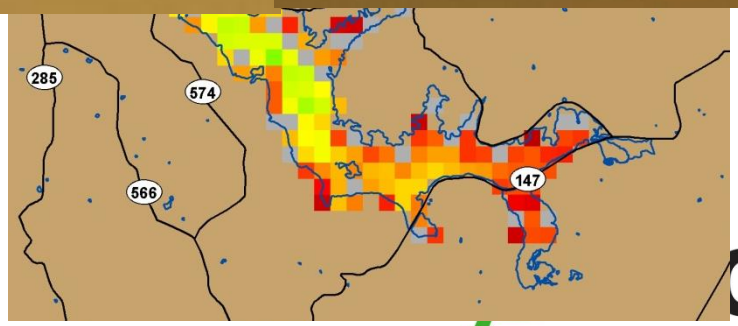






Harmful Algal Bloom? YES





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Consider Source Water Monitoring

- Review NOAA Data (Larger Lakes and Wide Rivers)
- Routine Algae Identification & Enumeration
- Phycocyanin / Chlorophyll-a Sensors
- Nutrient Monitoring (Stream & Reservoir)
- Identify Seasonal Trends
- Cyanotoxins and Genomics

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Phycocyanin/Chlorophyl-a Sensors

- Install at intake structure or wet well
  - Can integrate into SCADA system
- Lab Instruments
- Hand-held units
- Information on different types of sensors available here: http://epa.ohio.gov/ddagw/HAB.aspx

