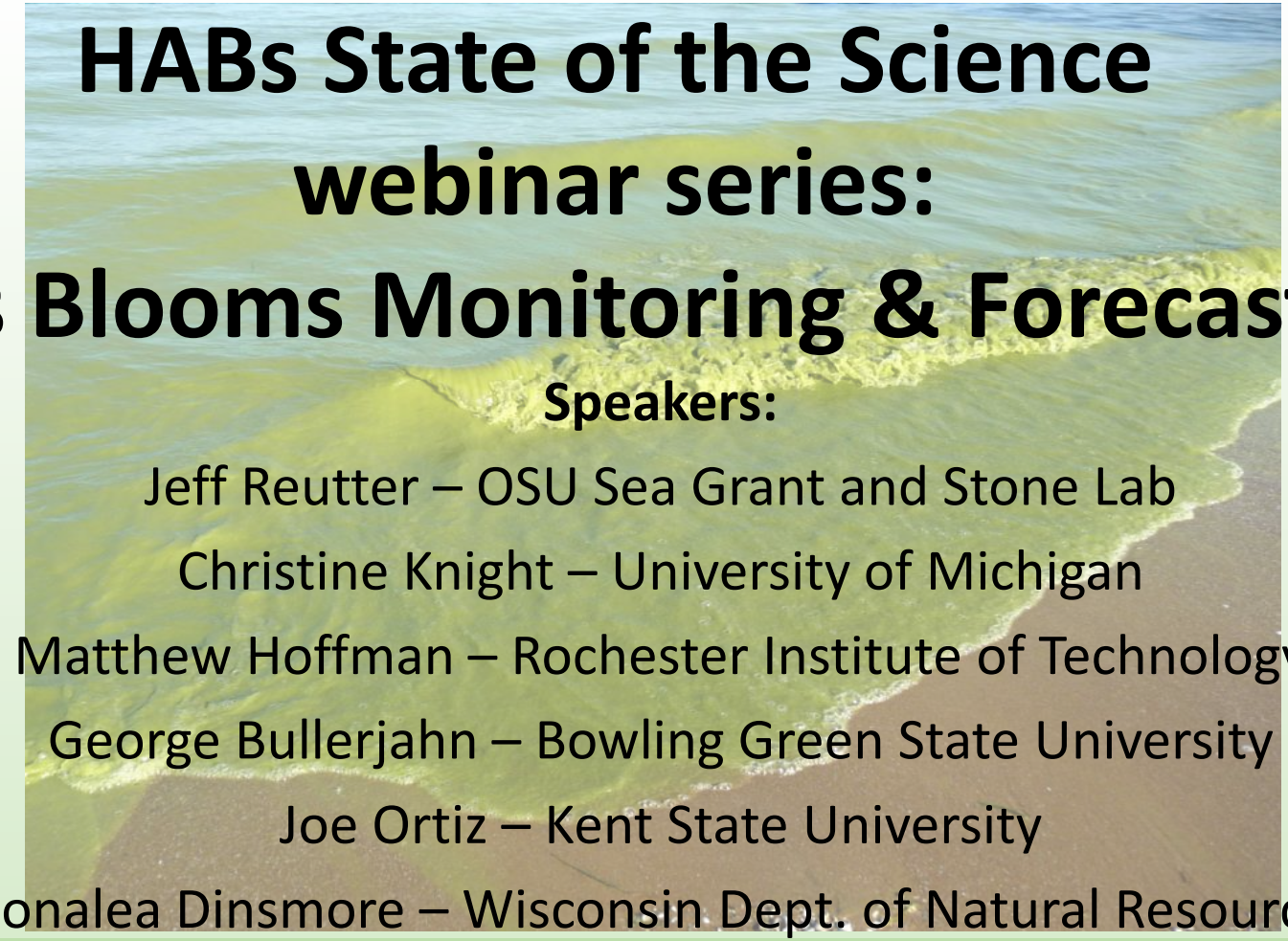
HABs State of the Science webinar series:
HABs Blooms Monitoring & Forecasting



Speakers:

Jeff Reutter – OSU Sea Grant and Stone Lab

Christine Knight – University of Michigan

Matthew Hoffman – Rochester Institute of Technology

George Bullerjahn – Bowling Green State University

Joe Ortiz – Kent State University

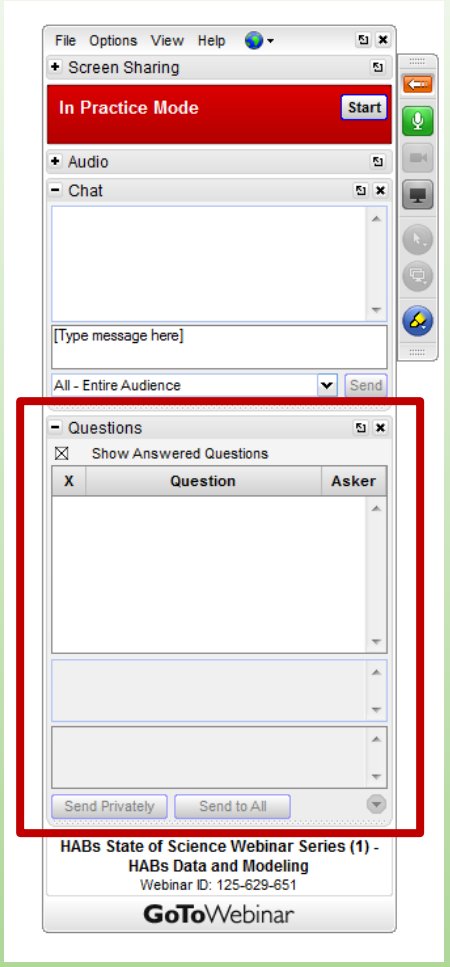
Donalea Dinsmore – Wisconsin Dept. of Natural Resources

In partnership with:

GoToWebinar Housekeeping Items

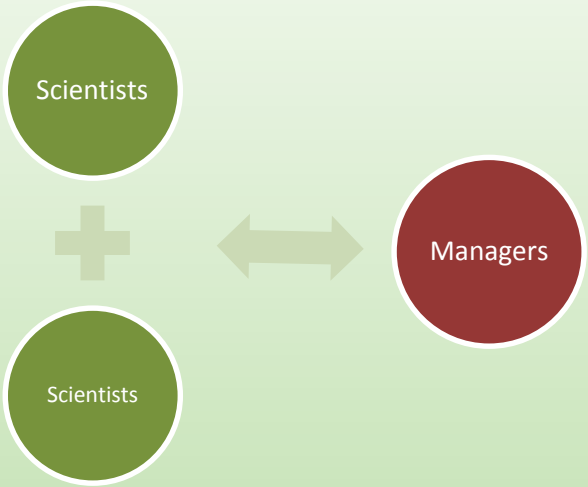
- Submit your text questions and comments using the Questions Panel

- 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
  - https://ohioseagrant.osu.edu/news/calendar/2016/09/15/o47km/understanding-algal-blooms

GLWQA Annex 4
Objectives and Targets Task Team

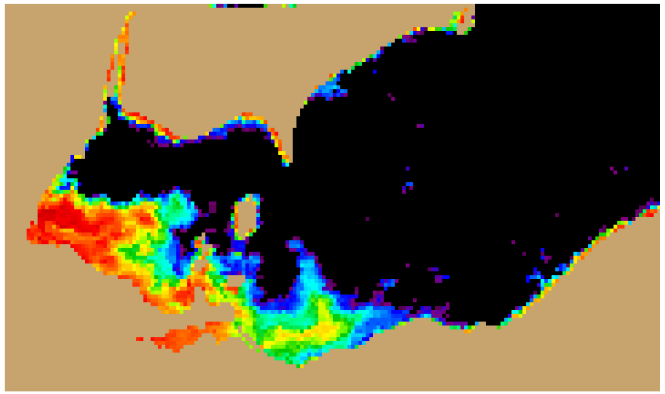
Dr. Jeff Reutter, OSU Sea Grant and Stone Lab, US Co-Chair

