HABs State of the Science webinar series:
HABs Data & Modelling

Speakers:

Doug Kane – Defiance College

Brian Roe – Ohio State University

Val Klump – University of Wisconsin Milwaukee

Isabella Bertani – University of Michigan

John Bratton – LimnoTech

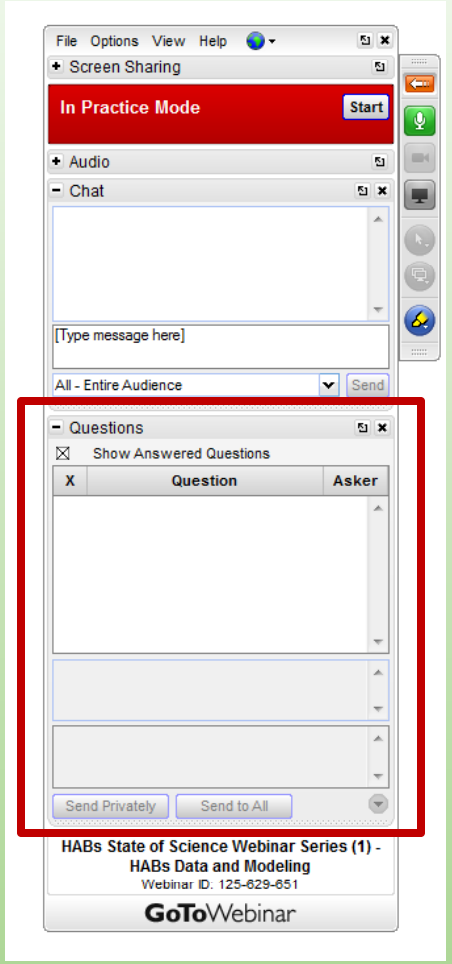
Ed Verhamme - LimnoTech

In partnership with:

GoToWebinar Housekeeping Items

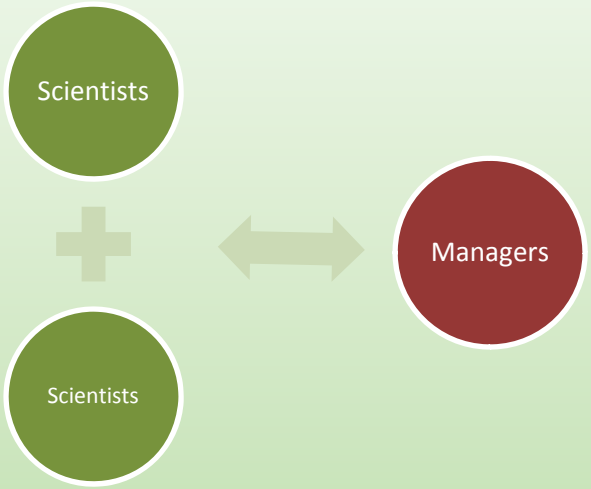
- Submit your text questions and comments using the Questions Panel

- Note: This webinar is being recorded and will be posted on the HABs Collaboratory website



Great Lakes HABs Collaboratory

"A virtual laboratory for information sharing and collective actions to address HABs"



- Multidisciplinary group, 100+ members from different Agencies, Ministries, Colleges, Universities and Organizations across the Great Lakes

Great Lakes Commission des Grands Lacs

USGS science for a changing world

HABs State of the Science webinar series

- Result of the inaugural meeting of the HABs Collaboratory
  - Identified need for communication between researchers, and between researchers and managers
- Present on-going research projects related to HABs in the Great Lakes region
- Goals:
  - Improve communication
  - Knowledge transfer
  - Opportunities for collaboration

Ohio Sea Grant / OSU Stone Lab

- Managing 55 HABS related projects (~$7,000,000)
  - 18 funded by Ohio Sea Grant
  - 5 funded by OSU's Field 2 Faucet initiative
  - 32 funded under the Ohio Department of Higher Education (OSU/UT; 18 vs. 14)
- Stone Lab Guest and Research Lecture Series
  - June 16th, 23rd, 30th, July 7th, 14th, 28th, and August 4th
  - 7pm -9pm
  - https://ohioseagrant.osu.edu/news/calendar
- 9/15/16 "State of Science" meeting in Toledo
  - Stranahan Theater
  - Modeling, BMPs, and Public Health-Water treatment

LET'S HEAR IT FOR THE BUOYS?- ACCURACY OF DATA BUOYS FOR MONITORING CYANOBACTERIAL BLOOMS IN LAKE ERIE

Doug Kane – Defiance College

Let's Hear it for the Buoys?- Accuracy of Data Buoys for Monitoring Cyanobacterial Blooms in Lake Erie

Douglas D. Kane[1,2] (dkane@defiance.edu)
Justin D. Chaffin[1] (chaffin.46@ osu.edu)

[1]Franz Theodore Stone Laboratory
[2]Defiance College

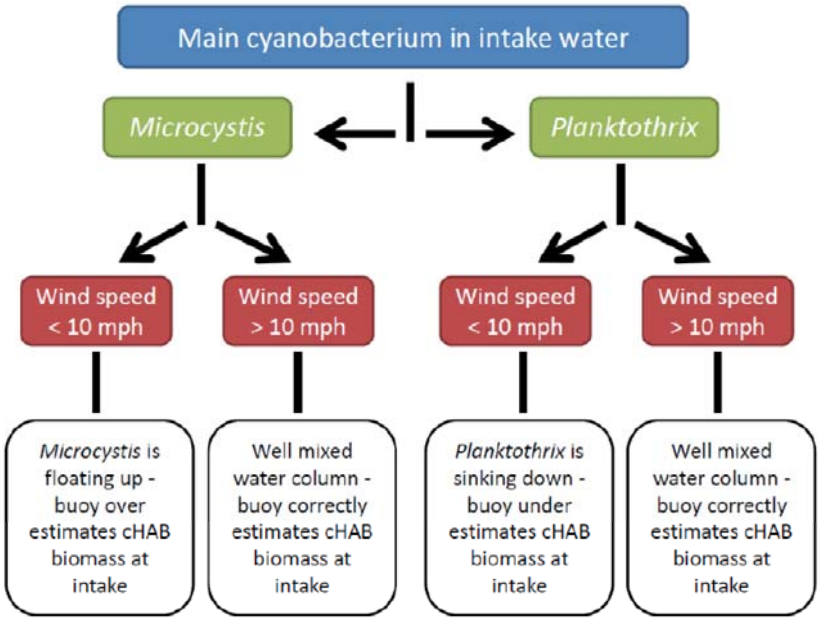


Figure 1. A hypothetical flow chart that uses cyanobacteria genera and wind speed to estimate cHAB biomass near the bottom of the lake.

WATER RESOURCES CENTER OHIO WRC

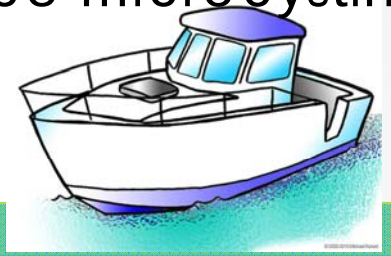
OhioHigherEd
Department of Higher Education

Microcystis

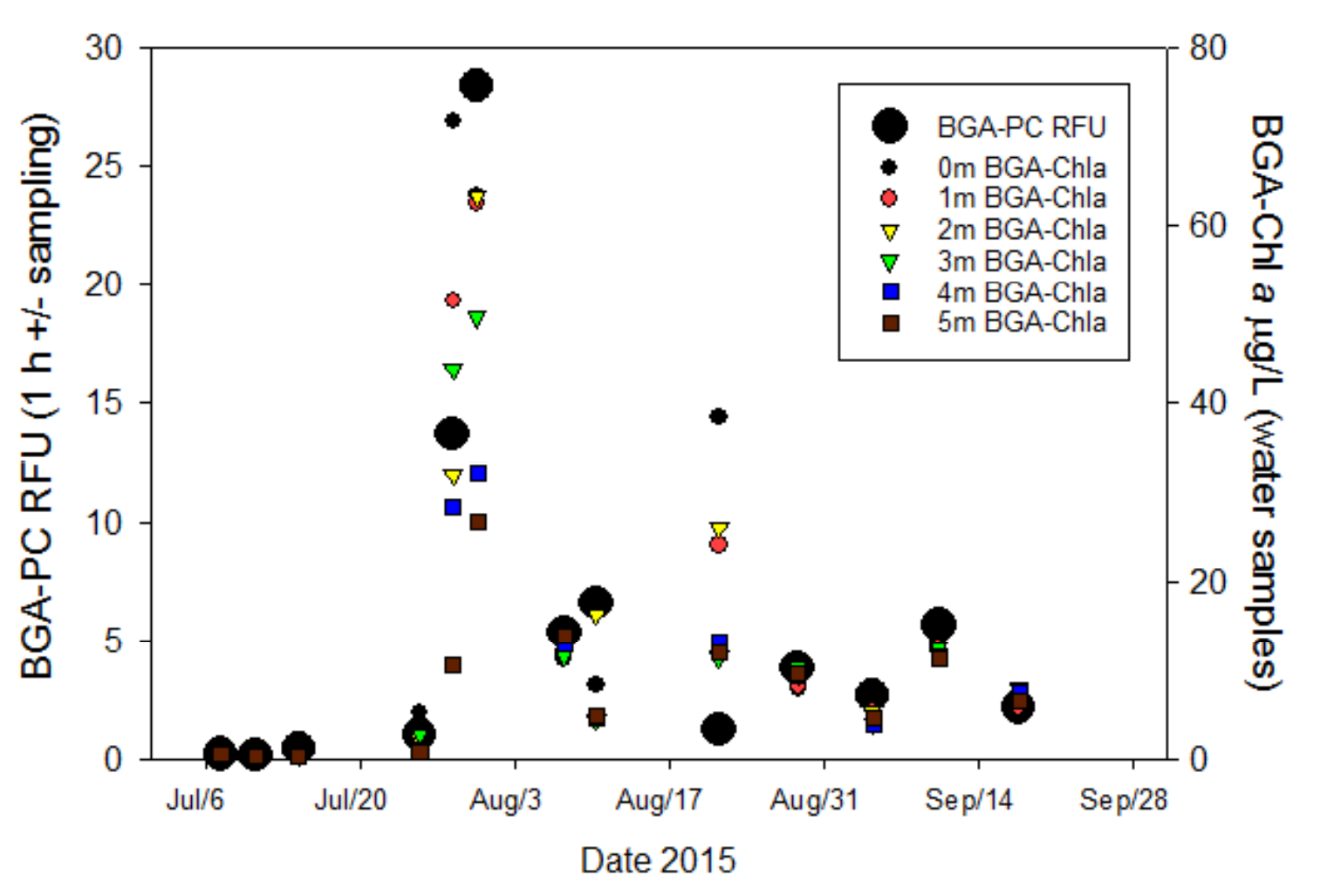
- Western Basin
- Surface scums
- Produces microcystin

Planktothrix

- Sandusky Bay
- Does not form surface scums
- Produce microcystin

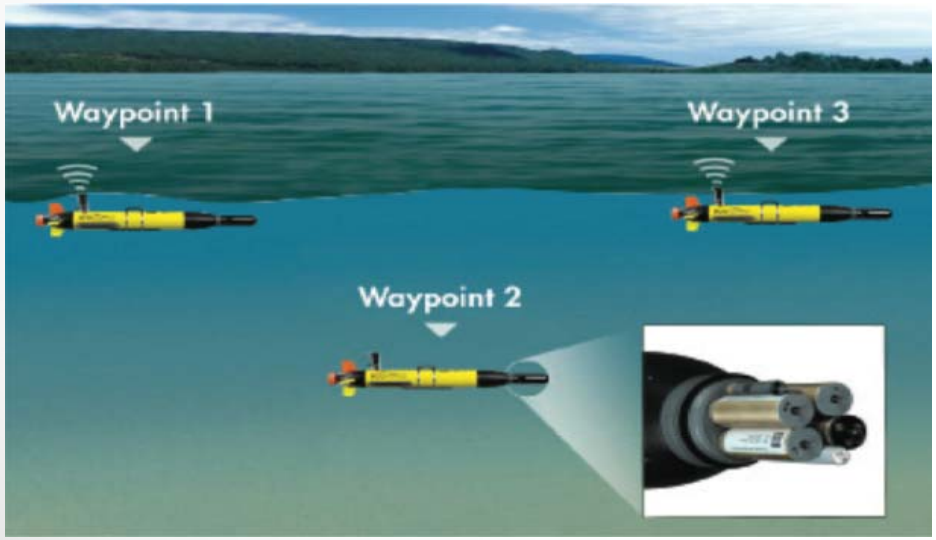


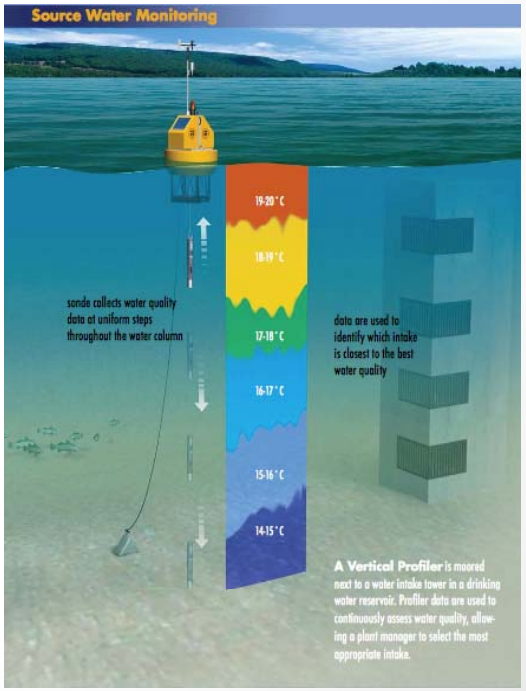
Buoy can overestimate or underestimate cyanobacteria biomass (Gibraltar Island)



HABs Collaboratory

- Has anyone done similar studies in different systems (i.e. Green Bay, Saginaw Bay)?
- Does anyone have an *in situ* vertical profiler/ glider?





