# HABs State of the Science webinar series: HABs Blooms Sources & Toxicity

**Speakers:**

Laura Johnson – Heidelberg University

Fasong Yuan, Cleveland State University

Audrey Sawyer – Ohio State University

Kevin Czakowski – University of Toledo

Greg Boyer – State University of New York

Tim Davis – NOAA Great Lakes Environmental Research Laboratory

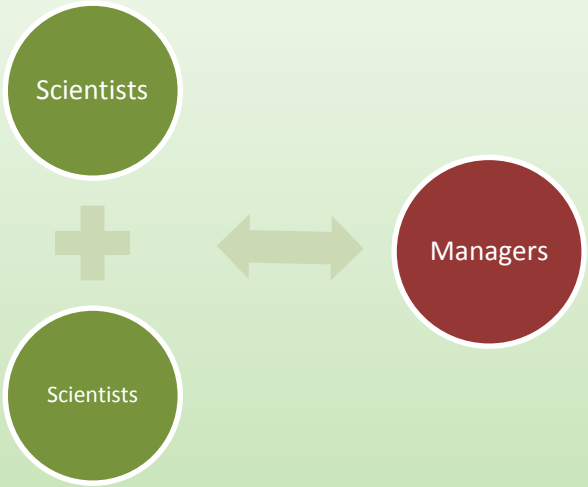
Arthur Zastepa – Environment and Climate Change Canada

In partnership with:

August 16, 2016

# 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

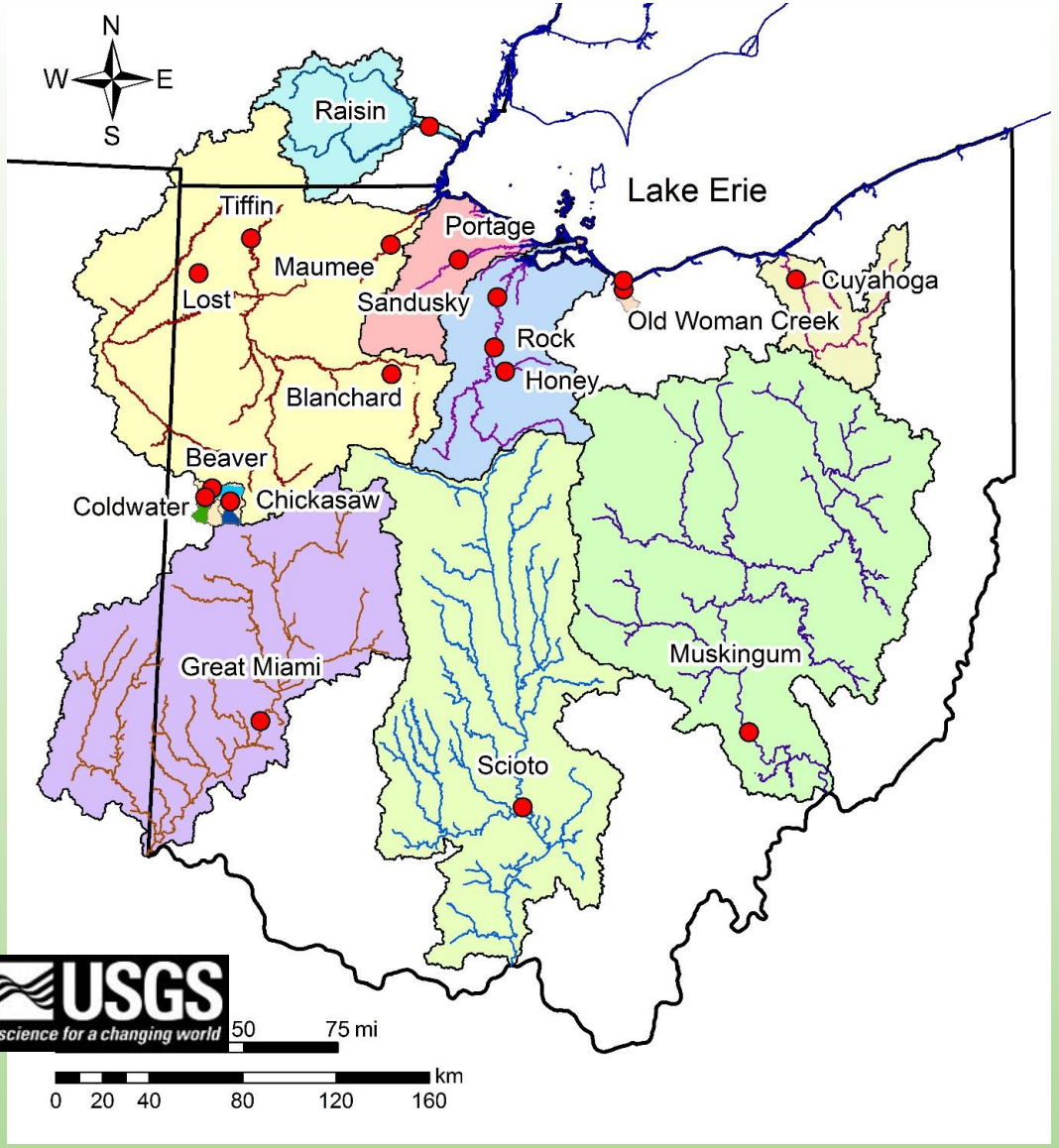
- Managing 55 HABS related projects (~$7,000,000)
  - 18 funded by Ohio Sea Grant
  - 5 funded by OSU's Field 2 Faucet initiative
  - 32 funded under the Ohio Department of Higher Education (OSU/UT; 18 vs. 14)
- **9/15/16 "State of Science" meeting in Toledo**
  - **Stranahan Theater**
  - **Modeling, BMPs, and Public Health-Water treatment**
  - **https://ohioseagrant.osu.edu/news/calendar/2016/09/15/o47km/understanding-algal-blooms**