Objectives and Targets Task Team

- Invitation to serve distributed 9/25/13
- 25-member, binational Task Team formed
- First conference call—11/12/13
- Final Report to Subcommittee 5/25/15
- Between times
  - Two 2-day meetings
  - Three 3-day meetings
  - 12 more conference calls
  - Worked by consensus
  - 25-member modeling committee formed, meet, and report results

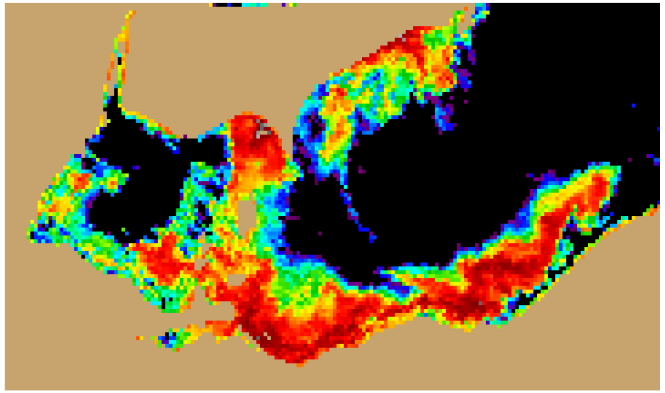
Charge to Task Team

- **Provide science-based recommendations to address HABs, hypoxia, and Cladophora**
  - **HABs—primarily Western Basin problem**
  - **Hypoxia—Central Basin problem**
  - **Cladophora—primarily an Eastern Basin north shore problem**
    - **A science-based decision on required P reductions to address Cladophora could not be reached.**
- **Recommended and needed approval of an adaptive management approach before proceeding with recommendations**
  - **Will HABs like 2012 be satisfactory, will climate change result in severe blooms more than 1 year in 10, etc.**



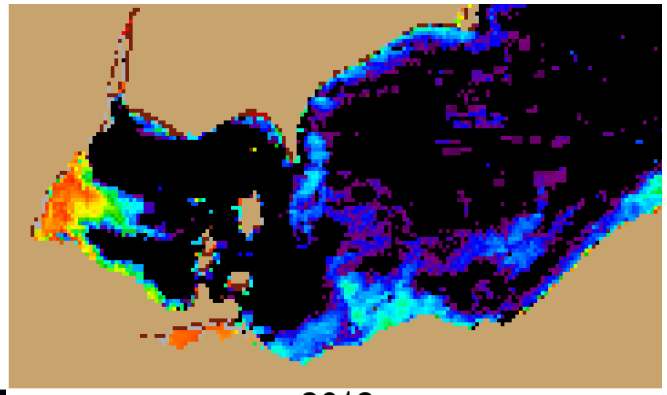
2008

- Ann. discharge = 8.0 billion m^3
- Spring discharge = 3.4 billion m^3
- Ann. P load = 3,812 tonnes
- Spring P load = 1,400 tonnes



2011

- Ann. discharge = 6.2 billion m^3
- Spring discharge = 5.0 billion m^3
- Ann. P load = 3,007 tonnes
- Spring P load = 2,300 tonnes



2012

- Ann. discharge = 6.1 billion m^3
- Spring discharge = 1.0 billion m^3
- Ann. P load = 2,411 tonnes
- Spring P load = 400 tonnes

RECOMMENDATIONS FOR MONITORING, MODELING, RESEARCH AND REPORTING TO SUPPORT ADAPTIVE MANAGEMENT

- **TT report to Subcommittee 11/24/15**

Annex 4 Subcommittee Response

- US and Canada officially approved loading targets on 2/22/16
- Working on domestic action plans to reach target loads
- Formation of 3 new, binational Work Groups to address recommendations
  - Tributary Monitoring Work Group (30 members)
  - Load Estimation Work Group (14 members)
  - Algae and Lake Monitoring Work Group (18 members)

Monitoring Recommendations

TT believes this science-based plan will be sufficient to detect and evaluate progress toward P reduction goals

- **Develop a long-term coordinated monitoring strategy and network for collecting compatible tributary, near-shore, and open lake data to evaluate progress toward WB, CB, and nearshore targets and understand and manage HABs, hypoxia and Cladophora.**
- **Strategy should include compatible sampling design, data storage, data sharing, data analysis, model maintenance, and adaptive management.**
- **Long term funding is necessary**

Monitoring Seasonal and Annual TP and DRP loads & FWMC in Priority Tribs for HABs & Hypoxia

- 14 Priority Tributaries in TT report
- For 11 of 14 (Thames River, River Raisin, Maumee River, Portage River, Sandusky River, Huron River (Ohio), Vermillion River, Cuyahoga River, Grand River (Ohio), Cattaraugus Creek, and Grand River (Ontario)) monitor load and FWMC's using a protocol that pairs high frequency event-based sampling with base-flow sampling.
- Near mouths of tribs but upstream of lake effect
- Co-located with discharge gauge

Sampling Frequency

- **Optimally—use Heidelberg protocol**
  - **Already in use for Raisin, Maumee, Portage, Sandusky, and Cuyahoga**
- **If not feasible—50-100 samples/year that captures monthly ambient conditions with more frequent sampling during runoff events**

What to Sample

- **15 parameters recommended in TT report**
- **Rationale included for each**

For more information:
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ESTABLISHING SPATIAL & TEMPORAL PATTERNS IN *MICROCYSTIS* SEDIMENT SEED STOCK VIABILITY IN WESTERN LAKE ERIE