OHIO RESIDENTS' WILLINGNESS TO PAY (WTP) TO REDUCE LAKE ERIE HABS

Brian Roe – Ohio State University

Project Overview

a) Ohio Residents' Willingness to Pay (WTP) to Reduce Lake Erie HABs

b) Greg Howard (East Carolina University), Brian E. Roe (Ohio State, roe.30@osu.edu), Erik Nisbet (Ohio State), Jay Martin (Ohio State), Elena Irwin (Ohio State)

c) National Science Foundation CNH 1114934

d) Study: Ohio, 2014

e) Hypothesis: Ohio Residents' WTP is Related to
   (a) the Degree of Reduction in Negative Consequences from Lake Erie HABs and
   (b) the Policy Used to Reduce HABs

APPROACH

a) Statewide online survey (n = 1210)

includes a hypothetical choice experiment that requires respondents to choose between competing policies with randomly assigned

a) implementation mechanisms
    a) Fertilizer Tax leading to higher food prices
    b) Income tax with voluntary programs for farmers
    c) Income tax with increased farmer regulations
    d) Sales tax with voluntary programs for farmers
    e) Sales tax with increased farmer regulations
b) reductions in the extent of Lake Erie HABs and its negative consequences in terms of fish kills and beach closures.

Summary of Findings

a) What did you learn from your work?
   i. Aggregate annual WTP in Ohio for a 10% reduction in the negative consequences of Lake Erie HABs (baseline is 2011 HABs and consequences) is about $150 million.
      i. PRELIMINARY: *Please don't cite without permission*
   ii. WTP is linear in the size of the reduction of the consequences, e.g., a 20% reduction is valued at $300 million

b) What happened that you didn't expect?
   - There was no change in WTP among a smaller panel of respondents who answered the survey both before and after the August 2014 Toledo water quality crisis.

c) Relevant conclusions for water quality managers?
   - Ohio residents place considerable monetary value on reducing the impacts of HABs

HABs Collaboratory

a) What questions still need to be answered about HABs?
   - Are the differences we observe in WTP robust to different descriptions of the reductions in the consequences of HABs and sensitive to the way program implementation details are described?
   - How much do residents outside of Ohio value reductions in Lake Erie HABs?

b) How can collaboration help your research?
   - Replication in other states
   - Linking to biophysical models that predict consequences of HABs valued by residents

GREEN BAY HYPOXIA: BIOGEOCHEMICAL DYNAMICS, WATERSHED INPUTS AND CLIMATE CHANGE (NOAA CSCOR)

Val Klump – University of Wisconsin-Milwaukee

PROJECT OVERVIEW

- **Green Bay Hypoxia: Biogeochemical Dynamics, Watershed Inputs and Climate Change (NOAA CSCOR)**

- **Restoring the health of the Green Bay ecosystem under a changing climate: Modeling land use, management, and future outcomes (Michigan Water Center)**

- **Transitioning Science to Management: Ecological and Socio-economic Tradeoffs of Hypoxia and Hypereutrophication in the Green Bay, Lake Michigan Ecosystem (pending – NOAA CSCOR)**

Project Team:
J. Val Klump, UW-Milwaukee, Kevin Fermanich, Paul Baumgart, Mike Zorn, UW-Green Bay, Hector Bravo, James Waples, Sajad Hamidi, Shelby LaBuhn, UW-Milwaukee, Joe Depinto, Ed Verhamme, Dan Rucinski, LimnoTech LLC, David Lorenz, Center for Climatic Research, UW-Madison

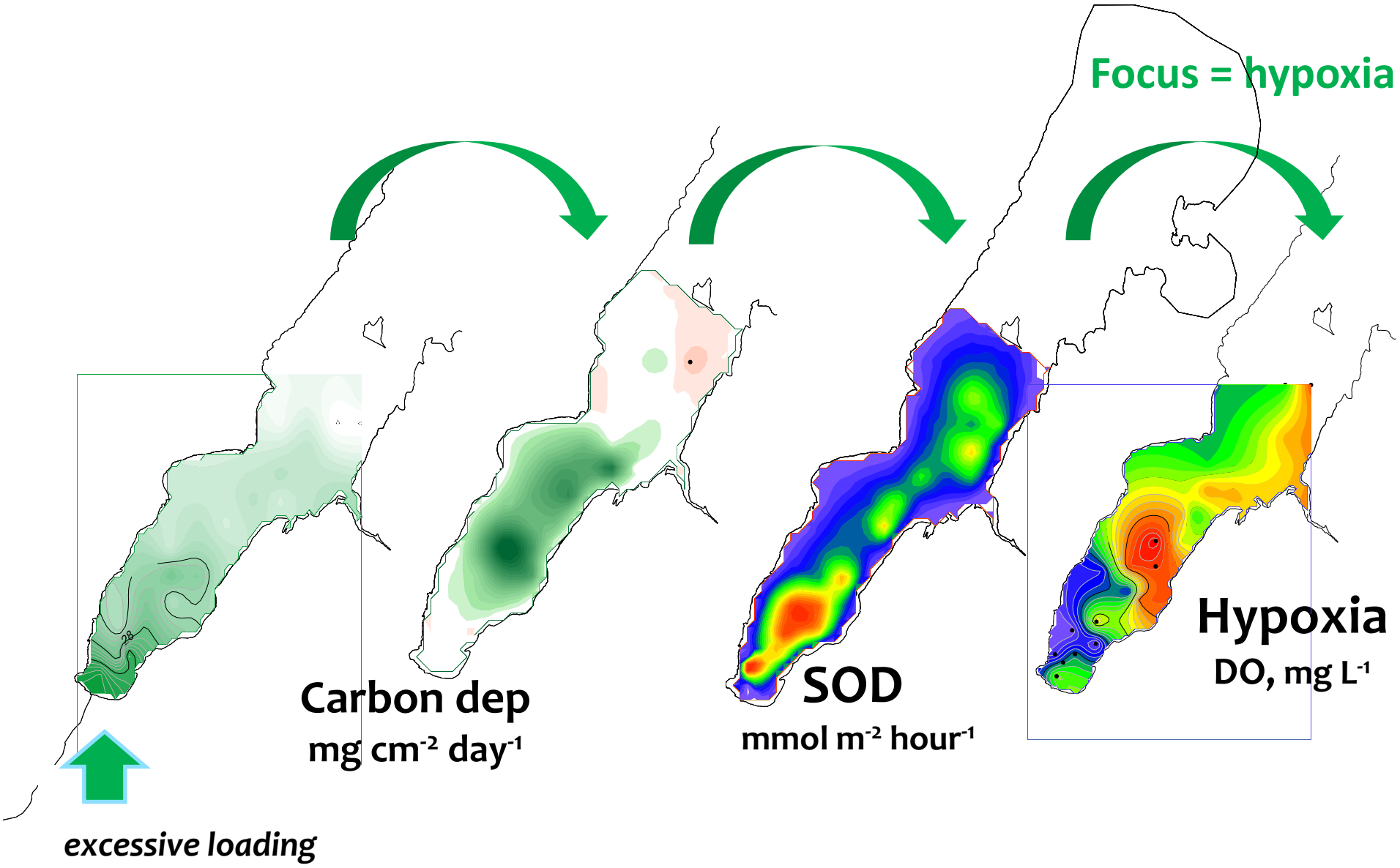
Bill Hafs, Erin Wilcox, NEW Water, Keith Marquardt, WDNR, Chad Cook, Ken Genskow, UW-Extension, Michael Finney, Oneida Nation, Julia Nordyk, WI Sea Grant

Collaborators:

Green Bay Metropolitan Sewage District – Bill Hafs, John Kennedy, Tracy Valenta, Erin Wilcox
WI DNR – Keith Marquardt, Laural Last, Nicole Clayton, Erin Hansen
USGS – Dale Robertson
Wisconsin Sea Grant – Vicky Harris, Julia Noordyk
UW Green Bay – Kevin Fermanich, Paul Baumgart, Mike Zorn, Bud Harris, Paul Sager, Dave Dolan, Patrick Robinson
NOAA Center for Sponsored Coastal Ocean Research
Limotech – Joe DePinto, Ed Verhamme, Dan Rucinski
University of Michigan Water Center
NOAA Great Lakes Environmental Research Laboratory
Michigan Tech University, Bob Shuchman
Oneida Nation – Michael Finney
UW Extension – Chad Cook
UW-Milwaukee – Val Klump, Hector Bravo, Sajad Hamidi, Shelby LaBuhn, Jim Waples
UW-Madison, Center for Climatic Research – David Lorenz, Dan Vimont

NOAA Center for Sponsored Coastal Ocean Research Coastal Hypoxia Research Program

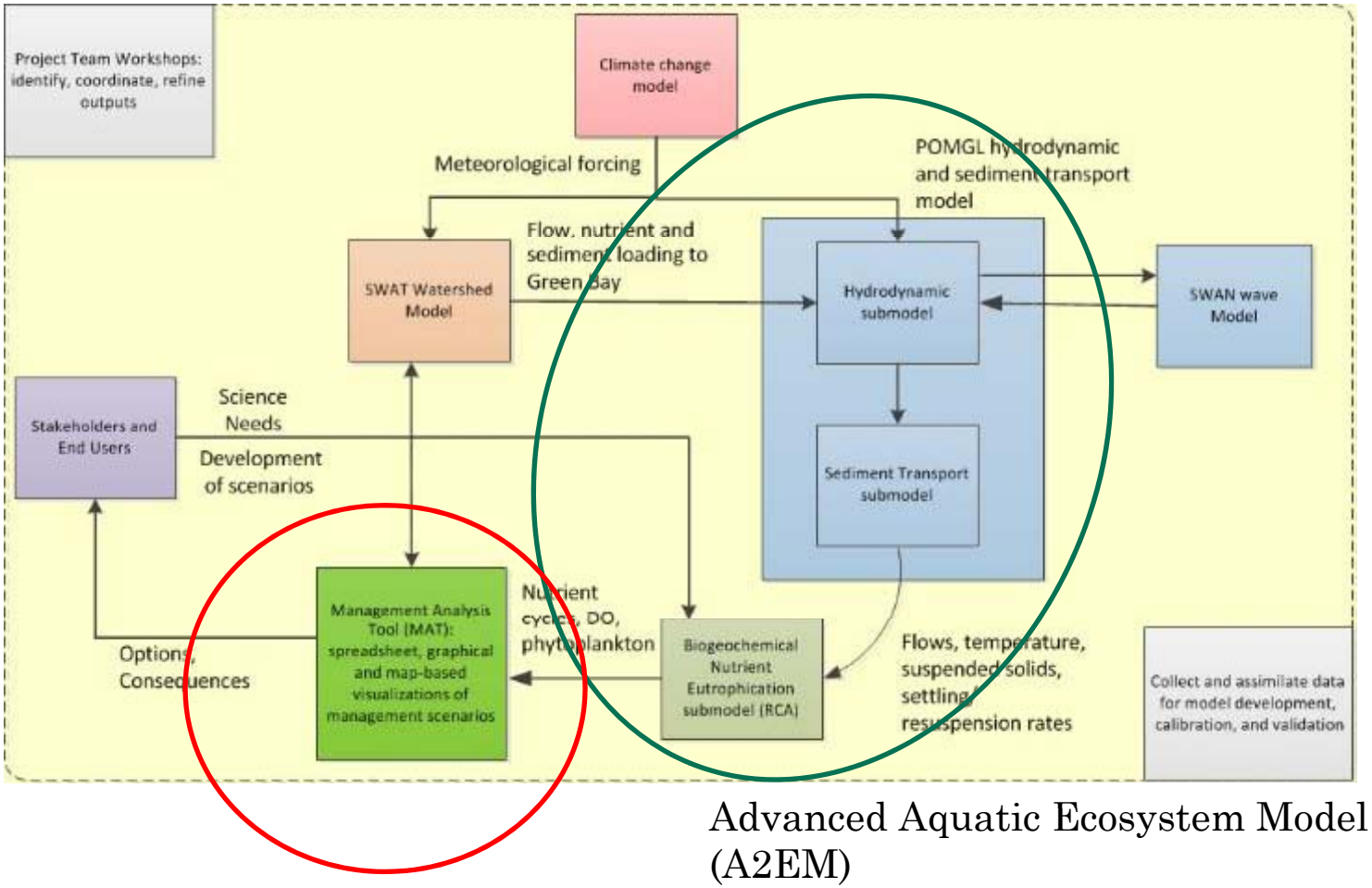
Fred A. and Barbara M. Erb Family Foundation