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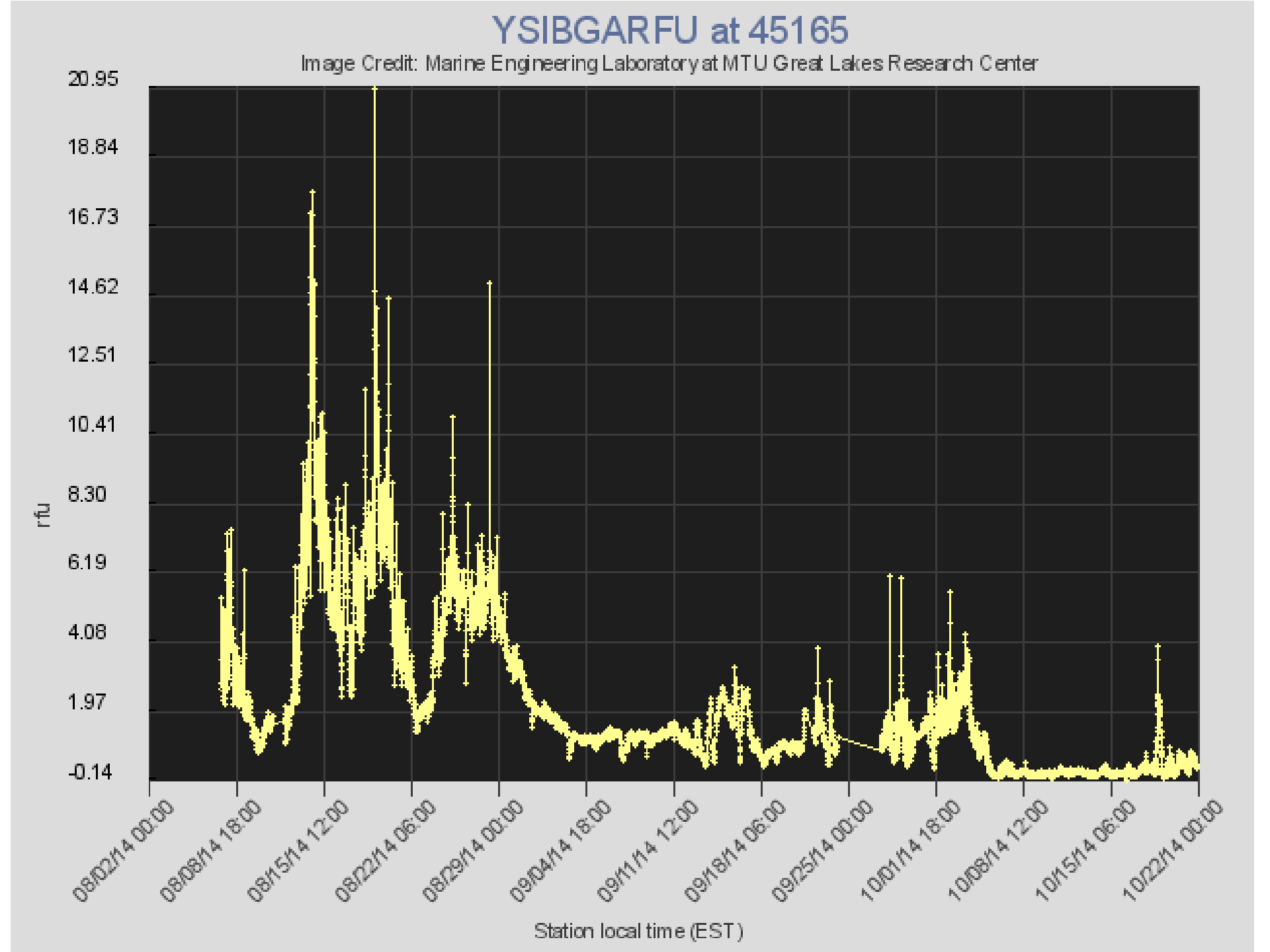
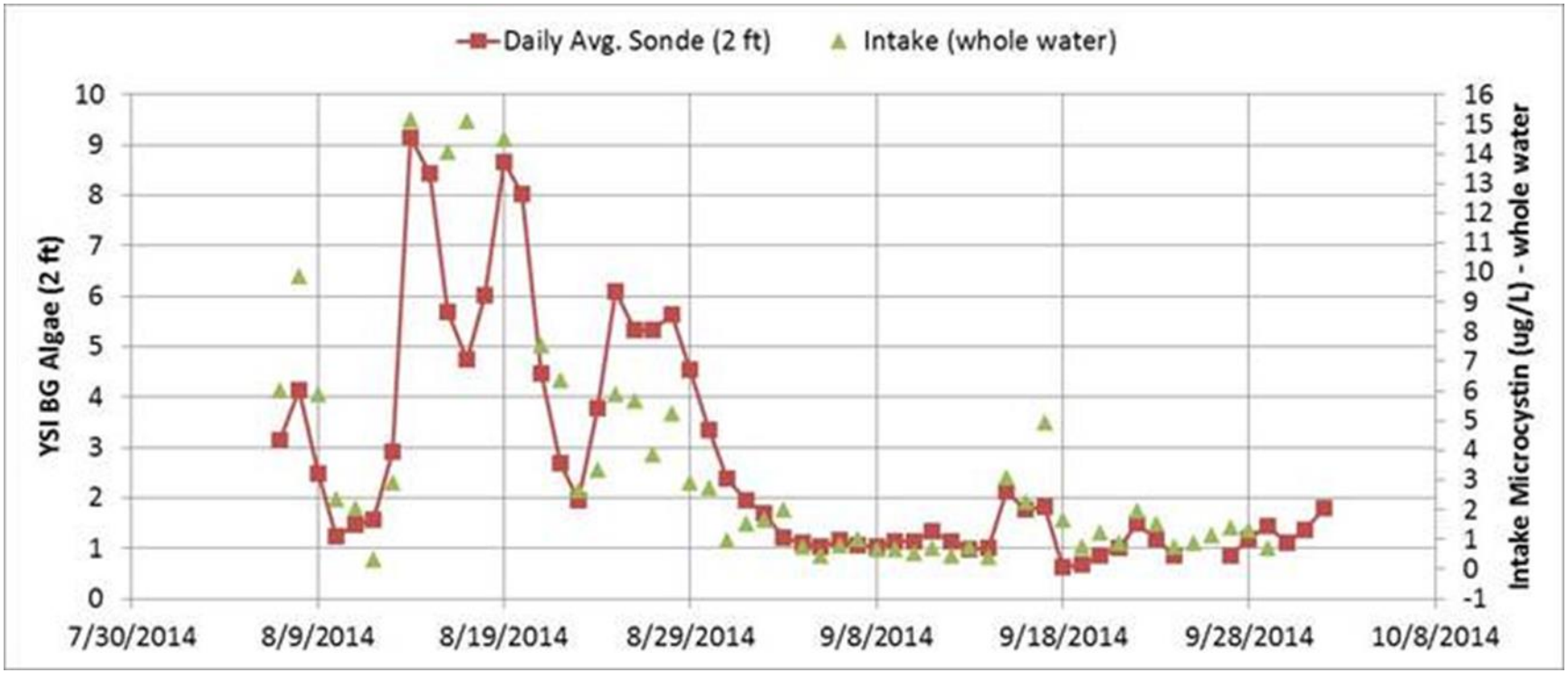