Christine Knight– University of Michigan

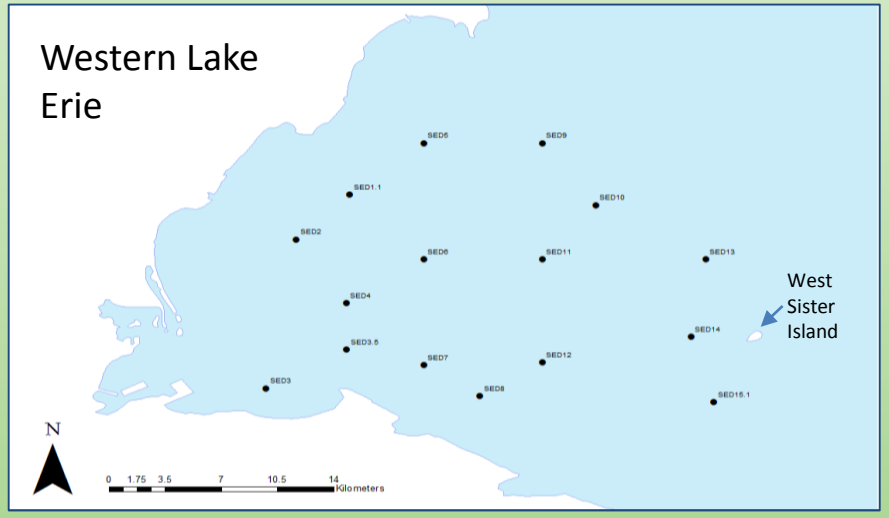
August 11, 2016

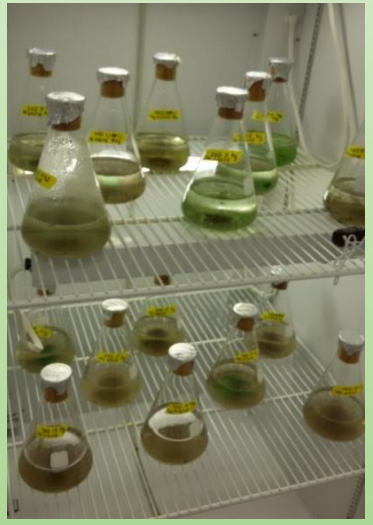
Project Overview

- Establishing Spatial and Temporal Patterns in *Microcystis* Sediment Seed Stock Viability in Western Lake Erie
- Authors
  - Christine Knight, University of Michigan
  - Tom Johengen, University of Michigan
  - Tim Davis, NOAA GLERL
- Project Funded by EPA Great Lakes Restoration Initiative
- Project Location & Study years
  - Western Lake Erie; November 2014, April 2015, November 2015 and April 2016
- Research hypothesis
  - Sediment seed stocks are a viable source of inoculation for annual blooms.

Approach

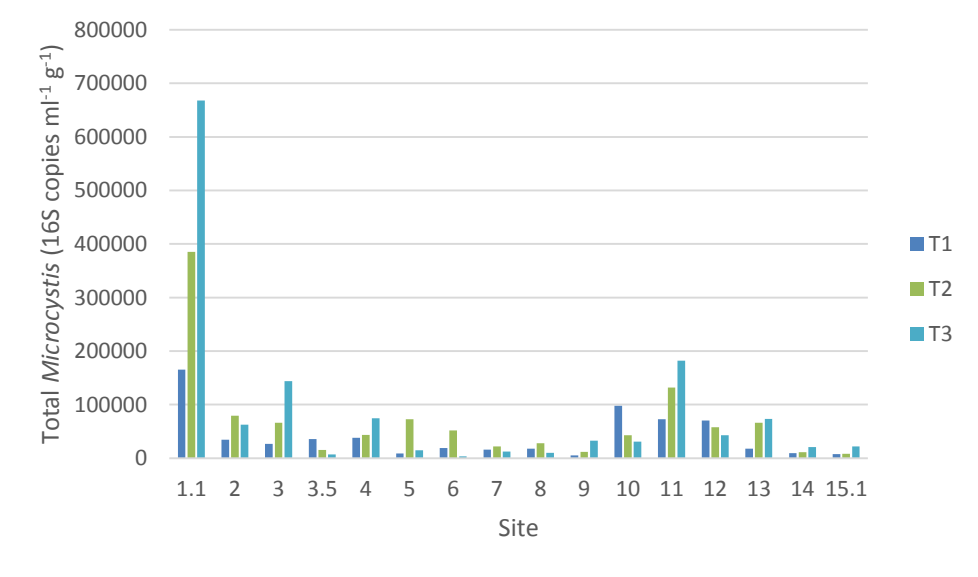
- Sample Collection
  - Sample from 16 stations across the Western Basin in November 2014, April 2015, November 2015, and April 2016
- Data Analysis
  - Quantify total and toxic *Microcystis* populations using qPCR (*Microcystis*-specific 16S and mcyD genes, respectively)
  - Confirm viability through grow out experiments (6 total weeks of incubation, subsample every 2 weeks)

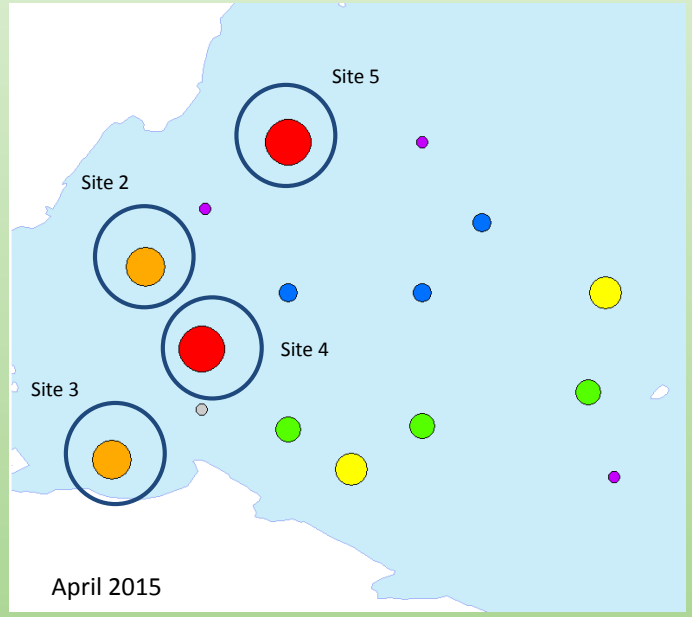




Summary of Findings

- Conclusions
  - Concentrations varied spatially and temporally
  - Positive growth was exhibited in sediments from all locations
  - Abundance did not always correspond to viability
- Relevant conclusions for water quality managers?
  - Preliminary research experiment





HABs Collaboratory

- What questions still need to be answered about HABs?
  - What other factors influence viability of sediment seed stocks?
  - Is there a relationship between seed stocks and subsequent blooms?
- How can collaboration help your research?
  - Increased communication so that we can cover greater temporal and spatial extents; Synchronize methodology to allow for better comparability.

USING LAGRANGIAN COHERENT STRUCTURES TO UNDERSTAND THE HYDRODYNAMIC IMPACT ON THE 2011 LAKE ERIE ALGAL BLOOM

Matthew J. Hoffman – School of Mathematical Sciences, Rochester Institute of Technology

Project Overview

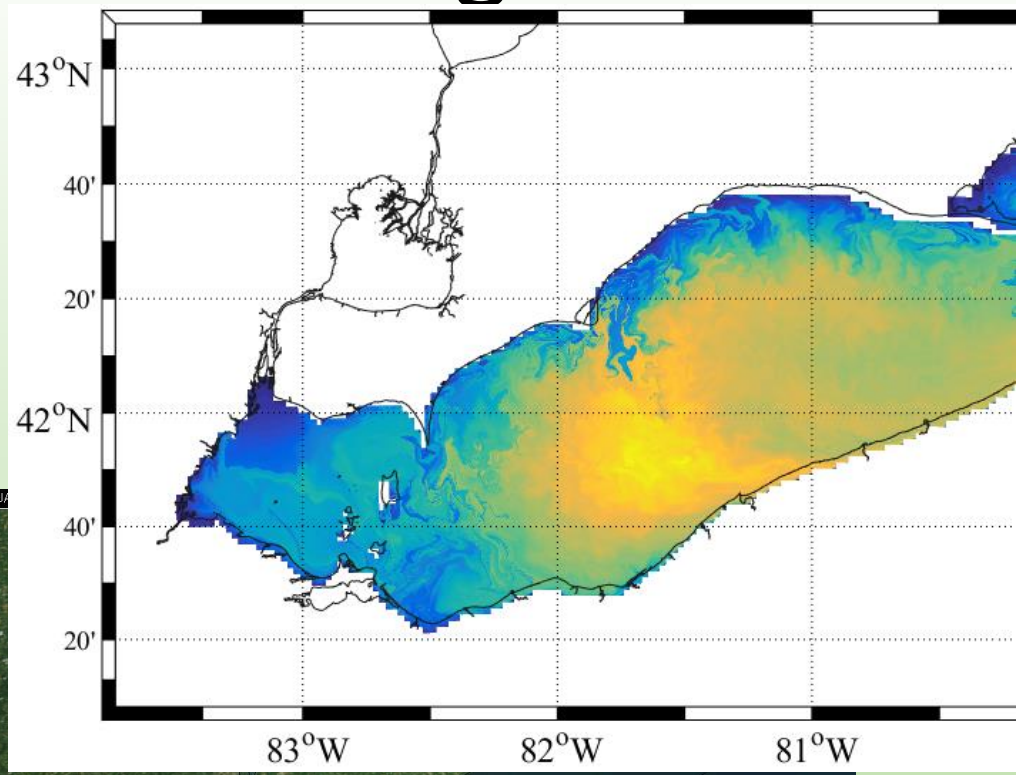
- Lagrangian Coherent Structures (LCS) are lines or surfaces that act as boundaries between regions of a flow where tracers exhibit different behavior
- We are investigating the utility of LCS for predicting both where HABs can build up and how they spread
- We have looked at 2011 Lake Erie bloom, where Michalak et al. (2012) identified blocking of transport as an important factor