"bloom today – dead zone tomorrow"

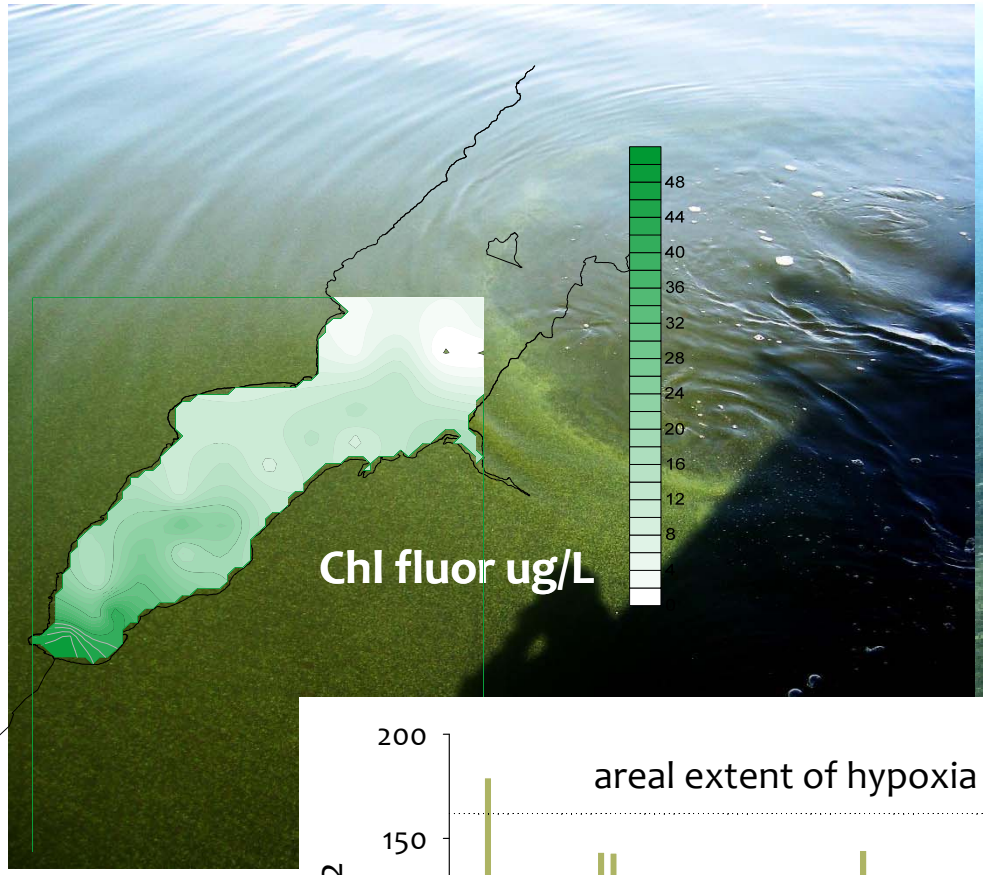
Approach: develop linked models → better informed management

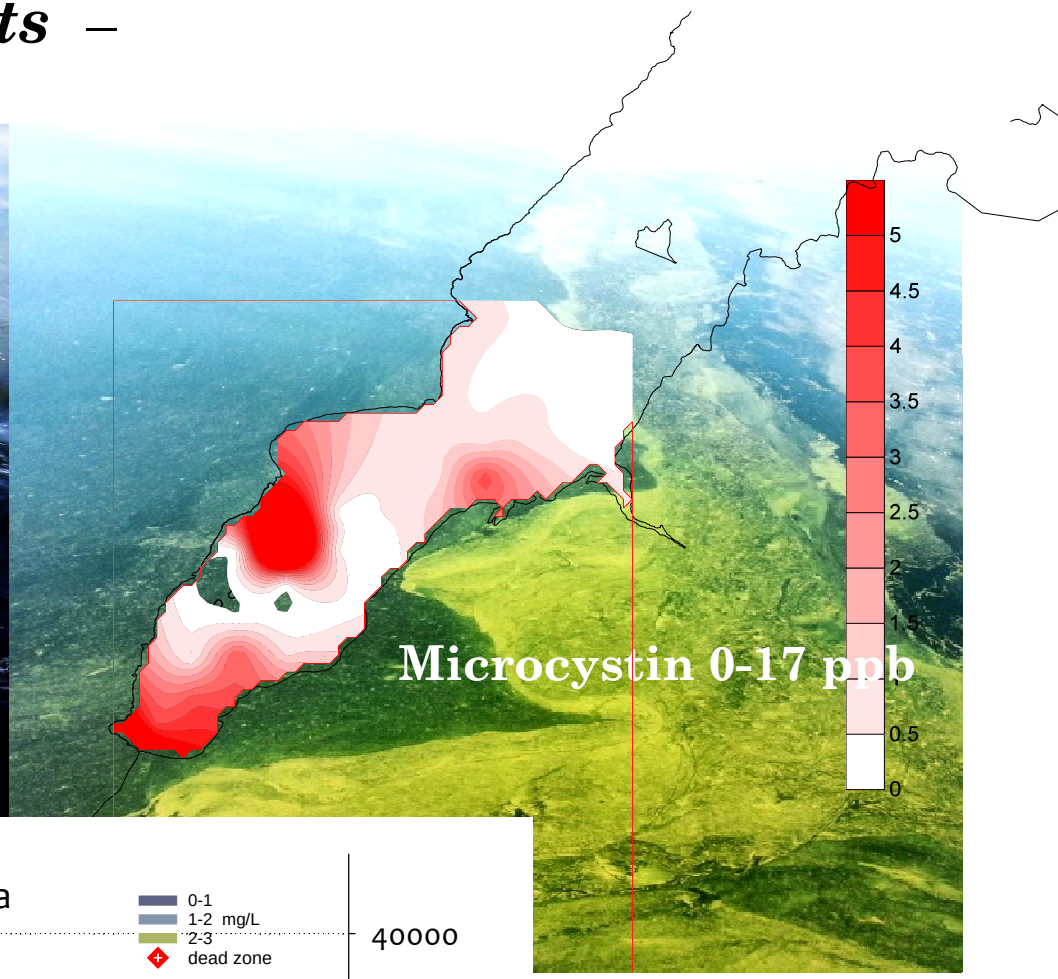
Linked Green Bay Model

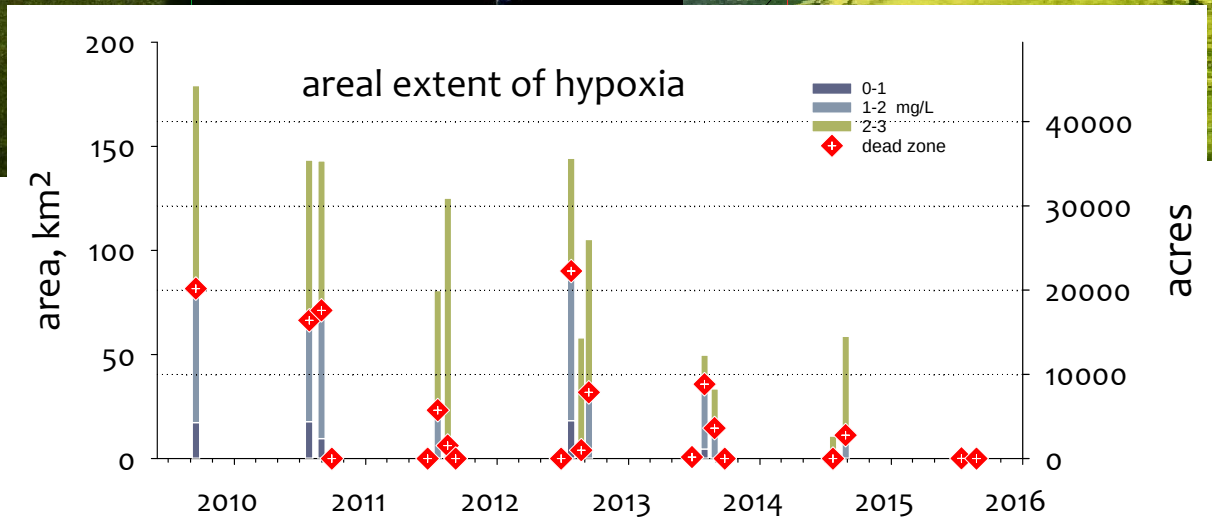


Advanced Aquatic Ecosystem Model (A2EM)