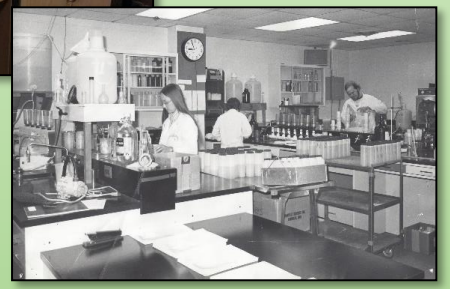
# THE HEIDELBERG TRIBUTARY LOADING PROGRAM: TRENDS FROM THE MAUMEE RIVER

Laura Johnson – National Center for Water Quality Research at Heidelberg University

National Center for Water Quality Research
HEIDELBERG UNIVERSITY

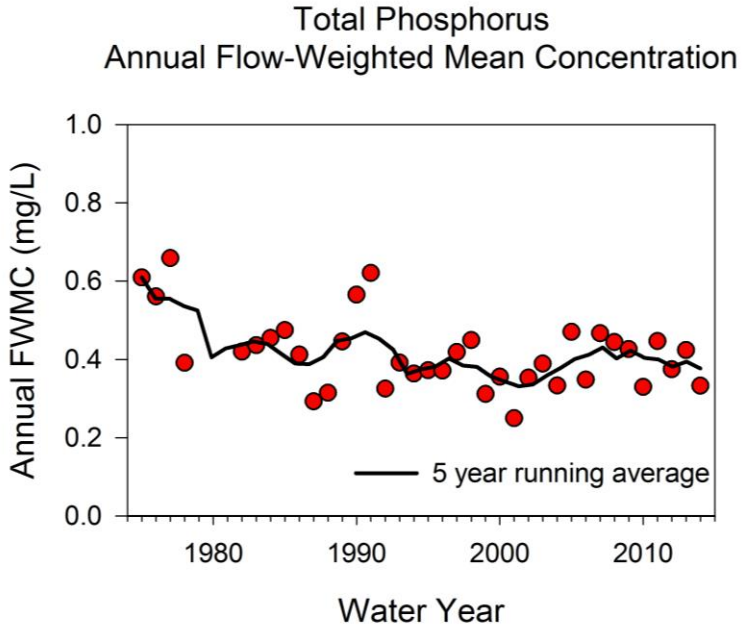
# Heidelberg Tributary Loading Program



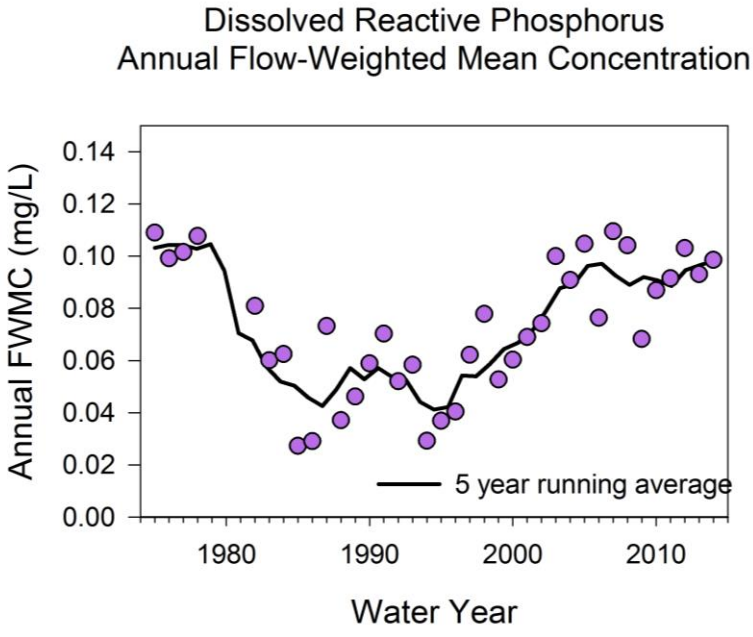



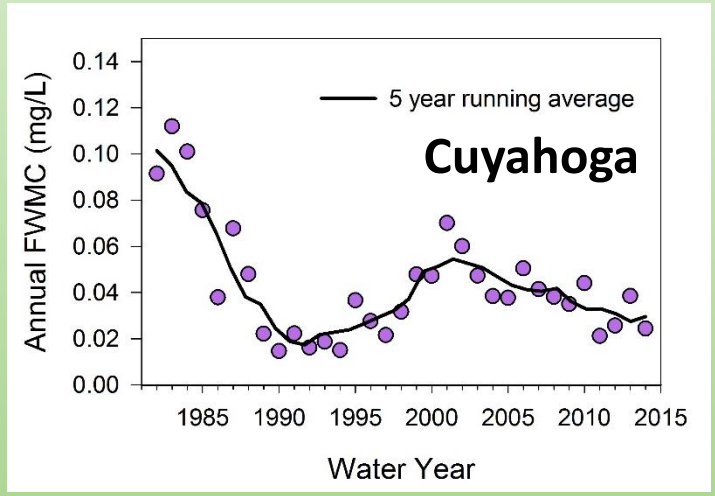
*Funding from an assortment of 12 different groups – primary funding from the State of Ohio*