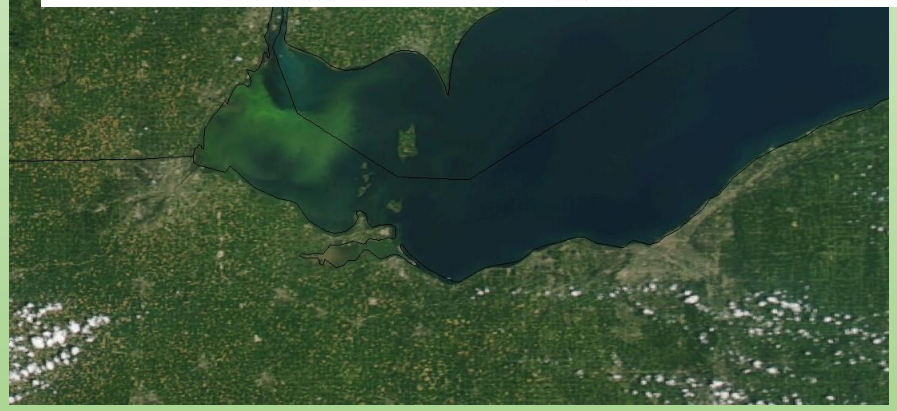
Approach

- One measure of LCS is the M-Function of Macho et al. (2013), which is the distance traveled by a particle (that is the integral of the velocity over the trajectory)
- Two nearby points in the same dynamic regime will travel similar distances, while those in different regimes travel different distances
- Gradients in M define manifolds
- We use GLERL GLCFS model nowcasts to propagate particle trajectories to find LCS

Summary of Findings

- In mid-July we see that the LCS captures the shape of the trapping of river discharge and some of the edge of the bloom

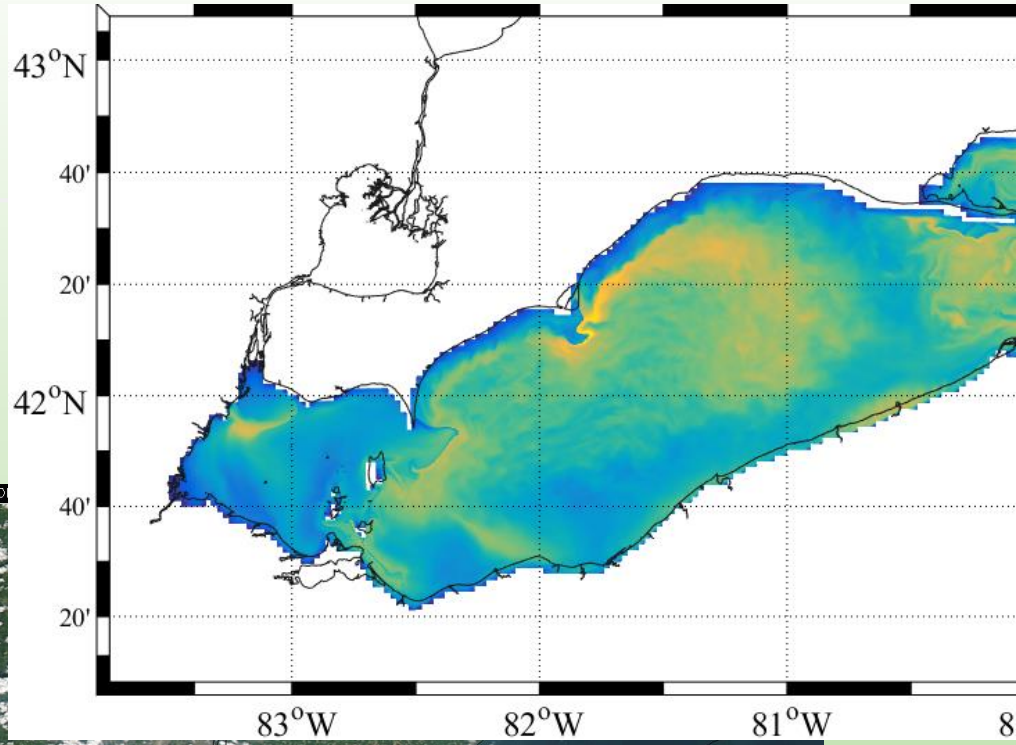


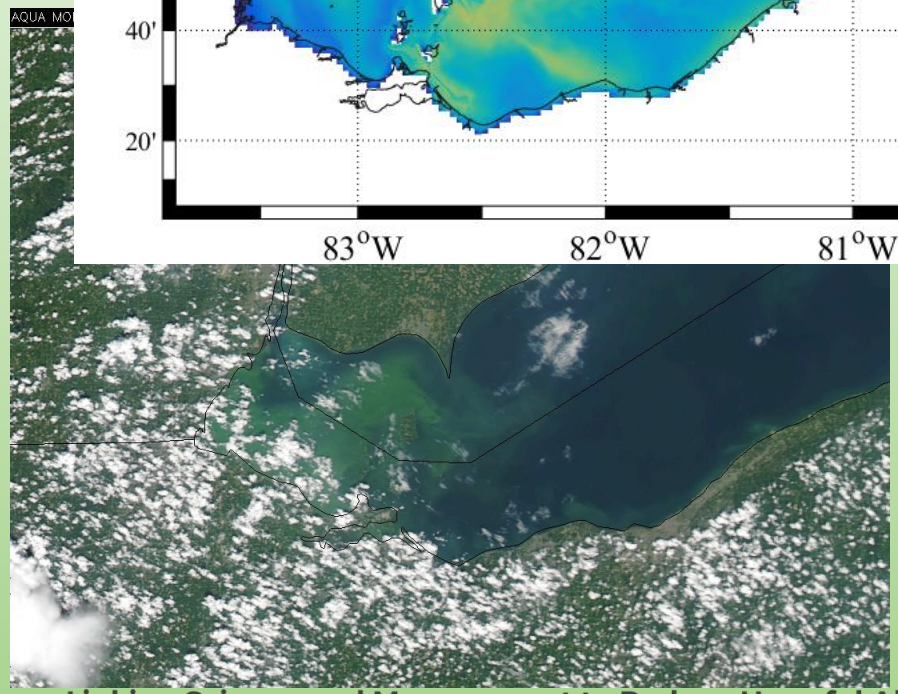


Summary of Findings

- On August 18th, the LCS captures the shape of the bloom as it escapes the western basin

- This emphasizes the role of the flow in the spread of the bloom.