✓ *Develop metrics/end points* –

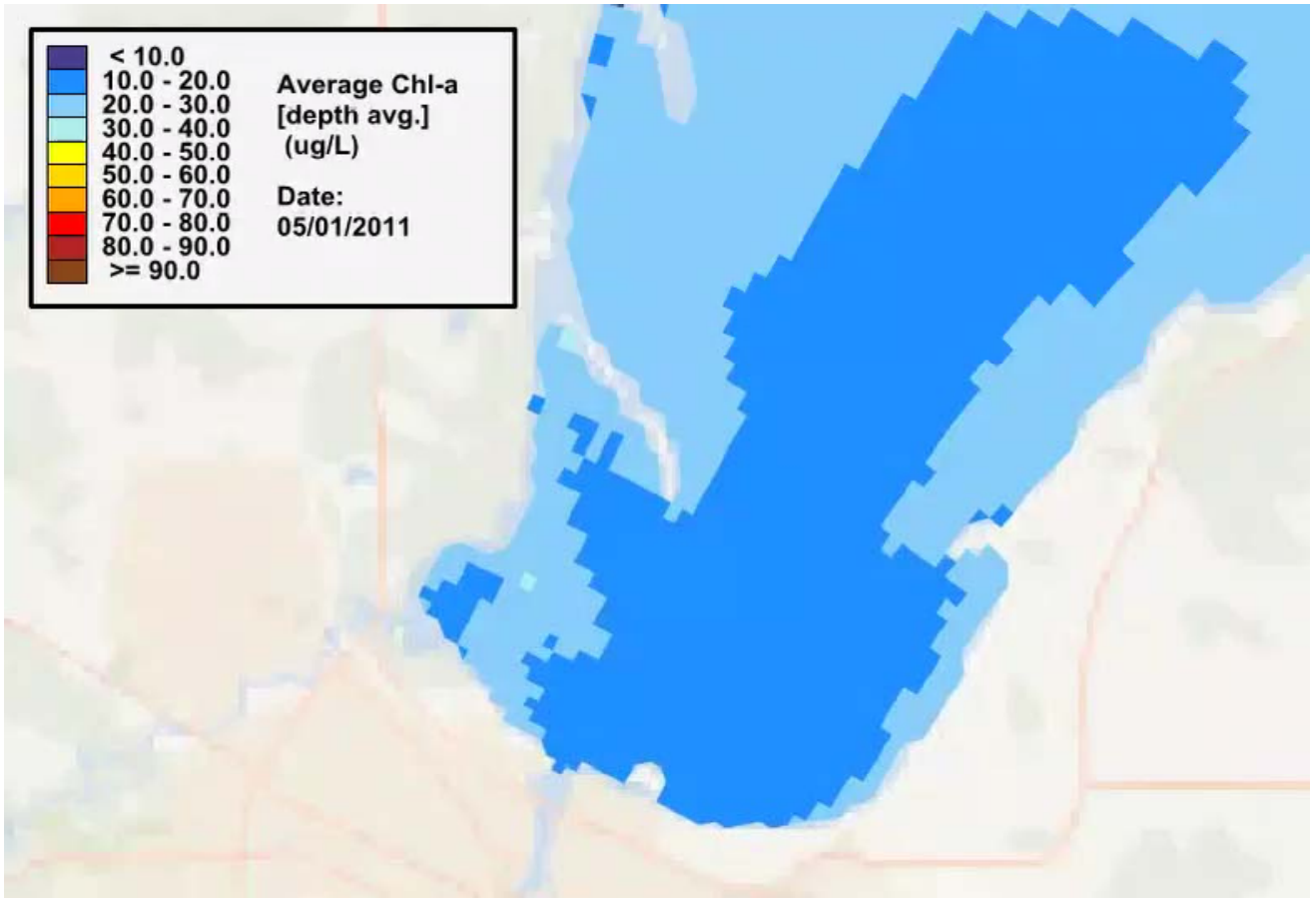






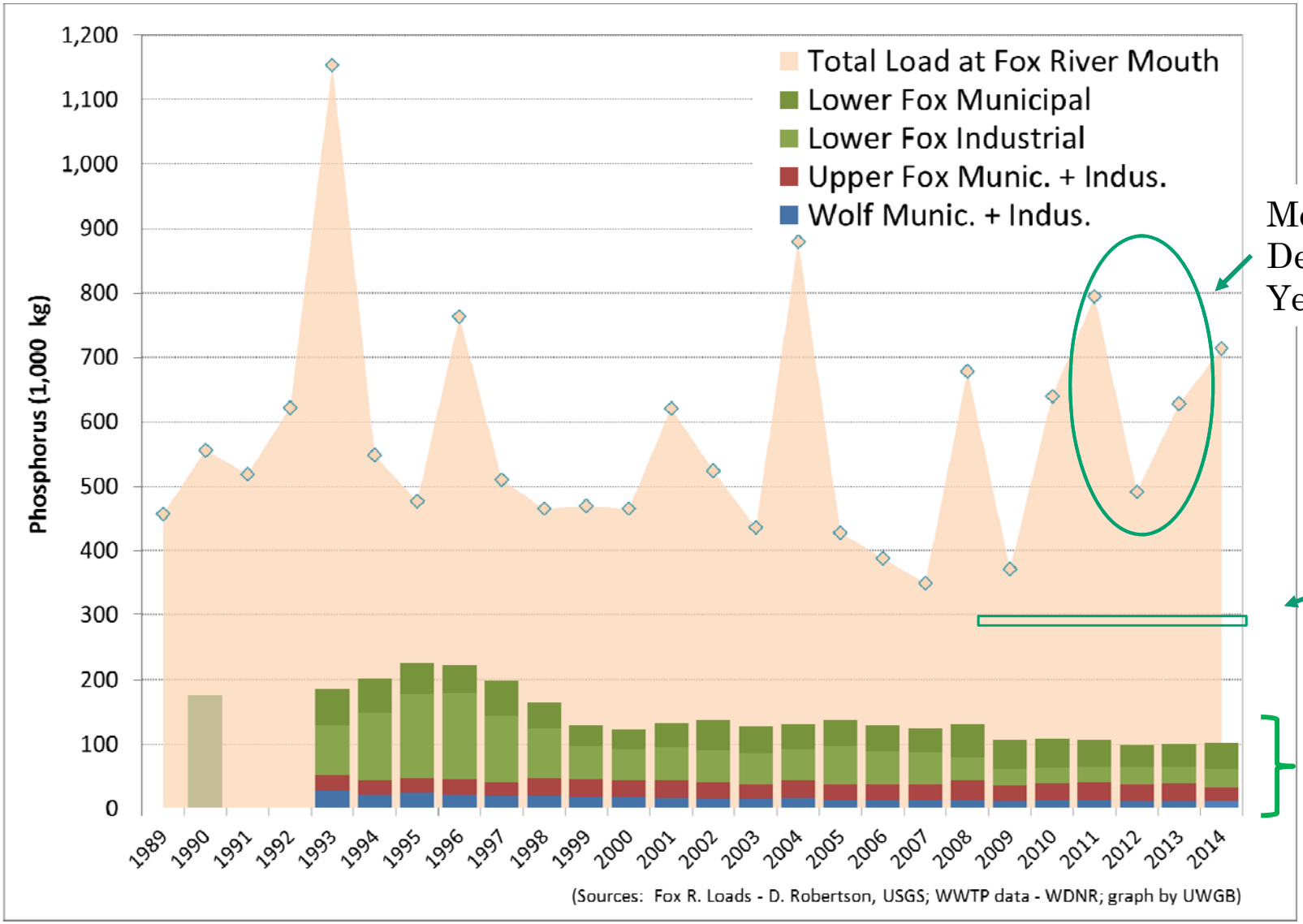
Outputs:

- ✓ **Linked watershed-biogeochemical-hydrodynamic modeling framework** (EFDC-A2EM) -- assess external and internal nutrient loadings, loading criteria and ecological endpoints under current and future climate



Trends in Fox River TP Export to Green Bay and WWTP Discharges

5 of last 7 years >600 MT



(Data Sources: Fox R. Loads: D. Robertson, USGS; Discharge data: WDNR; graph by UWGB)

An early summer storm flushes loads of sediment off farmlands southwest of Green Bay. Manure-covered farm field

By Dan Egan of the Journal Sentinel staff

A Watershed Moment: Anatomy of a 'dead zone'

Sep. 12, 2014

Algae blooms plaguing Green Bay are more than just a nuisance. When that material dies and decays, it burns up massive amounts of oxygen that can lead to "dead zones" – vast areas so low in oxygen that almost nothing can survive.

Dead zones haunt Green Bay as manure fuels algae blooms

JOURNAL SENTINEL 21

A WATERSHED MOMENT | GREAT LAKES AT A CROSSROADS

Dead zones haunt Green Bay as manure fuels algae blooms

Many gains from Clean Water Act are lost due to overloads of phosphorous entering waters

By Dan Egan of the Journal Sentinel staff

Sept. 13, 2014 3:30 p.m.

Nearly 400 years after French voyageur Jean Nicolet arrived with a bang on the banks of lower Green Bay — he fired two pistols skyward to announce the white man's arrival in the world's largest freshwater estuary — the same stretch of shoreline was the scene of another fateful landing.

Phones at the Wisconsin Department of Natural Resources started ringing in early August 2005 with an outrageous tale of a mass migration of fish from the center of the bay to its rocky beaches.

"The report from the caller was 100,000s of dead and dying small fish nosed up against the shore," Paul Peeters, a DNR fisheries biologist, reported in an email to his bosses at the time.

Peeters tossed his boots, nets, gauges and a clipboard into his truck and drove a half-hour south from his office in Sturgeon Bay to Bay Shore Park and found that the reports had not been exaggerated. The fish were so thick he could see nothing at the shore but mottled flesh.

MARK HOFFMAN

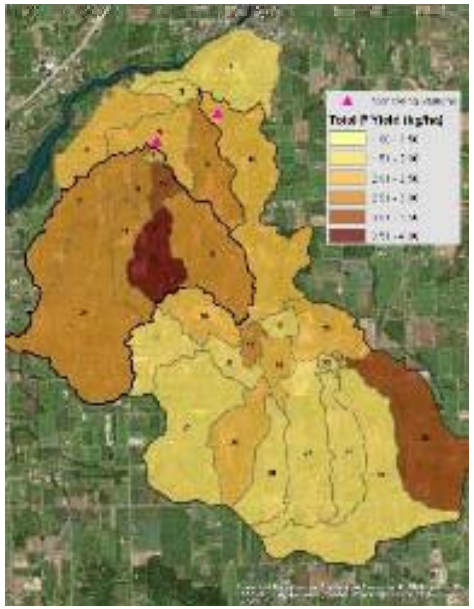
Postdoctoral student Dirk Koopmans (right) prepares to haul aboard a piece of equipment used to monitor conditions on the bottom of Green Bay, which is suffering from an oxygen deficiency. UW-Milwaukee faculty member Jerry Kaster (left) watches and Geoff Anderson operates the winch.

Dan Egan
Milwaukee JS
Sept. 12-13, 2014

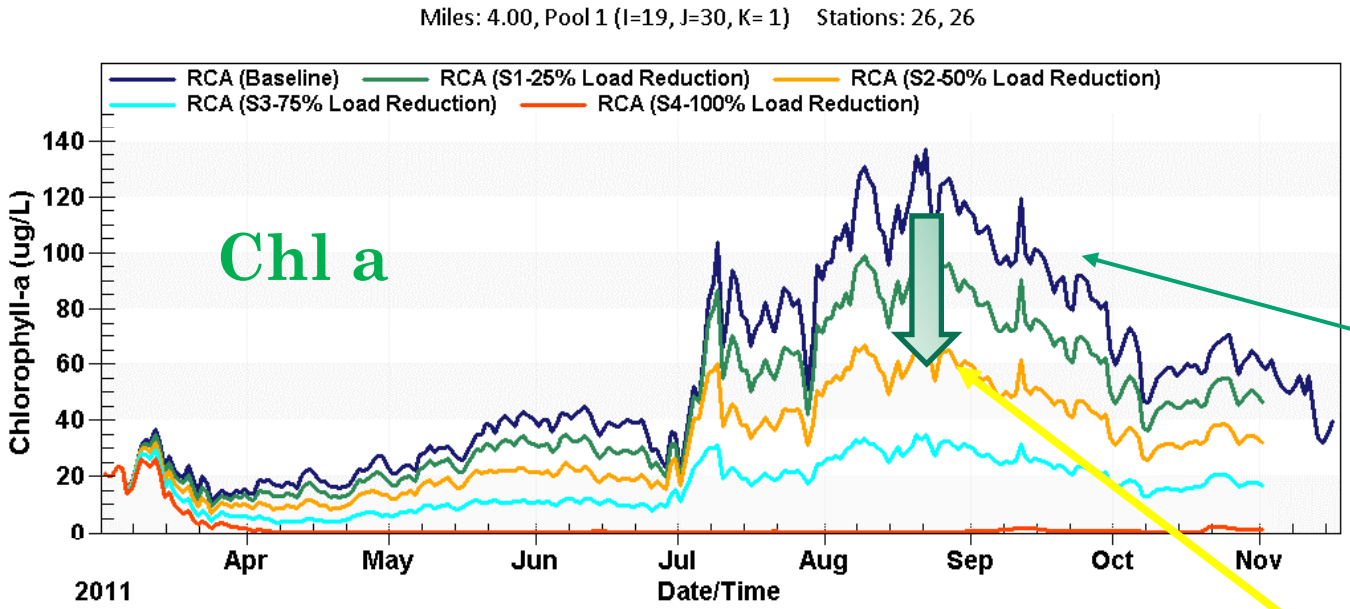
Outputs:

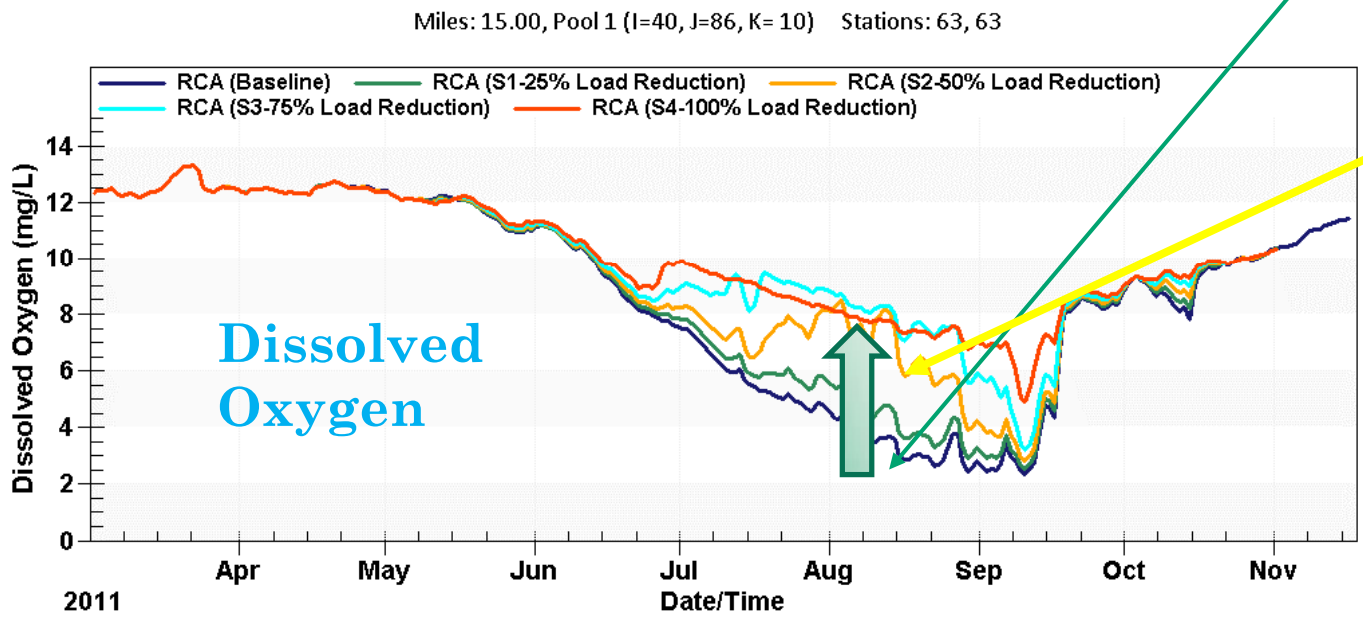
- ✓ End User **BMPs are modeled** at the local watershed scale to inform selection of basin wide scenarios to meet bay load response targets

Ag Management Scenarios	Many Combinations
Baseline	90% full inversion tillage (CT), 43 ppm STI
Cash rotation BMP	45% MT, 40% NT
Dairy fields NRCS Standards (reduced soil P)	Reduce Soil P to 25 ppm (50%)
Reduced Till - Dairy	15 - 65% CT and 10 - 40% NT
Cover Cropping after Corn Silage	forage and non-forage CC, up to 75%
Managed Grazing	10-50% of Dairy cropland
Reduced Till + Cover Crop	combinations
Reduced Till + Graze	combinations
Cover Crop + Graze	combinations
Reduced Till + Cover Crop + Graze, With and Without reduced STP, Cash Crop BMPs	Extensive BMP implementation



31 modeled sub-basins





Bottom line = 40-50% reduction needed

baseline

50% reduction

Driven by land use

Next steps:

- Management practices:
  - What is possible?
  - How will the bay respond?
  - What impact will changing climate impart?

QUANTITATIVE SYNTHESIS OF DIFFERENT LONG-TERM CHAB MONITORING PRODUCTS IN WESTERN LAKE ERIE

Isabella Bertani – University of Michigan

PROJECT OVERVIEW

Quantitative synthesis of different long-term CHAB monitoring products in western Lake Erie

Isabella Bertani[1], Cara E. Steger[1,2], Daniel R. Obenour[3], Gary L. Fahnenstiel[1,4], Thomas B. Bridgeman[5], Thomas H. Johengen[6], Michael J. Sayers[7], Robert A. Shuchman[7], Donald Scavia[1]

[1] Water Center, Graham Sustainability Institute, University of Michigan
[2] Graduate Degree Program in Ecology, Natural Resource Ecology Lab, Colorado State University
[3] Department of Civil, Construction, & Environmental Engineering, North Carolina State University,
[4] Great Lakes Research Center, Michigan Technological University
[5] Department of Environmental Sciences and Lake Erie Center, University of Toledo
[6] Cooperative Institute for Limnology and Ecosystems Research, University of Michigan
[7] Michigan Tech Research Institute, Michigan Technological University

- Funding Source

UM Water Center

- Project Location & Study years

Western Lake Erie, 2002-2013

- Research question

What is the degree of coherence of different CHAB monitoring approaches when modeling relationships with environmental drivers?

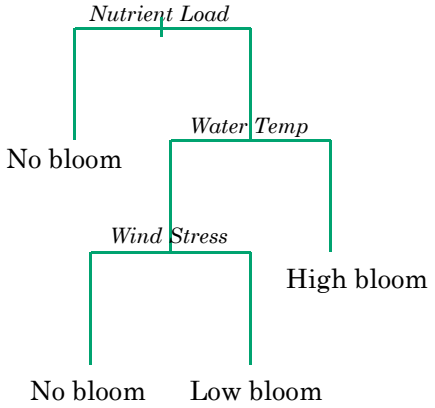
APPROACH

- How will you meet your project objectives to answer your hypothesis?

  - Synthesize multiple *in-situ* and remote sensing datasets providing long-term time series of bloom intensity in western Lake Erie

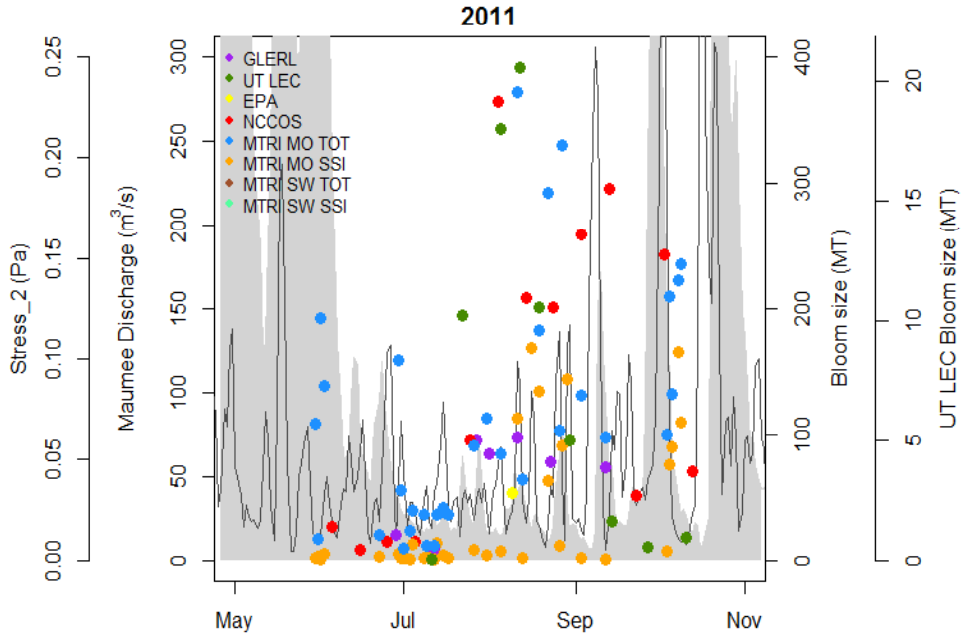
  - Apply a regression tree modeling approach to each of the bloom time series to analyze relationships between bloom size and a suite of predictors (nutrient loading, water temperature, river discharge, wind speed and direction, irradiance)

  - Compare modeling results to assess whether different monitoring products identify different key predictors and/or contrasting functional relationships with environmental variables



Summary of Findings

- Remarkable consistency of modeling results with known ecological requirements of cyanobacteria for some variables (e.g., nutrient loading, water temperature, tributary discharge)
- Inconsistencies across monitoring products in the relative importance, shape, and sign of the modeled relationships with variables characterized by high short-term variability, such as wind forcing
- → Importance of integrating multiple types of bloom measurements in CHAB modeling approaches



HABs Collaboratory

- What questions still need to be answered about HABs?

How can we best integrate multiple types of bloom detection methods into CHAB modeling approaches to leverage the advantages associated with each monitoring approach while overcoming the individual limitations?

- How can collaboration help your research?

Bring together multiple data sources and develop methods to synthesize and integrate them

USING MODELS TO LINK HABS TO NUTRIENT LOADS

John Bratton – LimnoTech

PROJECT OVERVIEW

a) **Using Models to Link HABs to Nutrient Loads**
b) John Bratton, LimnoTech
c) Funding: USEPA, USACE, Univ. of Toledo
d) Western Lake Erie, 2014-2016
e) Hypothesis: Numerical models can be used effectively to understand, simulate, and forecast HABs

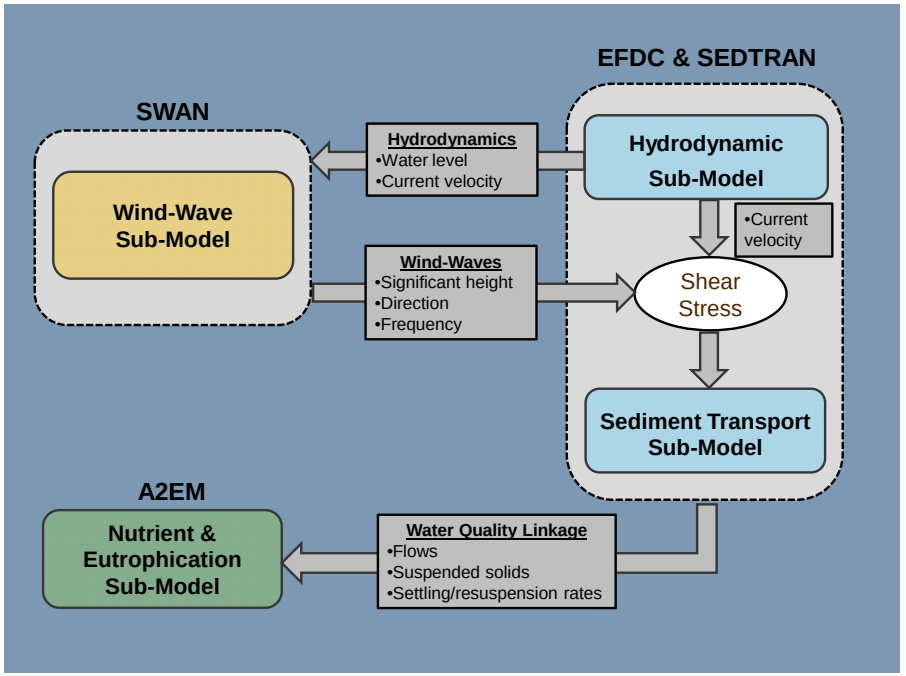
LimnoTech
Water Environment | Scientists Engineers

APPROACH

a) Link watershed, lake, and ecological models

b) Use data on nutrient loads, weather, lake conditions, and biology to calibrate and drive models