YSIBGARFU at 45165
Image Credit: Marine Engineering Laboratory at MTU Great Lakes Research Center
20.95
18.84
16.73
14.62
12.51
10.41
8.30
6.19
4.08
1.97
-0.14
rfu
08/02/14 00:00
08/08/14 18:00
08/15/14 12:00
08/22/14 06:00
08/29/14 00:00
09/04/14 18:00
09/11/14 12:00
09/18/14 06:00
09/25/14 00:00
10/01/14 18:00
10/08/14 12:00
10/15/14 06:00
10/22/14 00:00
Station local time (EST)

Correlation Between Microcystin Concentration and Phycocyanin Fluorescence at Toledo's Intake



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

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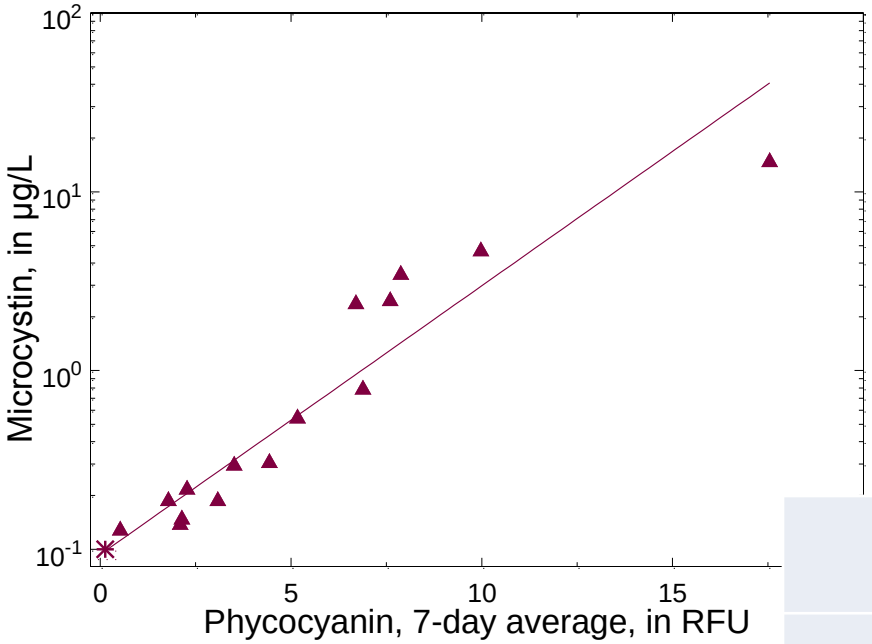
Harsha Main 2014—
USEPA Continuous Monitor



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 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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Algaecide Application

Issues

- Algaecides Can Cause Cells to Lyse (rupture) and Release Toxins
- Toxins May Bypass Conventional Water Treatment

Requirements

- Meet NSF Standard 60 or 61 - OAC 3745-83-01(D)
- Monitor for Copper at Least Weekly for at Least One Month - OAC 3745-83-01
- Submit Notice Of Intent to Ohio EPA's Division of Surface Water & Obtain Coverage under NPDES General Permit for Pesticide Application

http://www.epa.ohio.gov/dsw/permits/GP_Pesticide.aspx

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Current Permit Requirements

Operators may not use algaecides to treat severe blooms of blue-green algae (visible scum or > 100,000 cells/mL) that cover greater than twenty percent of the reservoir or are within 500 yards of the intake, unless information is provided to Ohio EPA prior to algaecide application that confirms:

- the bloom is not currently producing toxins, or
- the surface waters will not be used as a public drinking water source until monitoring is conducted to verify the toxin concentrations are below levels of concern, or
- toxin concentrations will remain below thresholds established in the State of Ohio harmful Algal Bloom Response Strategy for treated drinking water during and following application of the algaecide.