# Maumee River Trends



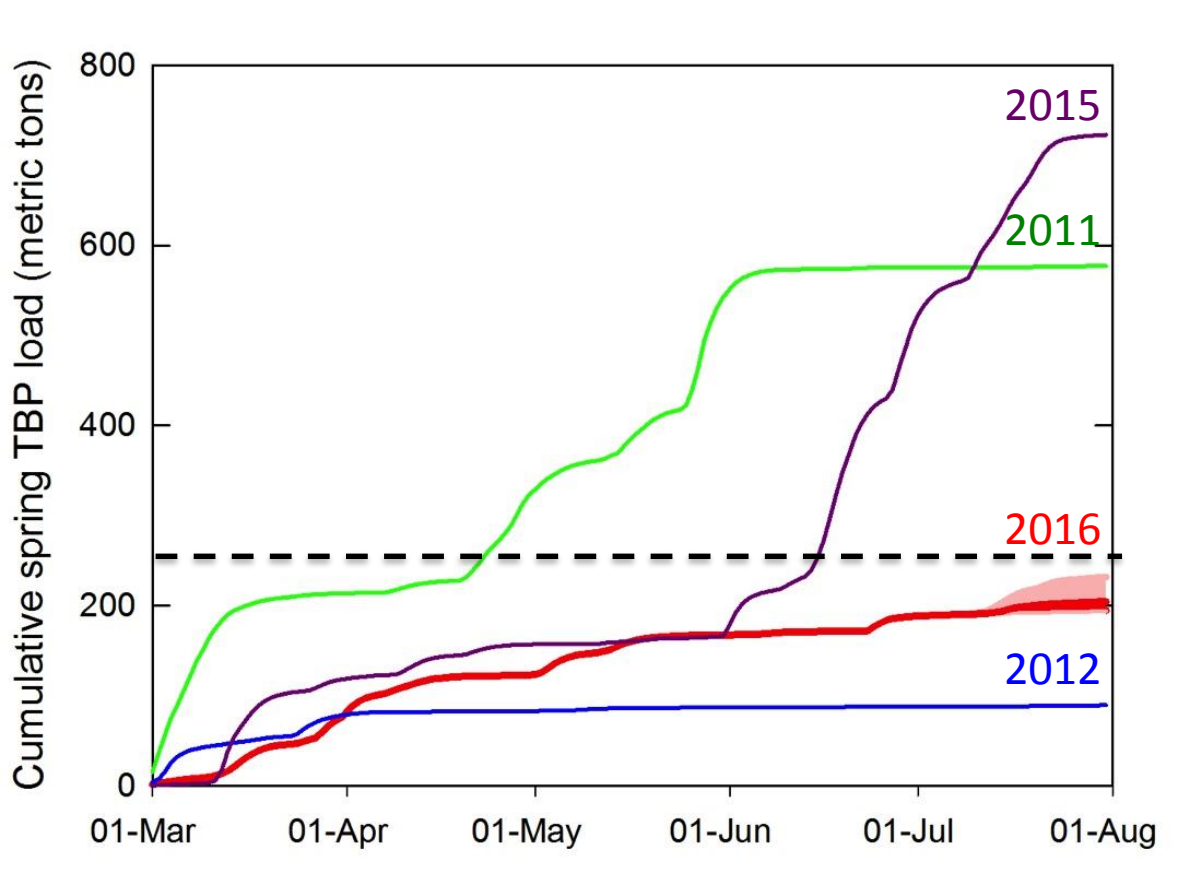

- Total P has decreased slightly over time
- Dissolved P has increased almost 