c) Use calibrated models to simulate scenarios and forecast blooms



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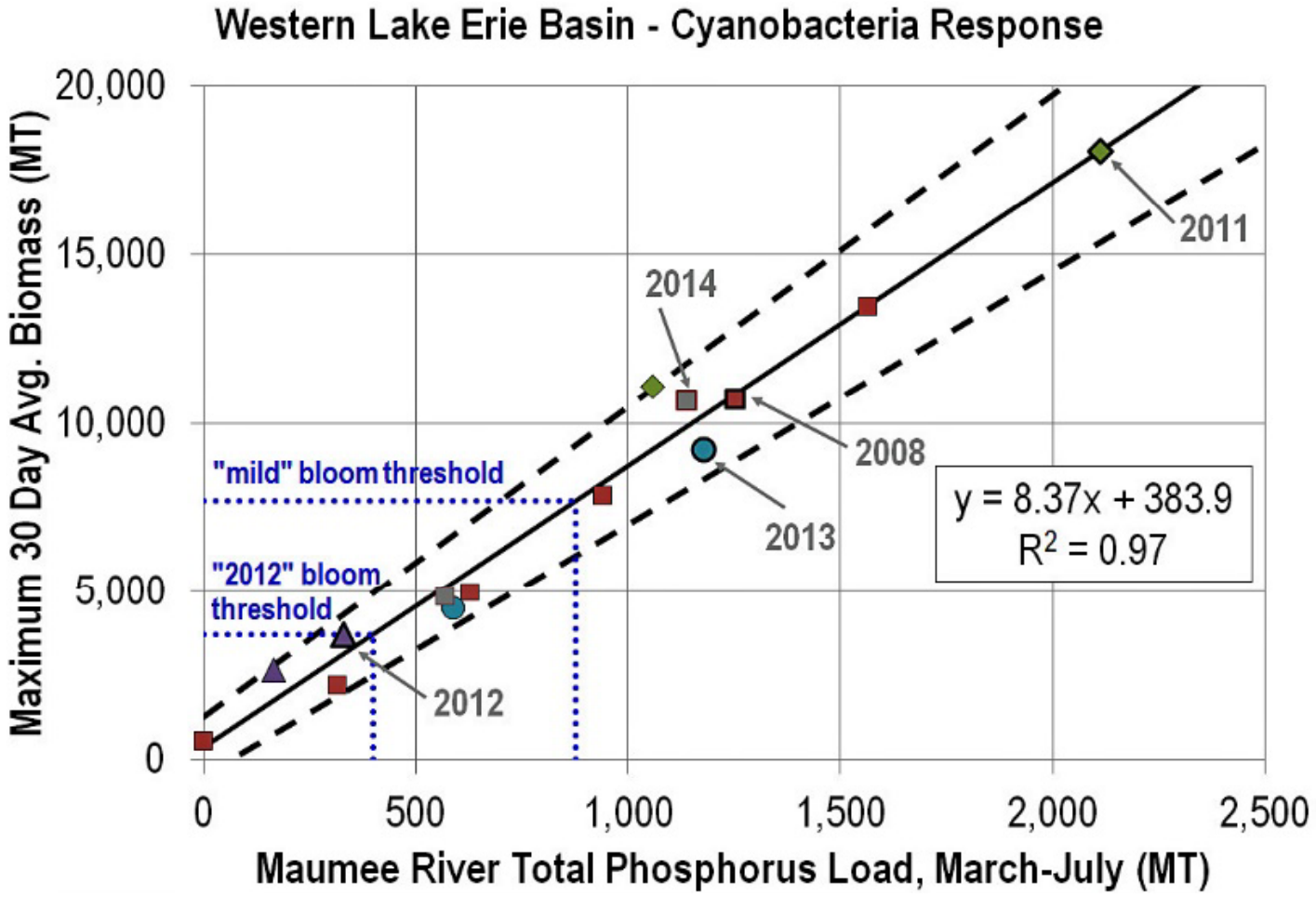
LOAD-RESPONSE: EMPIRICAL



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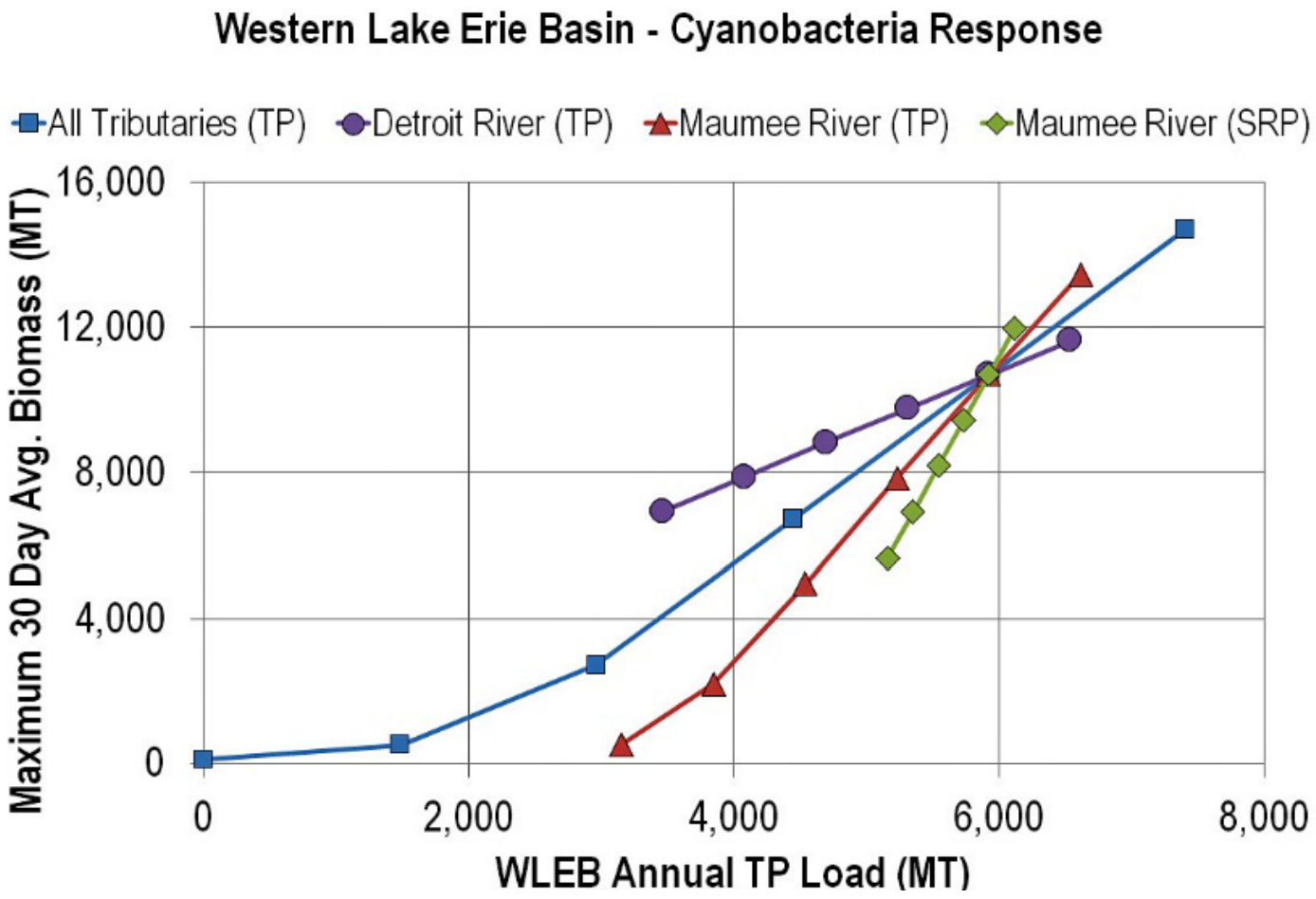
LOAD-RESPONSE: SCENARIO



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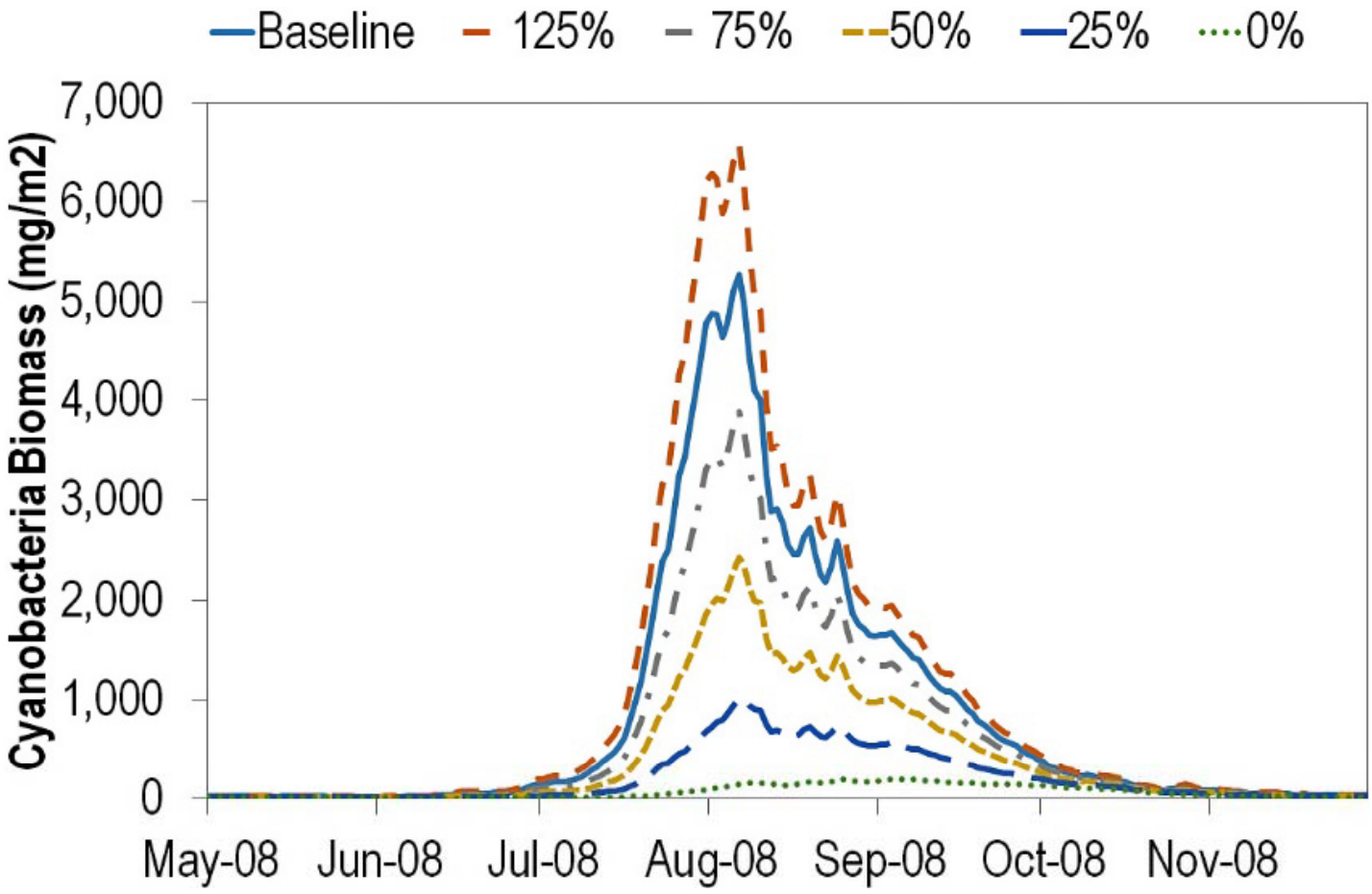
Bloom Season Hindcast Scenarios



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SUMMARY OF FINDINGS

a) Lessons learned:
--Modeling works: data synthesis, process understanding, prediction, decision support
--L. Erie is very sensitive to Maumee R. SRP loads

b) Surprises:
--Blooms are also quite sensitive to temperature
--Toxicity tends to peak early in the bloom season

c) Management implications:
--Nutrient reduction in the Maumee Basin will have the greatest impact
--Drinking water utilities should monitor before blooms start

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HABs Collaboratory

a) Remaining questions:
--environmental controls on toxin production
--roles of non-dominant HAB species
--3D HAB behavior
--most effective management and operational modeling approaches

b) How can collaboration help?
--divide-and-conquer efficiency
--refining of research agenda

LimnoTech
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HARMFUL ALGAL BLOOM MONITORING NETWORK

Ed Verhamme– LimnoTech

Project Overview

a) **A Harmful Algal Bloom Monitoring Network**

b) Ed Verhamme, LimnoTech

c) **Funding:** Ohio EPA (via USEPA), Great Lakes Observing System, City of Toledo

d) Western Lake Erie, 2014-2016

e) **Hypothesis**: Real-time HABs data supports improved drinking water treatment

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2015 HABs Real-Time Monitoring

great lakes observing system

- Temperature
- pH & ORP
- Conductivity
- Turbidity
- Dissolved Oxygen
- Chlorophyll
- Phycocyanin

Toledo
Oregon
Port Clinton
Marblehead
Sandusky
Elyria
Avon Lake
Mentor
Ashtabula
Painesville
Cleveland
Akron
Leamington
Livonia
Taylor