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Additional Recommendations

Apply Early to Cyanobacteria Blooms

- Before Blooms are Visible or if Cyanobacteria is <10,000 cells/mL

Evaluate Threat and Consider Toxin Monitoring

- Identify cyanobacteria to genus level & estimate amount present (cell count/biovolume)
- If >10,000 cells/mL, but does not meet severe bloom algaecide restrictions in permit-consider testing source water for algal toxins

Report Blooms to Ohio EPA and Coordinate with Agency Prior to Algaecide Application to HABs.

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Revised Pesticide General Permit Expected Fall 2016

- Can complete NOI online through Ohio EPA eBusiness Center: https://ebiz.epa.ohio.gov/login.html
- Intend on incorporating other thresholds in addition to cell counts.
- DSW will notify all public water systems with coverage under the general permit.
- DDAGW will notify all surface water PWSs.

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Norwalk Algaecide Case Study

- Operates 3 Reservoirs System the intercepts Norwalk Creek
- 8 square mile, predominantly agricultural, watershed
- Overflow from Upper to Memorial, valved from Memorial to Lower Reservoir
- Used OEPA Grants to Purchase ABRAXIS testing equipment, microscope, and data-sonde
- Historically, treated Lower Reservoir with Copper Sulfate (in 2013 switched to EarthTec) every 2-3 weeks for total algae control.

Information courtesy Rick Schaffer, City of Norwalk
Thank you!

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August 2014 HAB on Upper Reservoir

2014 HAB Response

- August 18, 2014- Extensive *Microcystis* bloom discovered in Upper Reservoir. Just two days prior, reservoir appeared clear.
- Microcytins concentrations 15 ug/L. Posted Recreational Adviosry on Memorial R.
- Dry Weather left Upper R. below capacity, enabling isolation from other reservoirs.
- Two algaecide applications killed the *Microcystis* in Upper Reservoir. HABs not detected on other reservoirs
- Reservoirs checked daily until September, no further HABs detected.

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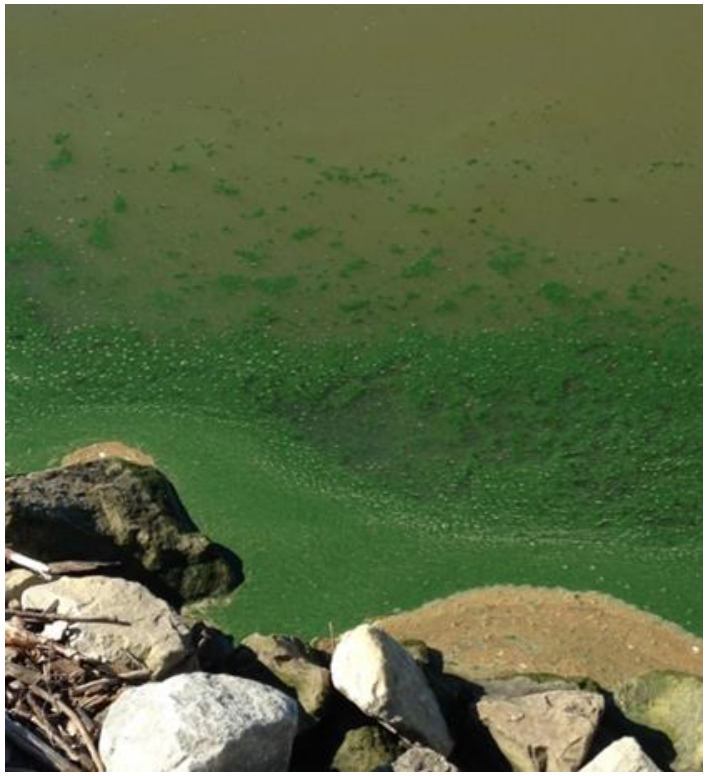