HABs Collaboratory

- LCS can be computed in 3D as well to look at vertical mixing
- Can use current forecasts to look at structures in the lakes at the moment or the near future.
- Need to investigate how predictive this can be?
- What other information is needed (e.g. runoff)?

Project Overview

- "Seasonal quantification of toxic and nontoxic *Planktothrix* in Sandusky Bay by qPCR"
  - New project
- George Bullerjahn, Robert M. McKay, BGSU
  - Taylor Tuttle, PhD student, BGSU
  - Tim Davis (NOAA GLERL), assisting w/ PCR
- Ohio Department of Higher Education
- BGSU and Sandusky Bay, 4/16 – 5/18
- Hypothesis: Shifts in toxic and nontoxic genotypes can be tracked and linked to environmental changes

BGSU® Bowling Green State University

OhioHigherEd Department of Higher Education

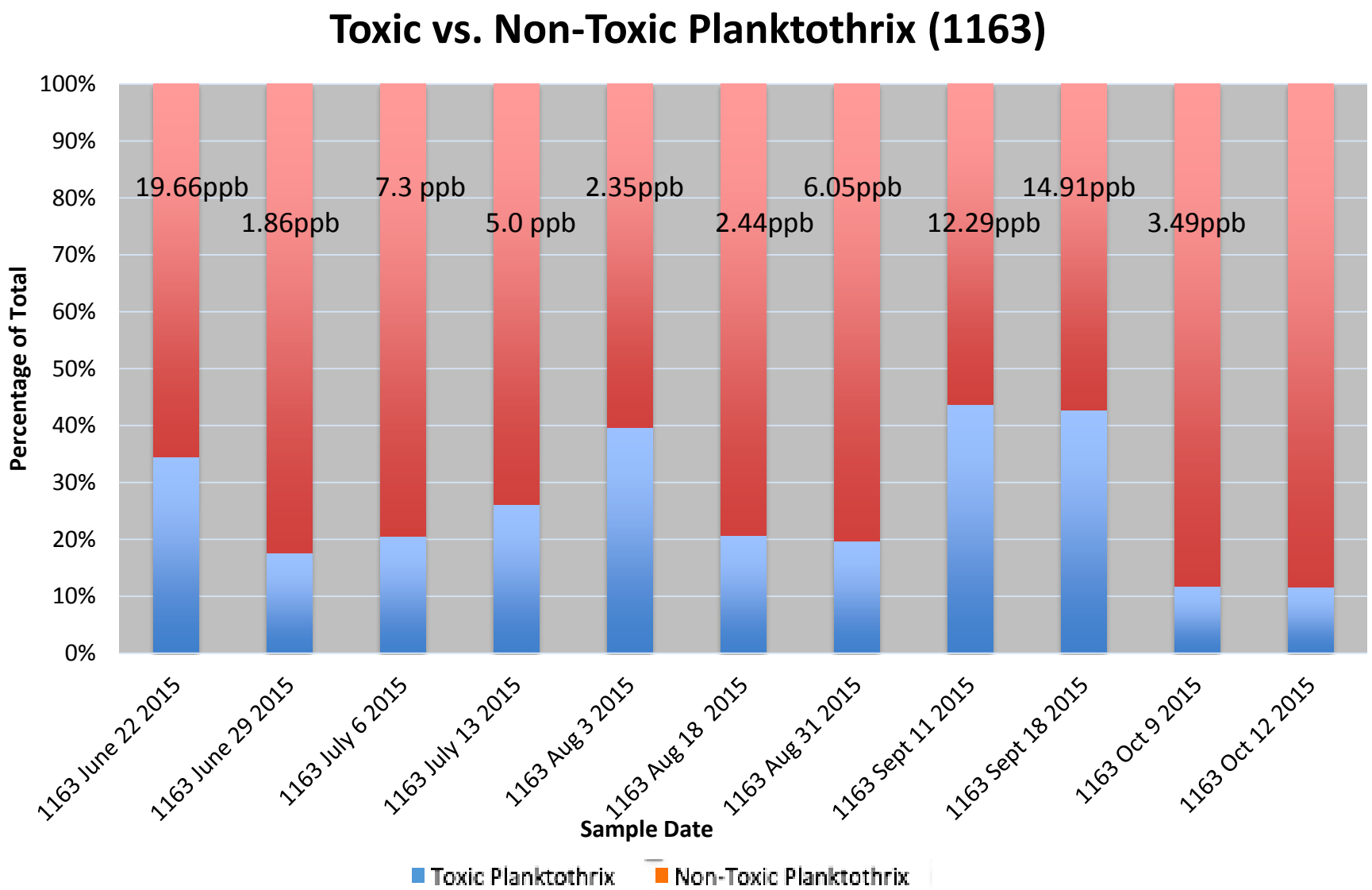
Project Background

- *Planktothrix* blooms from May – October in Sandusky Bay, yielding variable microcystin levels throughout the summer
- What controls toxigenicity?
  - Shifts in toxic/nontoxic genotype abundance?
  - Shifts in toxin gene expression?
  - Both?
- Can predictive models on toxigenicity be developed for Sandusky Bay?
  - Can these be extended to other sites plagued with *Planktothrix* blooms?

Approach

- DNA obtained from weekly/biweekly water samples
  - Detailed environmental metadata obtained concurrently
- qPCR with *Planktothrix* specific 16S primers to get total *Planktothrix*
- qPCR with *Planktothrix* specific mcyA (toxin) primers to get toxic *Planktothrix*
- Testing cultured toxic strains of *Planktothrix* from Sandusky Bay for maximum microcystin production
  - What lab conditions promote microcystin synthesis?

Ratios of toxic/non-toxic *Planktothrix* are variable (2015)



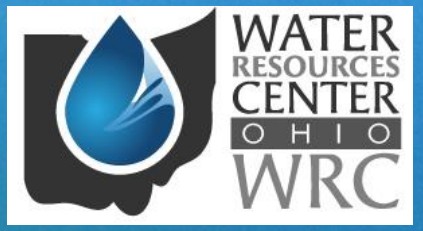
No relationship between chlorophyll, % toxic and microcystin

HABs Collaboratory

- What questions remain?
  - Why are some cyanoHABs blooms highly toxic (e.g. 2014 WLE *Microcystis*) and others not very toxic (e.g. 2015 WLE)?
- Collaboration can help by:
  - Obtaining samples from other sites affected by *Planktothrix*
  - Mapping *Planktothrix* abundance by remote sensing (Joe Ortiz)
  - Advice regarding improving qPCR/qRT-PCR (Tim Davis, NOAA-GLERL…others?)
  - Genomic analysis of toxic and nontoxic genotypes from Sandusky

Acknowledgements

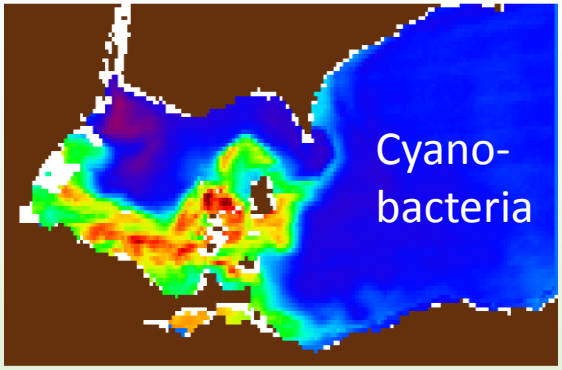
- Joe Ortiz, Kent State
- Darren Bade, Kent State
- Justin Chaffin, OSU Stone Lab
- Doug Kane, Defiance College
- ODNR, OSU and USGS crews