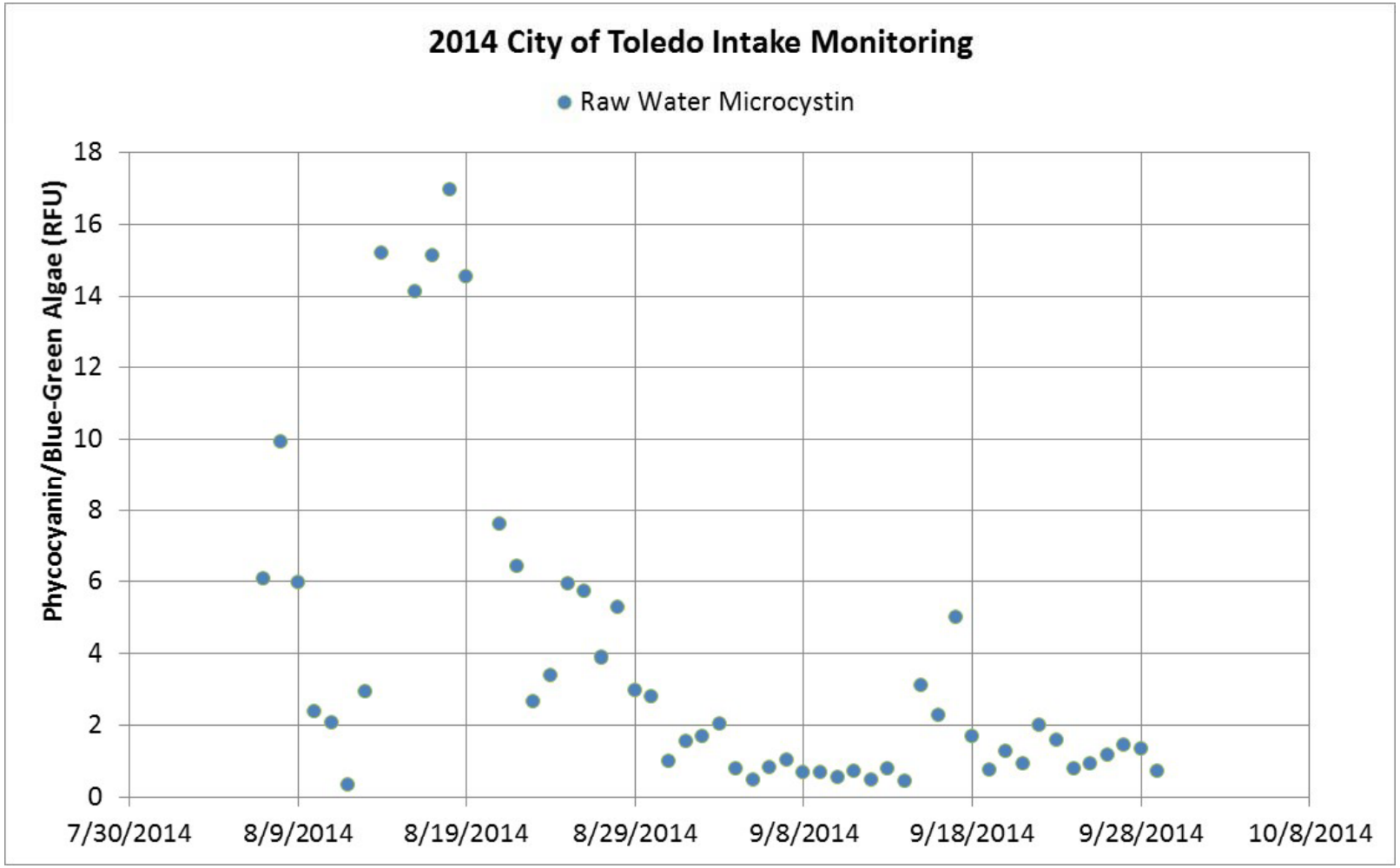
Organization

- Bowling Green State U.
- NOAA GLERL
- Stone Lab-OSU
- Univ of Toledo
- LimnoTech/Water Plants

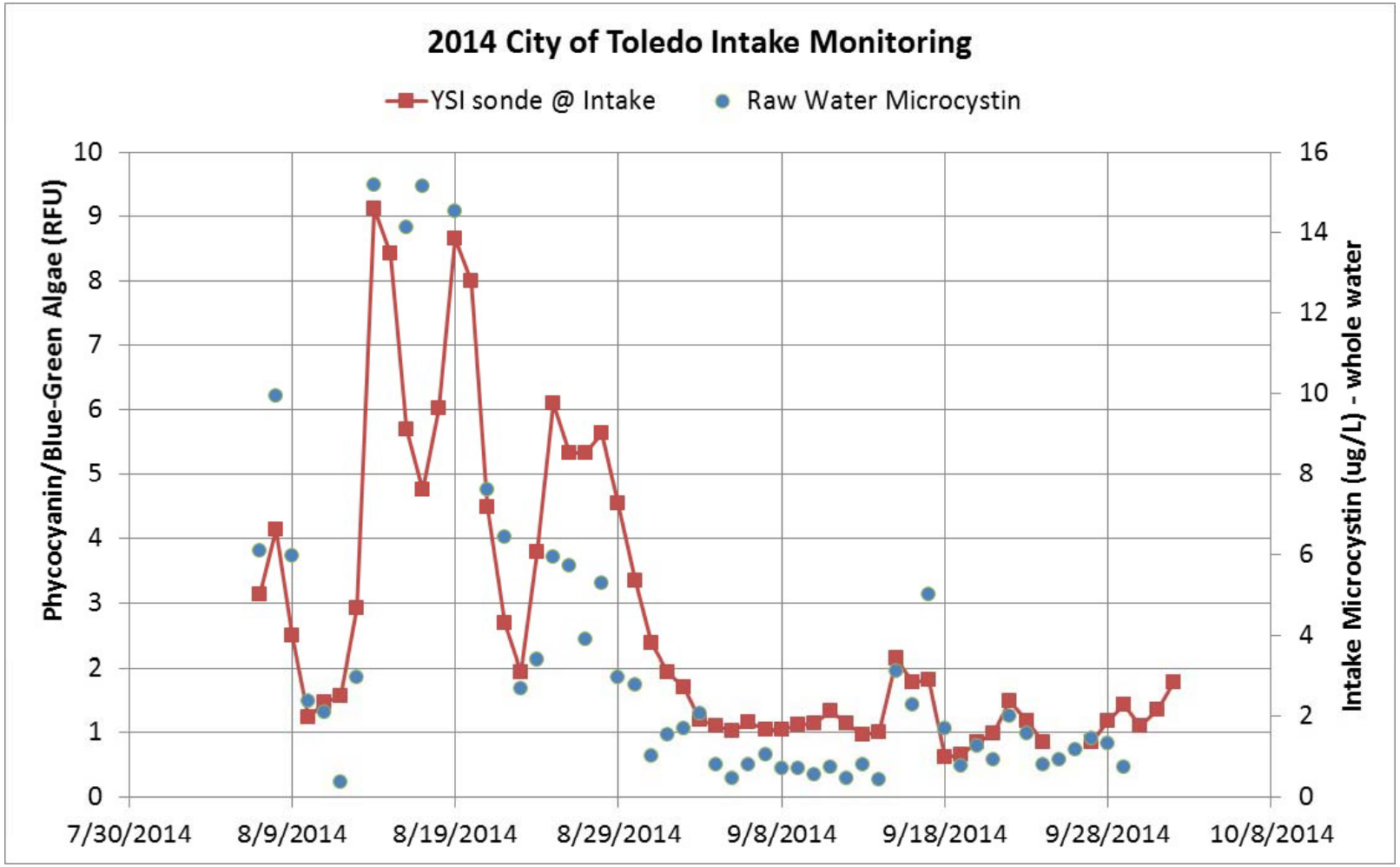
0 15 30 60 Miles

THE UNIVERSITY OF TOLEDO
THE OHIO STATE UNIVERSITY
BGSU Bowling Green State University
GLERL Great Lakes Environmental Research Laboratory
LimnoTech