June 2015 HAB on Upper Reservoir

August 2015 Small HAB

2015 HAB Response

- HAB Appeared on Upper Reservoir much earlier, perhaps due to extremely wet June.
- *Aphanizomenon* detected on June 18, by June 22 a significant bloom had developed on Upper R.
- Rain event caused some biomass to transfer to Memorial Reservoir.
- Treated Upper R. with EarthTec and spot treated Memorial R.
- Microcystins concentrations were >25 ug/L in Upper R. and in Memorial R. at the spillway from Upper R.
- A Recreational Advisory was posted for Upper and Memorial Reservoirs and valve was closed between Memorial and Lower Reservoirs to protect intake.
- Conducted another algaecide treatment on June 25. Took an additional week for cyanotoxins to dissipate.
- Small blooms “popped up” in July & August and species shifted to *Microcystis*.
- Treated entire Upper R.
- Spot treated Memorial to protect “good” green algae.
- Memorial full treatment in Sept.

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Considerations for 2016

- Added PAK-27 to NOI to better target cyanobacteria.
- Consider more proactive treatment to stay ahead of HABs. Somewhat concerned about modifying Memorial Reservoir ecology, but have not seen ill effects after routine treatments on Lower Reservoir.
- Considering putting all three reservoirs on a regular schedule of treatment, similar to what has been done for Lower Reservoir in the past.

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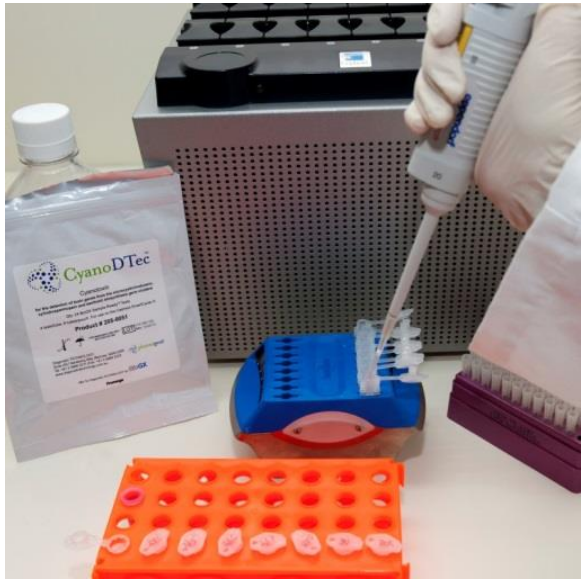
Cyanobacteria Screening: Multiplex qPCR

- Commercial Multiplex Quantitative Polymerase Chain Reaction (qPCR) Simultaneously Identifies and Quantifies the presence of genes unique to:
    - Cyanobacteria (16s rRNA genes, good correlation with cell counts)
    - Microcystins & Nodularin (mcyE)
    - Cylindrospermopsin (cyrA)
    - Saxitoxin (sxtA)
  - Test completed within 2-3 hours (includes extraction)
  - Scalable
  - Cost effective
  - Utilizes certified reference material
  - Specific: no gene, no toxin
- Ohio EPA SOP development this spring, lab certification beginning in 2017
- http://www.phytoxigene.com/products/