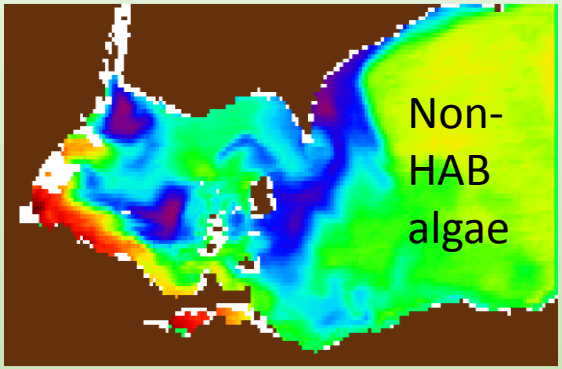


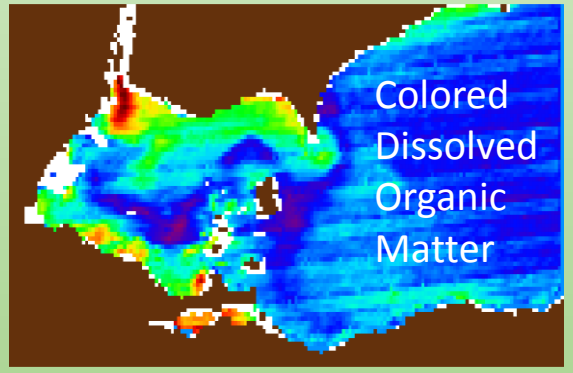
HAB DETECTION, MAPPING AND WARNING NETWORK: SANDUSKY BAY

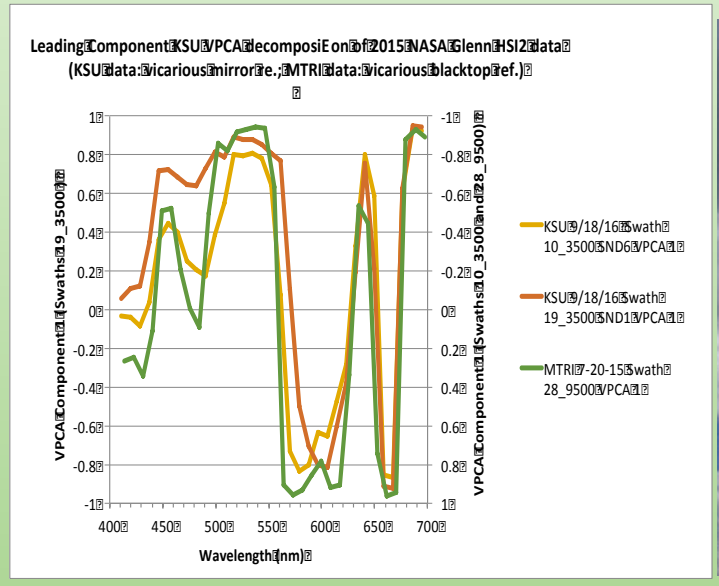
Dr. Joseph D. Ortiz – Kent State University Department of Geology (jortiz@kent.edu)
Collaborators: Bullerjahn (BGSU), McKay (BGSU), Kane (Defiance), Bade (KSU Biology), Chaffin (OSU Stone Lab)

July 28 2015 Decomposed MODIS









Project Overview

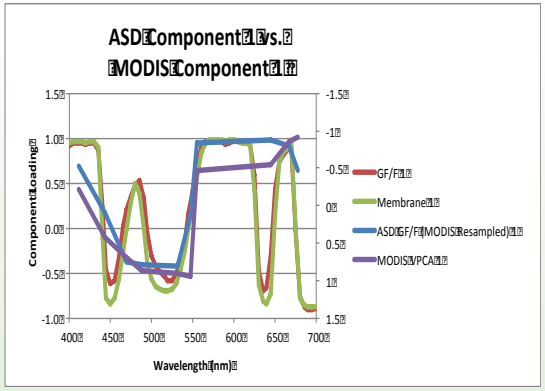
- Spectral decomposition of Lake Erie HABs
- Ortiz, Bullerjahn, McKay, Lekki, Shuchman
- KSU, BGSU, NASA, MTRI, other OhioView groups
- ODHE, NASA, Ohio Sea Grant
- Western Basin of Lake Erie, Sandusky Bay and Central Basin Coastal Zone Transect 2014-2016.

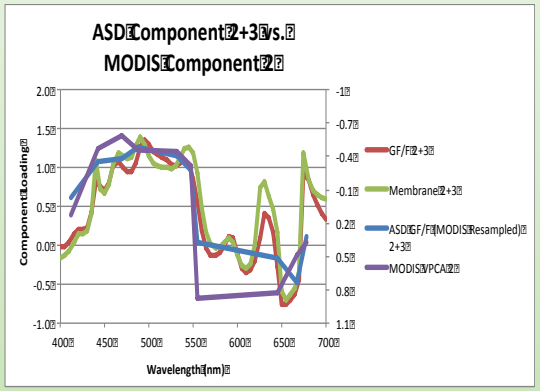
Research hypothesis:

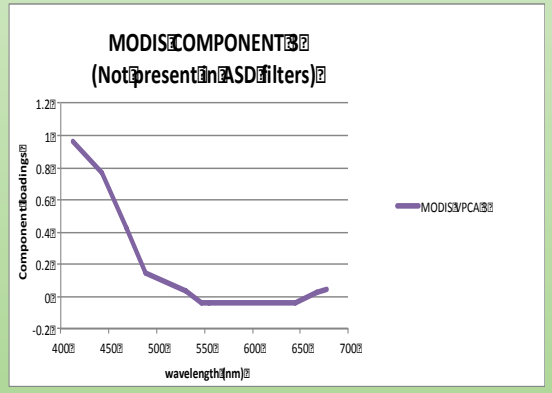
- *Remote sensing data from HABs can be partitioned into their constituent parts for enhanced prediction and monitoring.*

Approach

- Collect field sampling from locations in the Western Basin, Sandusky Bay and southern coast of the Central basin from Sandusky to Lorain
- Hyperspectral ASD Field Spectroradiometer and ASD Lab Spectrophotometer for comparison with Remote Sensing images
- Identification of derivative spectral signals against published reflectance libraries and HPLC absorption spectra
- VPCA spectral decomposition of hyperspectral and multispectral data from field and lab instruments, NASA HSI2, MODIS and Landsat