2 fold since the mid-1990s



# Maumee at Waterville 2016

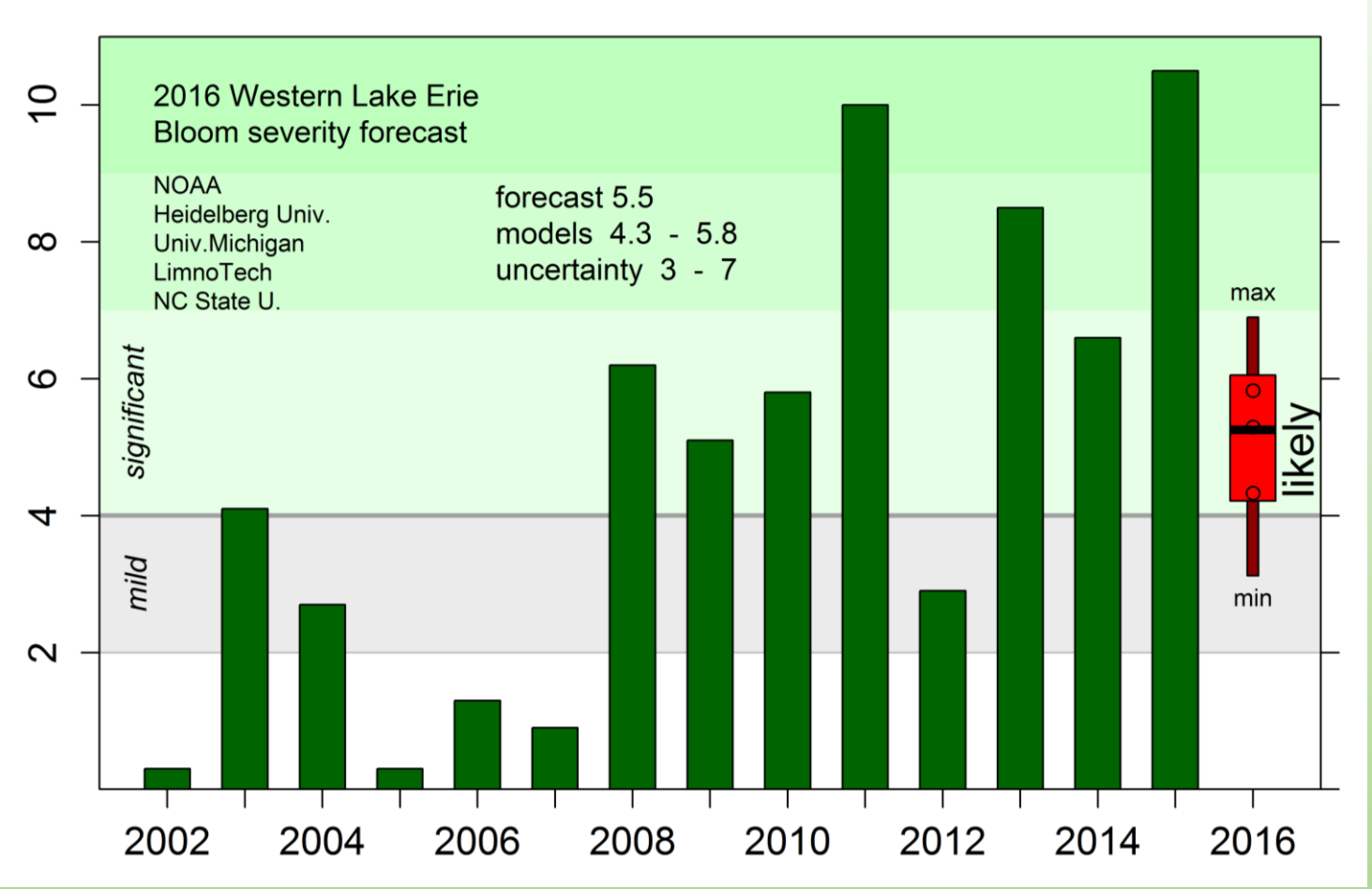
## *Total bioavailable P load • March – July*