http://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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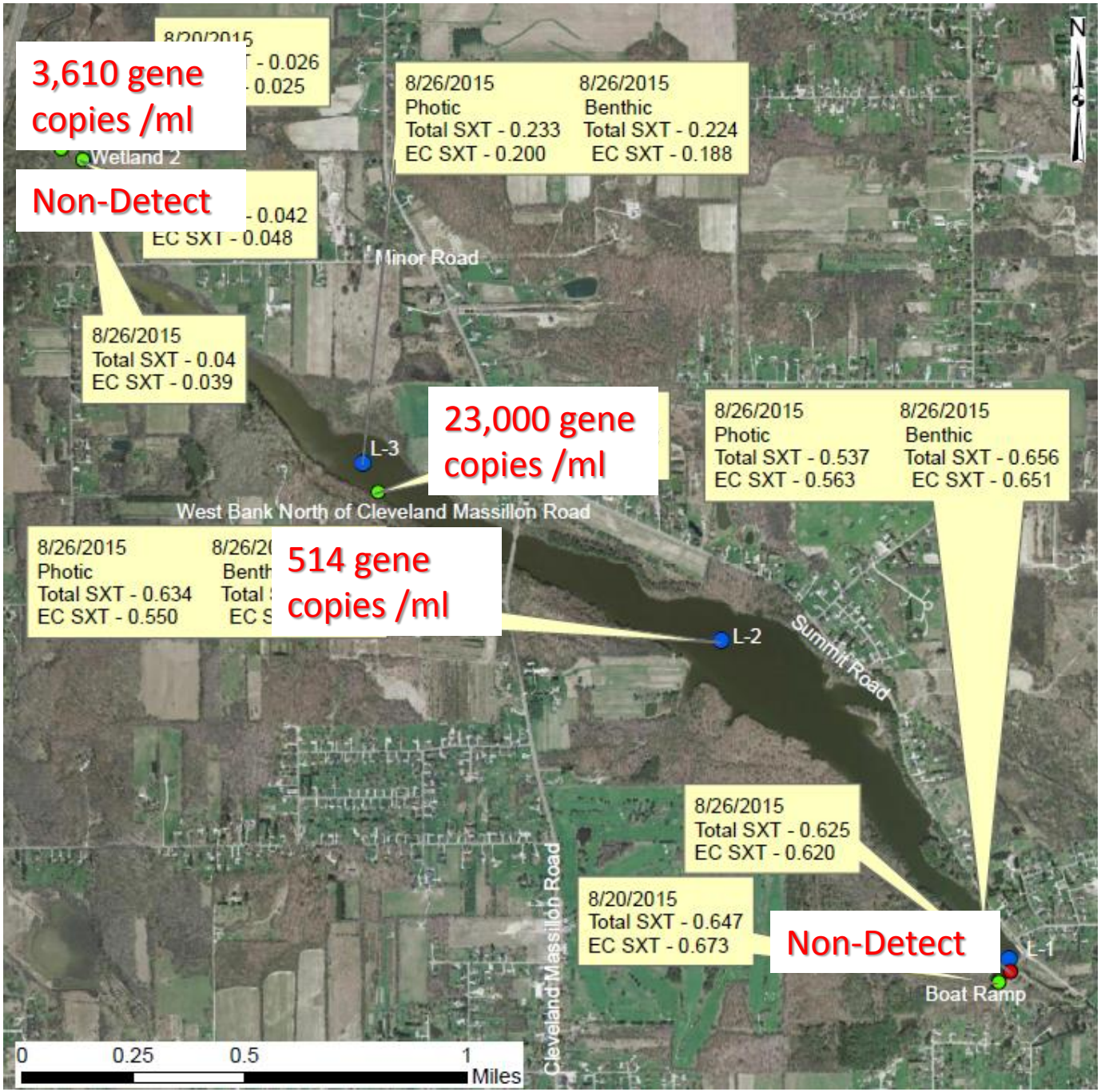