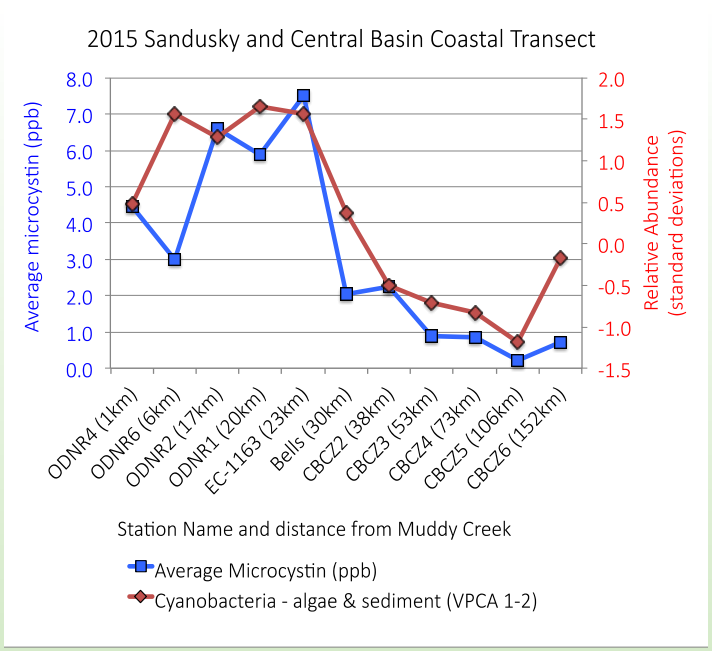


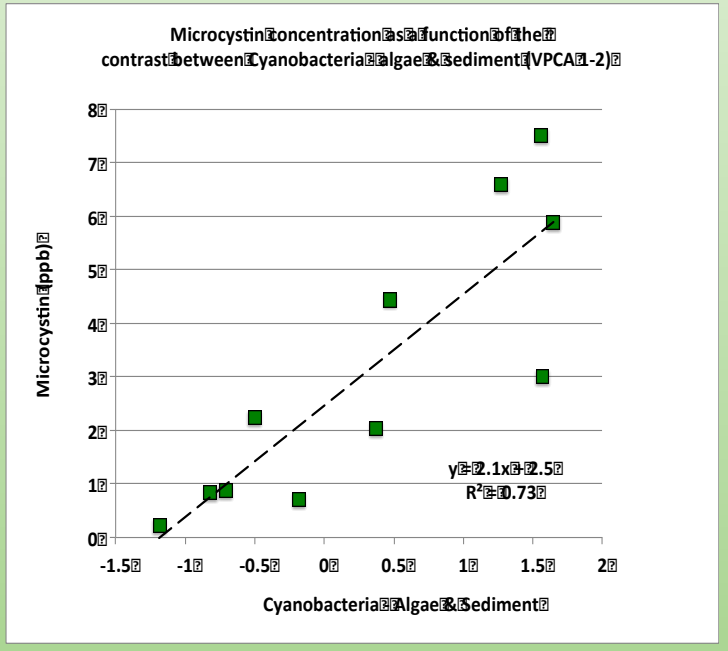




Summary of Findings

- VPCA ties optical assemblages to cyanophytes, algae, CDOM and sediment
- 2015 Sandusky and Central Basin Coastal Transect field data documents export of toxic plankton from Sandusky to Central Basin
- Relationship between microcystin and VPCA components is direct and linear
- KSU VPCA method can be applied successfully to NASA HSI2, MODIS, Landsat
- VPCA is well suited for application to Sentinel-3, HyspIRI, PACE: Makes use of all information present in hyperspectral spectra
- This method hold potential for “first look” estimation of Microsystin from Remote Sensing data





HABs Collaboratory

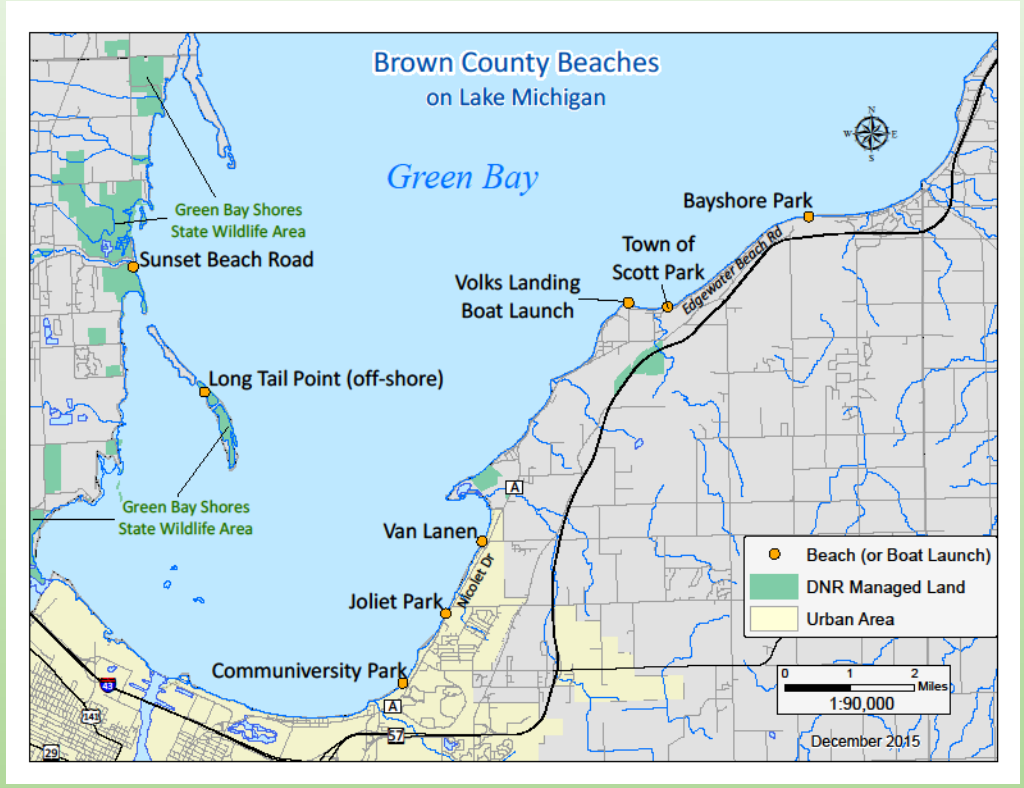
- What specific set of environmental changes triggers toxin production?
- How have the spectral components in Lake Erie changes with time?
- Interdisciplinary research is necessary to address this complex problem that disciplinary boundaries

Recent Publications

- See Water quality webpage at: http://www.personal.kent.edu/~jortiz/home/wqr.html
- Ali, K.A., **JD Ortiz**, N Bonini, M Shuman, C Sydow, Application of Aqua MODIS sensor data for estimating chlorophyll a in the turbid Case 2 waters of Lake Erie using bio-optical models, GIScience & Remote Sensing, 53(4), 2016
- GS Bullerjahn, RM McKay, TW Davis, DB Baker, GL Boyer, LV D'Anglada, … **JD Ortiz** …, Global solutions to regional problems: Collecting global expertise to address the problem of harmful cyanobacterial blooms. A Lake Erie case Harmful Algae, 54, 223–238, 2016.
- Ali, K.A., and **J.D. Ortiz**, Multivariate approach for chlorophyll-a and suspended matter retrievals in Case II waters using hyperspectral data, Hydrological Sciences Journal, 2016. DOI 10.1080/02626667.2014.964242.
- **Ortiz, J.D.,** Witter, D.L., Ali, K.A., Fela, N., Duff, M., and Mills, L., Evaluating multiple color producing agents in Case II waters from Lake Erie, International Journal of Remote Sensing, 34 (24), 8854-8880, 2013.
- Mou, X, Jacob, J., Lu, X., Robbins, S., Sun S.**, J.D. Ortiz.** Diversity and distribution of free-living and particle associated bacterioplankton in Sandusky Bay and adjacent waters of Lake Erie Western Basin, Journal of Great Lakes Research 2013.
- Ali, K.A., Witter, D.L., and **J.D. Ortiz**, Application of empirical and semi-analytical algorithms to MERIS data for estimating chlorophyll a in Case waters of Lake Erie, Environmental Earth Sciences; DOI 10.1007/s12665-013-2814-0, published Oct 1, 2013.
- Ali, K.A., Witter, D.L., and **J.D. Ortiz**, 2012, Multivariate approach to estimate color producing agents in Case 2 waters using first-derivative spectrophotometer data, Geocarto International, Early online release: 10/30/2012 DOI:10.1080/10106049.2012.743601.
- Witter, D., **Ortiz, J.D.**, Palm, S. Heath, R., Budd, J., Assessing the Application of SeaWiFS Ocean Color Algorithms to Lake Erie, Journal of Great Lakes Research, 35, 361-370, 2009.