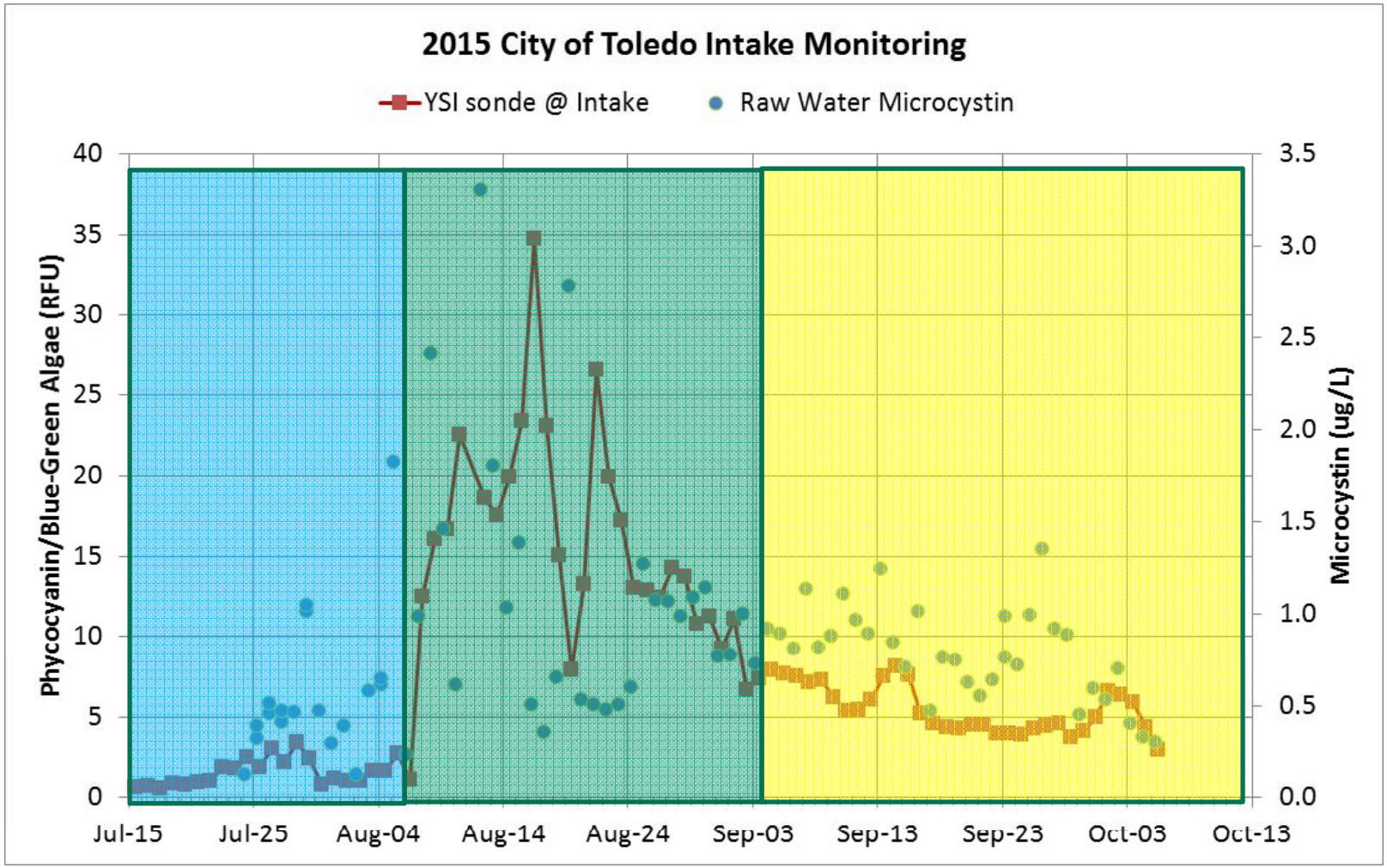
2014 City of Toledo Lake Monitoring



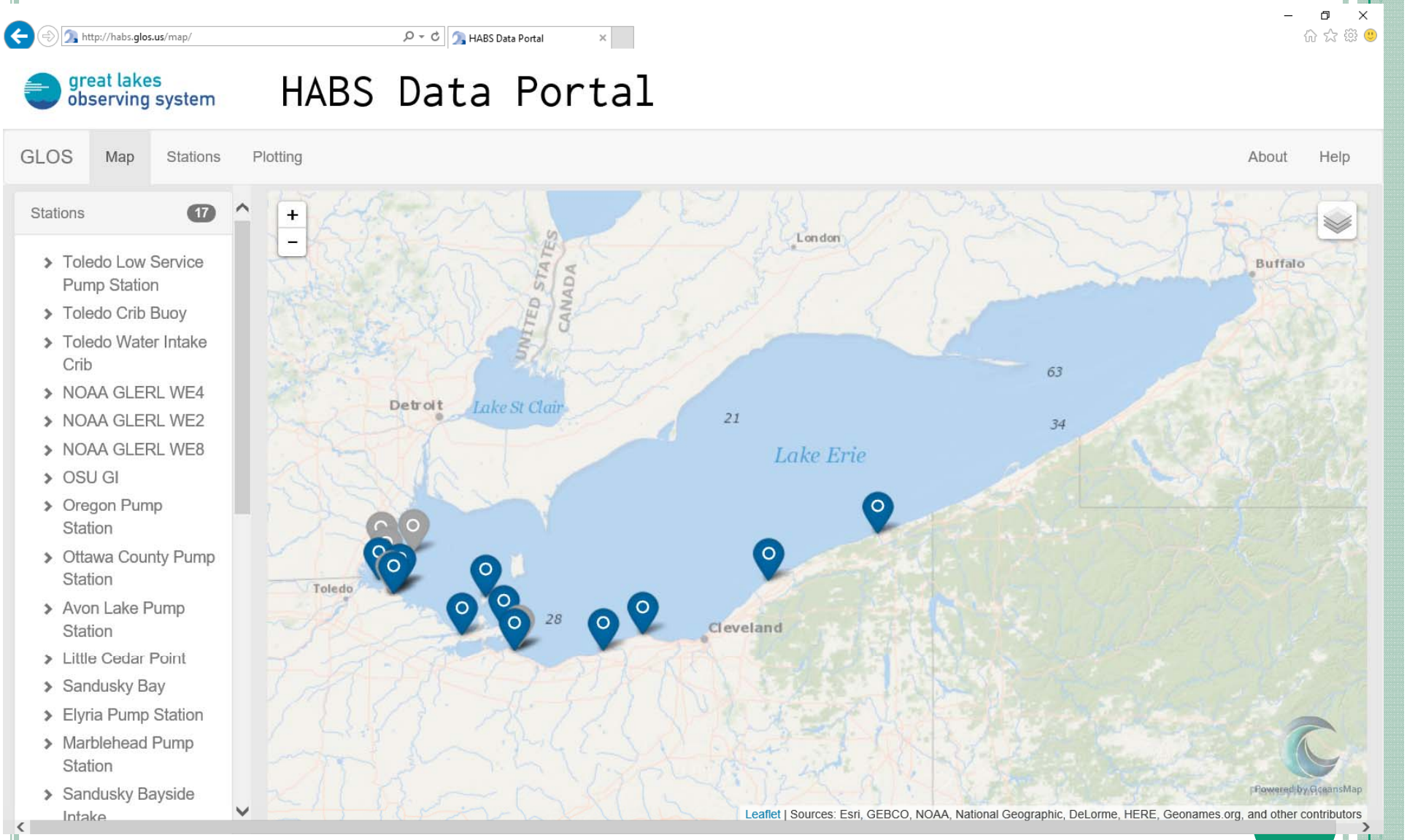
2014 City of Toledo Lake Monitoring



2015 City of Toledo Lake Monitoring

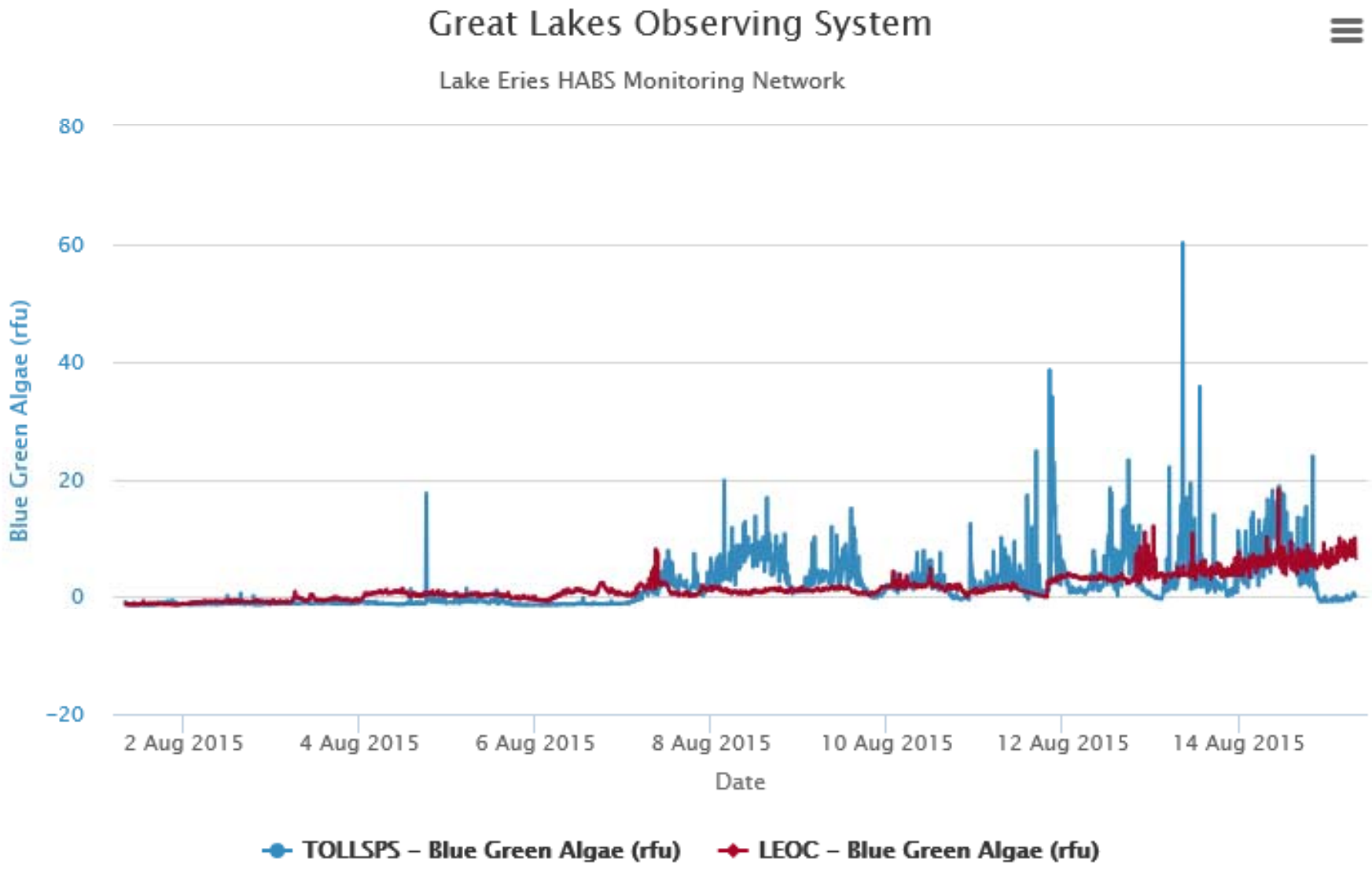


GLOS HABs Data Viewer

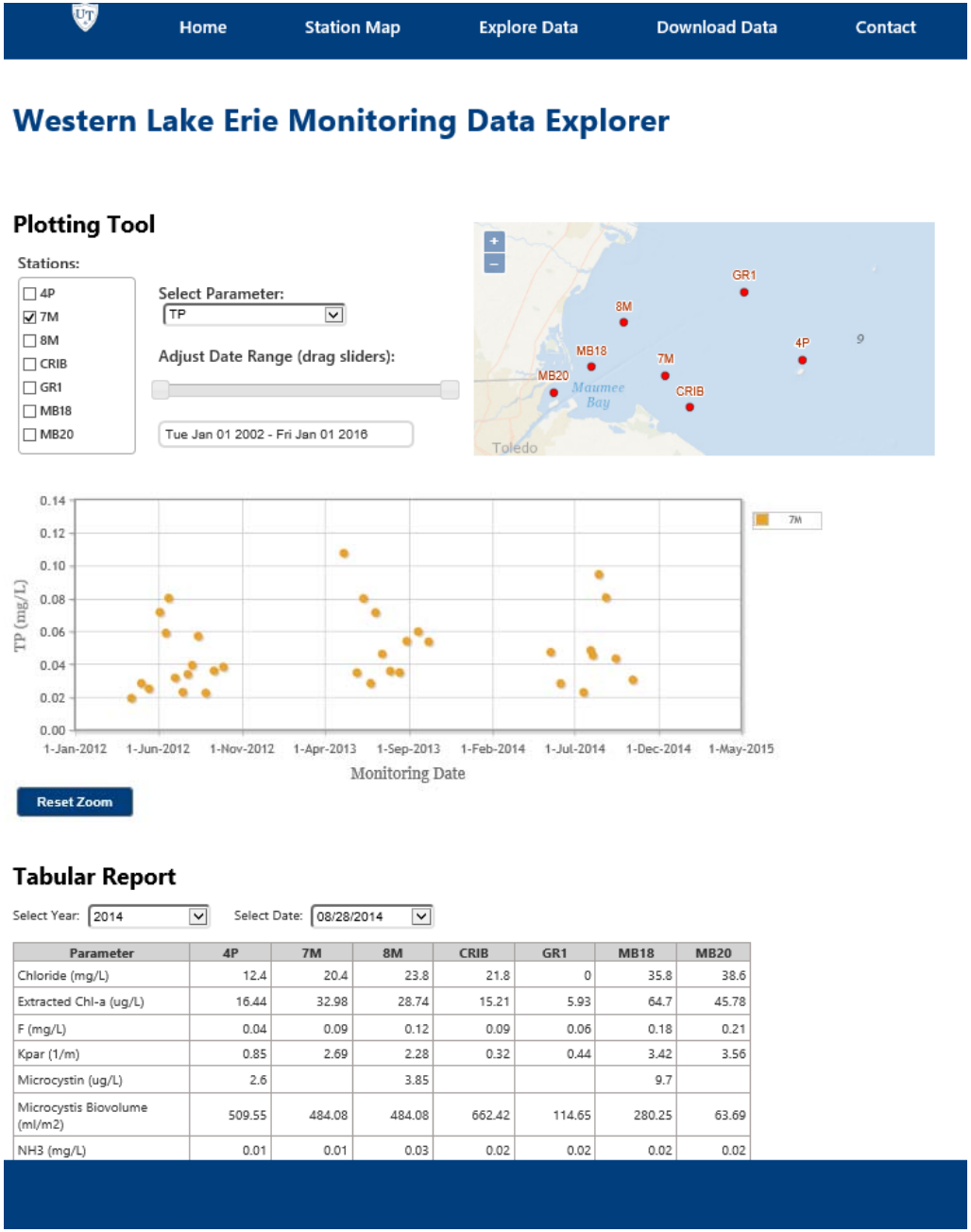


http://habs.glos.us

Toledo & Port Clinton - Aug 2015 BGA



Sneak Peak - University of Toledo HABs Dataset



Parameter	4P	7M	8M	CRIB	GR1	MB18	MB20
Chloride (mg/L)	12.4	20.4	23.8	21.8	0	35.8	38.6
Extracted Chl-a (ug/L)	16.44	32.98	28.74	15.21	5.93	64.7	45.78
F (mg/L)	0.04	0.09	0.12	0.09	0.06	0.18	0.21
Kpar (1/m)	0.85	2.69	2.28	0.32	0.44	3.42	3.56
Microcystin (ug/L)	2.6		3.85			9.7	
Microcystis Biovolume (ml/m2)	509.55	484.08	484.08	662.42	114.65	280.25	63.69
NH3 (mg/L)	0.01	0.01	0.03	0.02	0.02	0.02	0.02

14 yrs of HABs/nutrient data from 7 primary stations

Tom Bridgeman @

THE UNIVERSITY OF TOLEDO

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great lakes observing system

SUMMARY OF FINDINGS

a) **Lessons learned:**
--Sharing "research" data with decision makers is extremely valuable, BUT need to educate audience
--Sonde data trends track microcystin well

b) **Surprises:**
--Once data management was in place getting participation from other partners was easy(er).
--Maintaining QA/QC (and centralizing) is difficult

c) **Management implications:**
--New "real-time" on the ground tools to assess HABs presence w/strong correlation to toxin trends

--Decreased operational costs

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a) **Remaining questions:**
--What does a sustainable funding model for the pseudo-operational pilot project look like?
--Can we better understand the phycocyanin/microcystin relationships to have a better proxy for toxin trends?

b) **How can collaboration help?**
--Use data from the sonde network in your research!!!
--Work with us to share additional (research) data with decision makers.

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Environment | Engineers

HABs Data & Modelling

In partnership with:

Coming up next:

HABs Blooms Sources & Movements

Thursday June 23, 2016 1:00 p.m. (EDT)

HABs & Safe Drinking Water – July 7, 2016
HABs Blooms Detection, Composition & Effects – TBD
HABs Blooms Sources & Toxicity - TBD
HABs & Public Health – TBD
HABs Blooms Monitoring & Forecasting – TBD
HABs: Educate and Engage - TBD

To learn more about the HABs Collaboratory and the HABs State of the Science Webinar Series, visit us at:
http://glc.org/projects/water-quality/habs/