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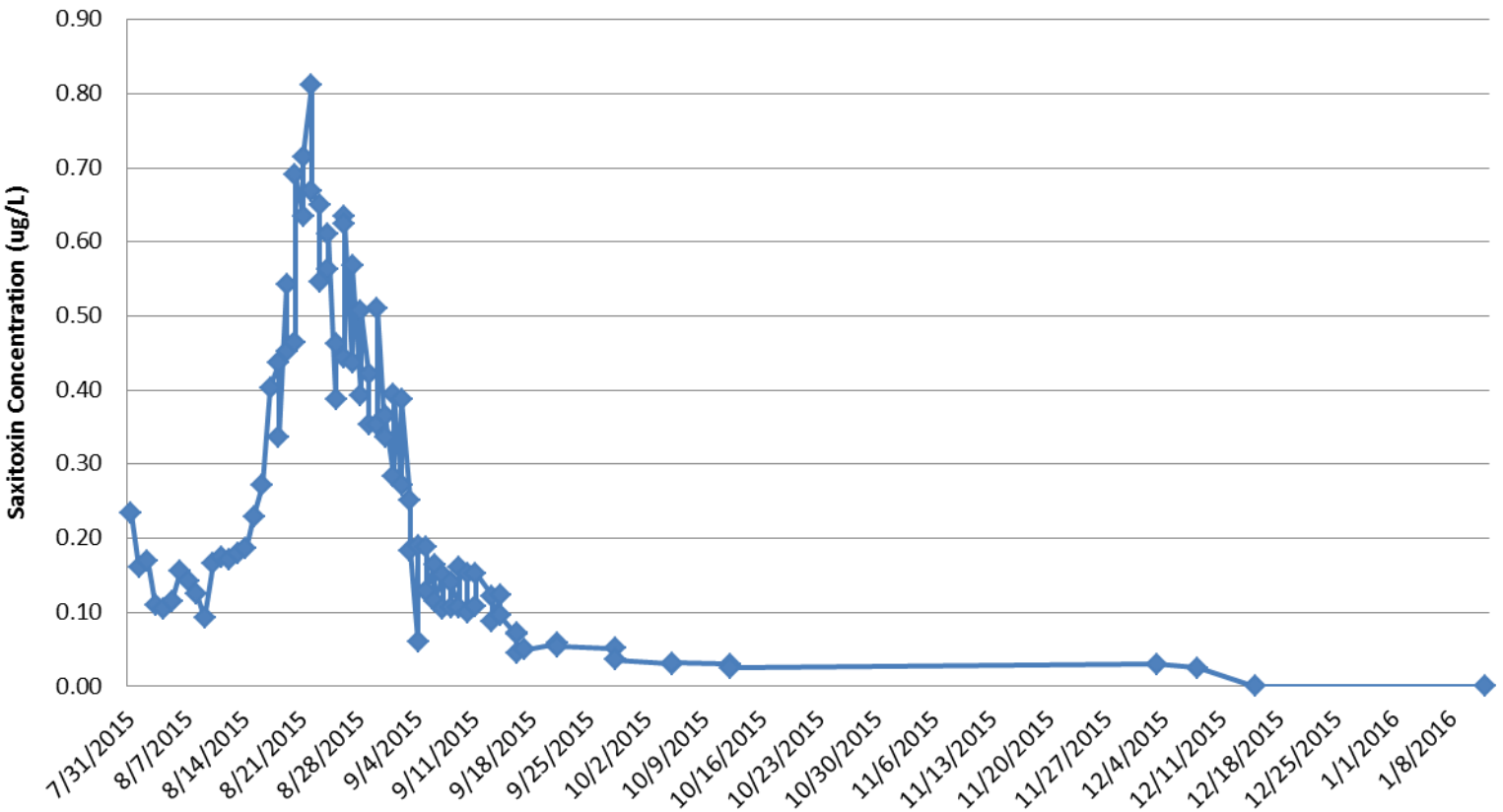

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Applied HAB Research Grants

http://ohioseagrant.osu.edu/archive/research/bor/

- Ohio Board of Higher Education Provided $3.9 Million in Funding to State Universities across five Focus Areas:
  - Lake Erie HABs and Lake Water Quality
  - Producing Safe Drinking Water
  - Land Use Practices, Sources of Enrichment, Water Quality and Engineered Systems
  - Human Health and Toxicity
  - Economics and Policy

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Ohio's Recent Nutrient Reduction Efforts

- More than $2 Billion invested in Lake Erie Watershed since 2011
  - Improve drinking water and wastewater facilities, fix faulty septic systems
  - Plant cover crops and install controlled drainage systems on fields
  - Monitor water quality
- Historic reforms
  - Ban manure/fertilizer application (frozen, snow covered or rain soaked ground)
  - Require major WWTPs to monitor their discharge for phosphorus
  - Require other WWTPs to determine the feasibility of limiting phosphorus
- Statewide program to certify farmers applying fertilizer in Ohio (4Rs)
- Nutrient TMDLs