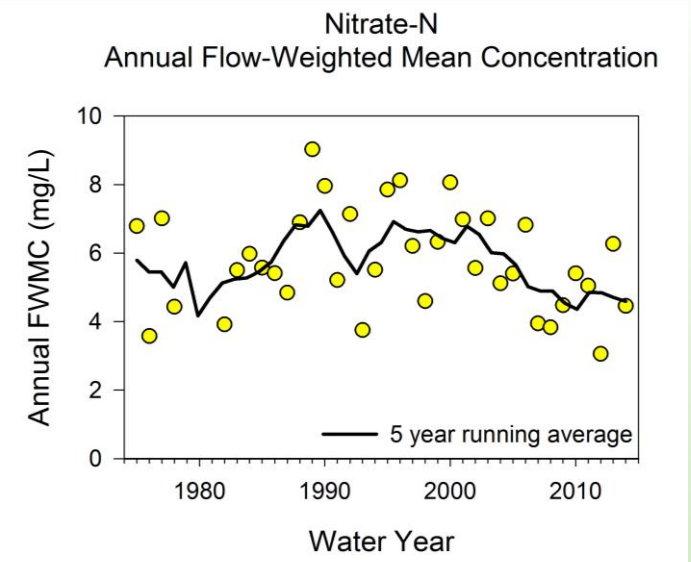


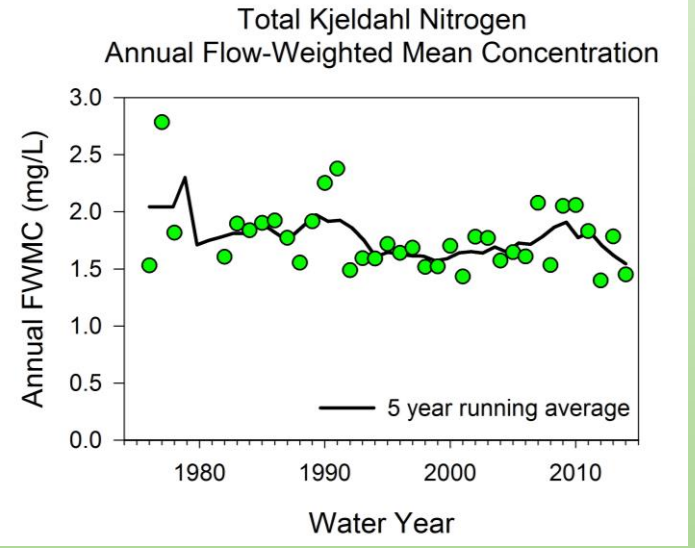

July 5 – 31 projected with NWS Ohio River Forecast Center data

Loads are below target reductions, but concentrations are not!

# Western Lake Erie Harmful Algal Bloom forecast 2016






# HABs Collaboratory

- How can we link inputs of nitrogen from tributaries to HAB dynamics?
- How will the changing ratio of N:P influence HABs?
- What happens to nutrients after entering Western Lake Erie? Especially March loads?