ASSESSING CHABS IN LOWER GREEN BAY (AREA OF CONCERN)

Donalea Dinsmore
Great Lakes Beach & QA Coordinator
Wisconsin DNR
Office of the Great Lakes



Assessing CHABS in Lower Green Bay

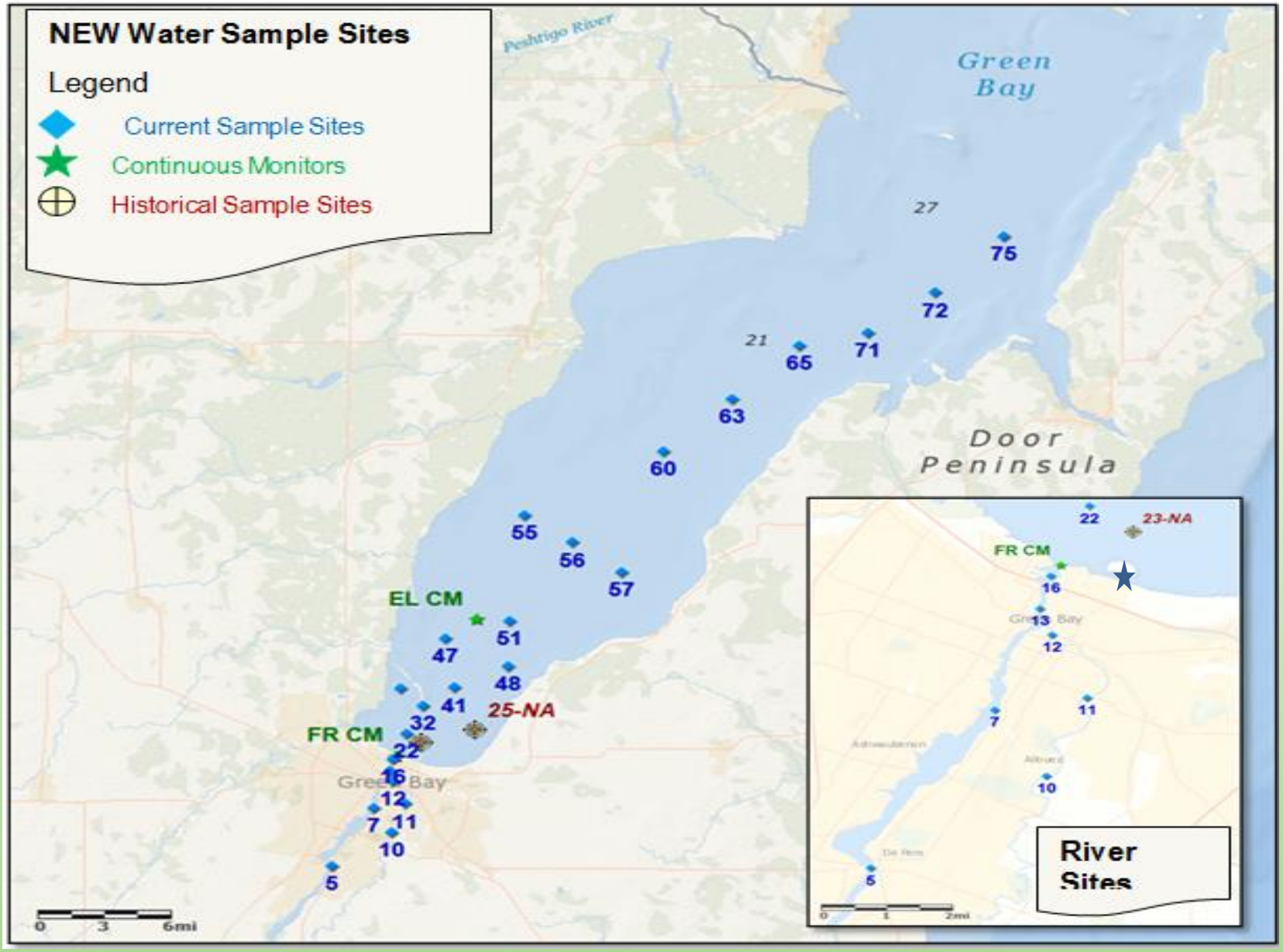
- AOC project through beach program lens
- Boundaries of AOC extend to Long Tail Point
- GLRI funding through EPA
- Collaboration - DNR, UW-Milwaukee (Todd Miller +), NEW Water (Erin Wilcox), NOAA (Tim Davis +), USGS (Mary Ann Evans +)
- Three Year Project (2016 – 2018)

Background

- Lower Green Bay in an AOC - Several impairments are linked to algae including Beach Closings – little data
- Community leaders began process to restore swimming at Bay Beach
- ***How do we manage recreational risk?***
- Donna Francy at USGS used Virtual Beach and NOAA's Lake Erie data to estimate microcystin concentrations http://authors.elsevier.com/a/1TVmA5aloFF-SC
- Many projects in Green Bay – overlapping needs
- Advisory Group

Objectives

- Extent, severity, toxicity, trends – intensify during peak periods (usually July – September)
- Develop data set to support modeling tools
  - Implemented locally – Virtual Beach (recreation risk)
  - Time scale appropriate for beach use
- Inform status of BUIs – baseline or removal
- Provide rich data set to support compatible research – share data to avoid duplication
- Comparison with Lake Erie
- Transferable methods (Lake Winnebago)


NEW Water Sample Sites
Legend
Current Sample Sites
Continuous Monitors
Historical Sample Sites
Peshtigo River
Green Bay
Door Peninsula
27
21
75
72
71
65
63
60
55
56
57
EL CM
51
47
48
41
25-NA
FR CM
32
22
16
12
7
11
10
5
0 3 6mi
22
23-NA
FR CM
16
13
12
11
7
10
5
River Sites
0 1 2mi

Basic Sampling Plan

- Weekly Sampling at 4 New Water sites May - September
- 2 Nearshore sites 2-3 times/week
  - Soft algae, toxins, phycocyanin, chlorophyll a , nutrients
  - Genetic markers
- Buoys – mouth of river, Long Tail Point, nearshore@ Bay Beach
  - YSI EXO 2 sonde - DO, pH, conductance, temperature, and turbidity sensors;
  - Turner Cylcops 7 fluorimeters for chlorophyll and phycocyanin
  - Wind monitor
  - Photosynthetically Active Radiation (PAR) – one buoy

HABs Collaboratory

- What HAB questions still need to be answered?
  - How do we manage recreational risk to swimmers?
  - Optimal monitoring plans – multiple needs
  - Are predictive tools like Virtual Beach transferrable?
  - Dynamics of toxin production
- How can collaboration help?
  - Equipment pool – ADCP, buoys, cycling P
  - Shared data on select sites to develop rich data set
  - Decision-maker & OTG Management toolbox

HABs Blooms Monitoring & Forecasting

In partnership with:

Coming up next:

HABs Blooms Sources & Toxicity

Tuesday, August 16 2016, 11 am - 12 pm (EDT)

https://attendee.gotowebinar.com/register/1547742298938032 67

HABs: Educate & Engage

Thursday, September 1, 1-2 pm (EDT)

https://attendee.gotowebinar.com/register/5120501893285023236

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/

Great Lakes HABs Collaboratory

NOAA

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