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Public Drinking Water Supply Beneficial Use

New Impairment Criteria in 2014

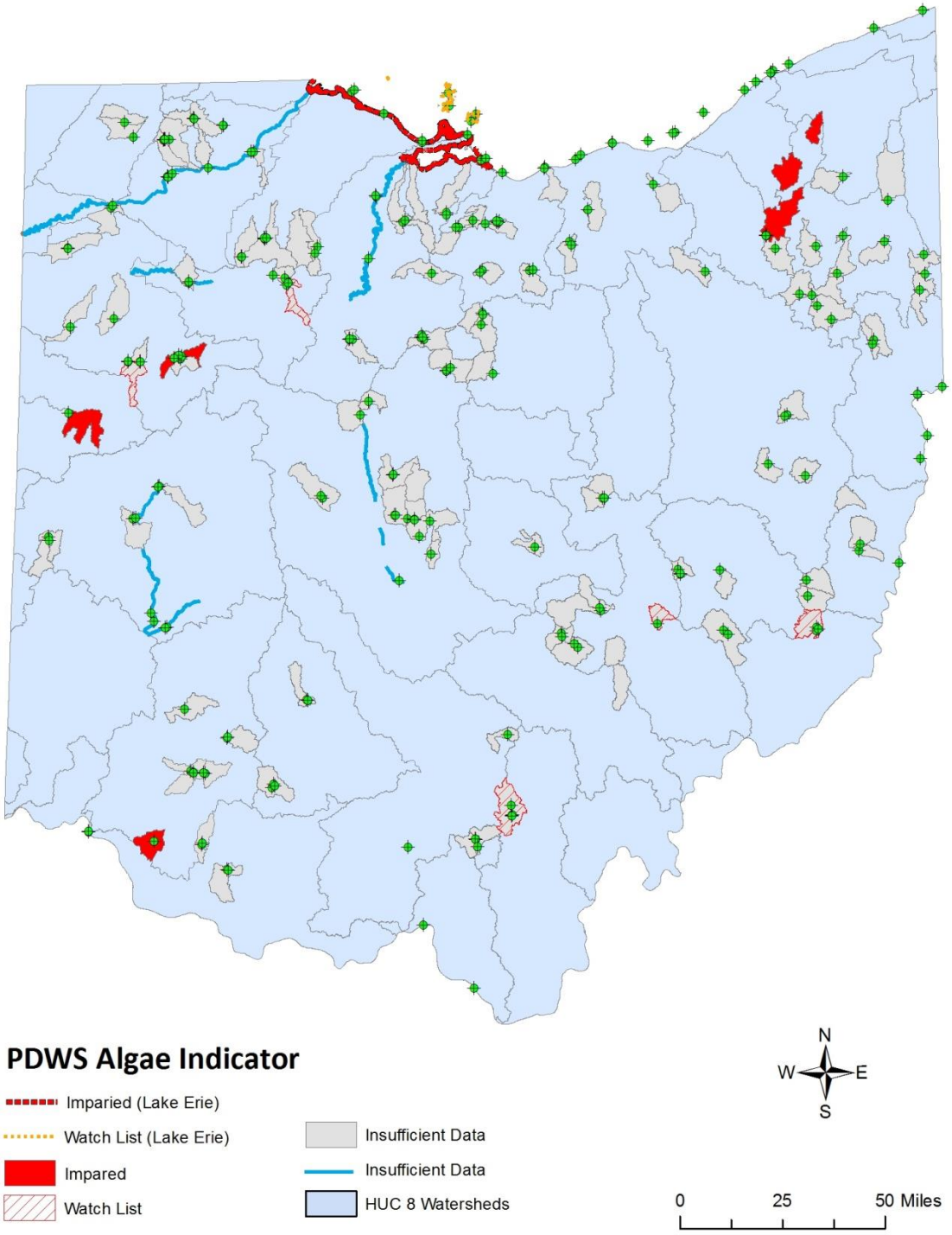
2014 Clean Water Act Integrated Water Quality Monitoring and Assessment Report:

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



Thank you!

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http://www.epa.ohio.gov/ddagw/HAB.aspx

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