Sea Grant
Ohio Sea Grant College Program

# ANTHROPOGENIC PHOSPHORUS STORAGE, BIOAVAILABILITY, AND CYCLING IN THE MAUMEE BAY AND WESTERN LAKE ERIE

Fasong Yuan, PhD – Cleveland State University

Cleveland State University

Northeast Ohio Regional Sewer District

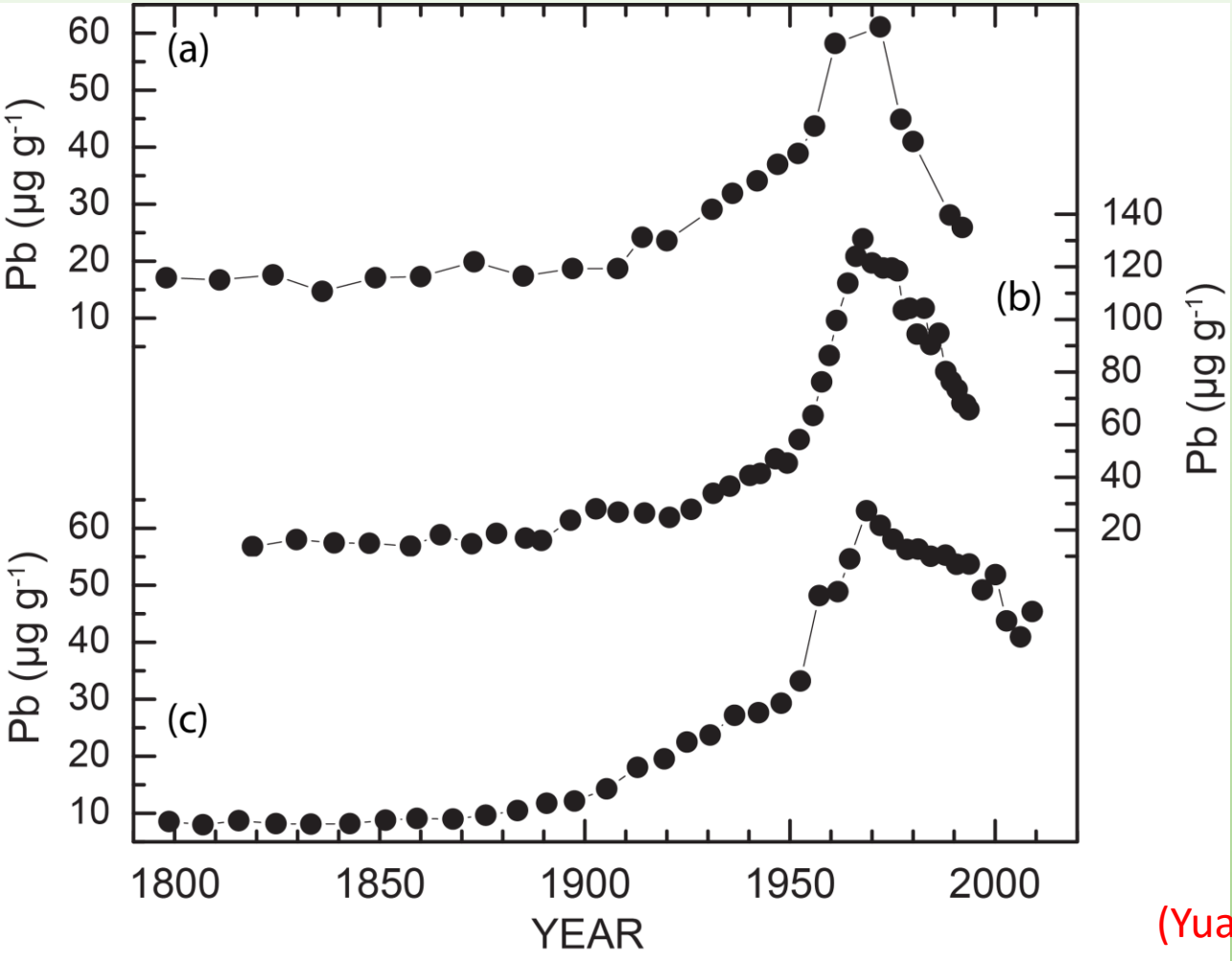
# Project Overview

- Anthropogenic P Storage, Bioavailability, and Cycling in the Maumee Bay and Western Lake Erie
- Dr. Fasong Yuan, Cleveland State University
- Funding Source: Ohio Sea Grant
- Maumee Bay & Western Lake Erie (2016-2018)
- Main Hypo: The internal P loading has changed significantly over the last century.

# Project background

- What lead you to this project?
  - My recent work on the distribution of trace metals in the sediments from the Sandusky basin
  - Influence of active in-lake biogeochemical transfer and cycling

# Sediment Pb Profiles from Eastern, Central, and Sandusky Basins of Lake Erie




(Yuan et al., 2014)

# Research Questions

- How much P has been stored there?
- Are there any sediment P depositional hotspots?
- To what extent the sediment P has been recycled?
- How bioavailable is the sediment P?
- What are the major factors that control the P storage, cycling, and bioavailability in the sediments of the western basin?

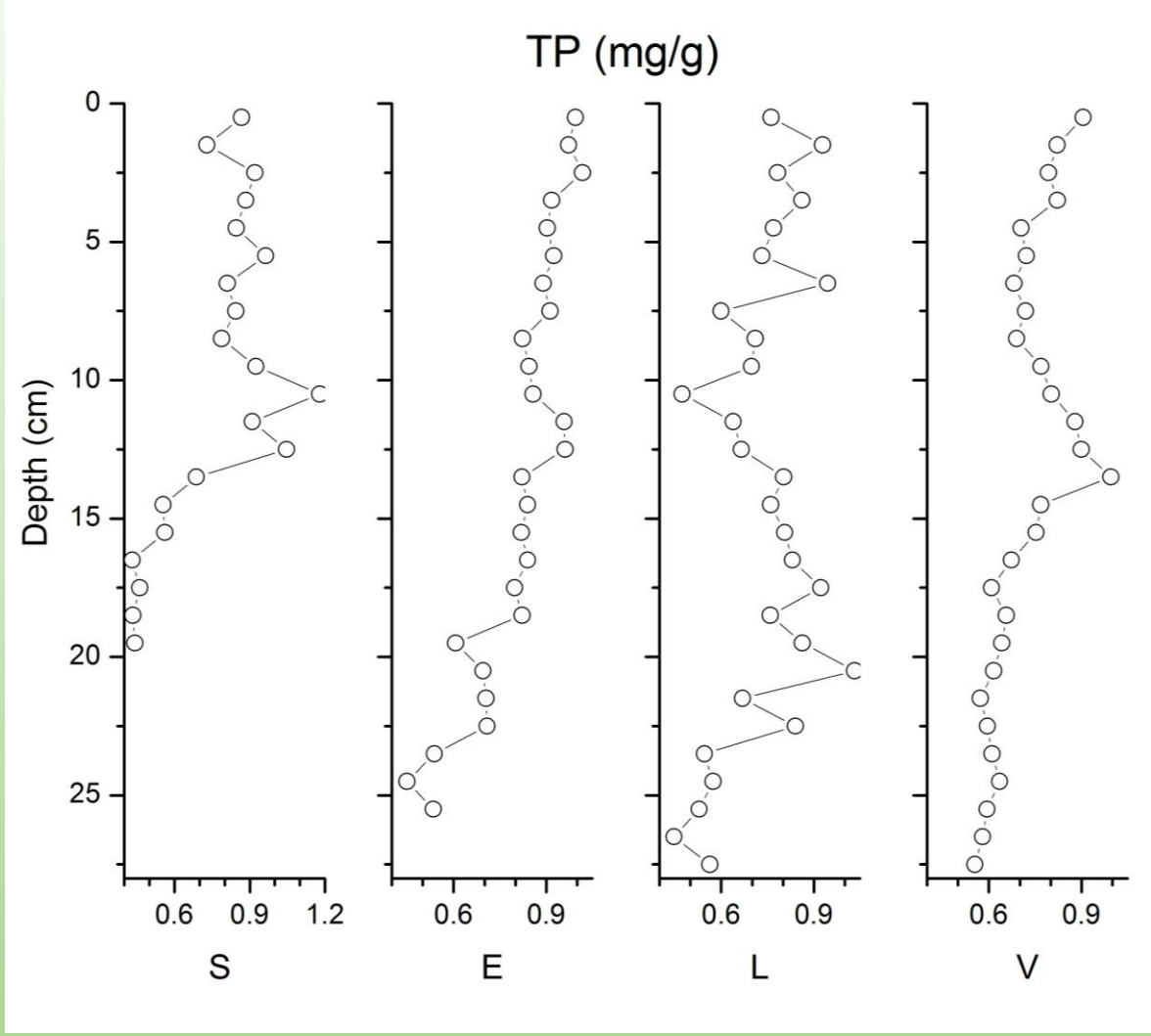
# Objectives

- To characterize the distribution of unconsolidated deposits
- To estimate the magnitude of anthropogenic P storage
- To determine the extent of P bioavailability and cycling,
- To identify the patterns of variability in P storage and cycling
- To unravel the major factors controlling the P storage and bioavailability in sediments across the Maumee Bay and western Lake Erie.

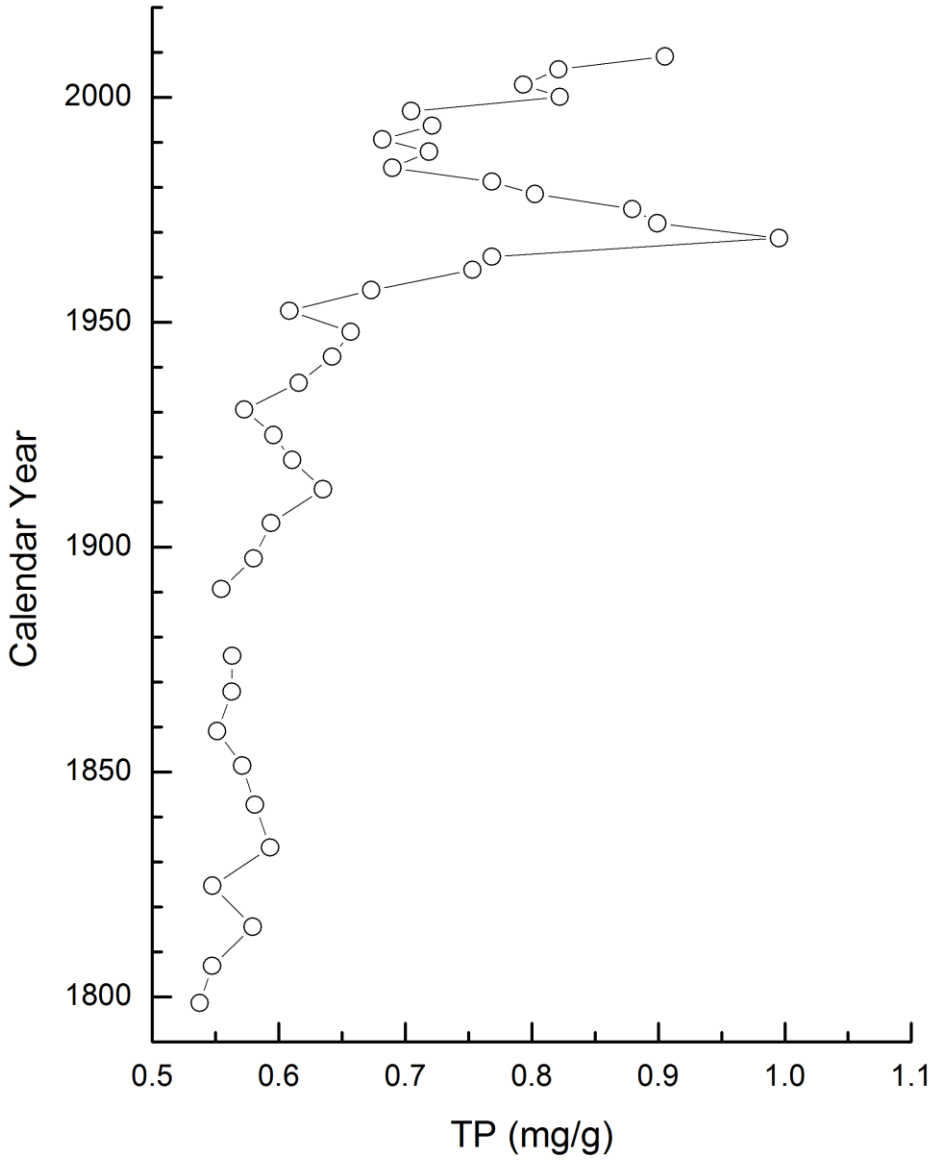
# What we have done?

- A 3-day seismic survey was carried out to obtain over 3G of seismic data from 5 transects.
- A 5-day field sampling effort was made to collect 88 samples of surficial sediments and 3 short (20-28cm long) sediment cores.
- Samples were processed for isotopic and geochemical analyses.

# Preliminary Results from the Project



# Core V-12:


Calendar Year
2000
1950
1900
1850
1800
0.5
0.6
0.7
0.8
0.9
1.0
1.1
TP (mg/g)

# HABs Collaboratory

- What questions still need to be answered about HABs?
  - How variable is the internal loading?
  - What are the major factors affecting the variability of internal loading?
- How can collaboration help your research?
  - We found the basin is spatially variable and much more work is needed in order to nail down the internal loading variability issue.


Photo: Brenda Culler/ODNR Coastal Management, 2011

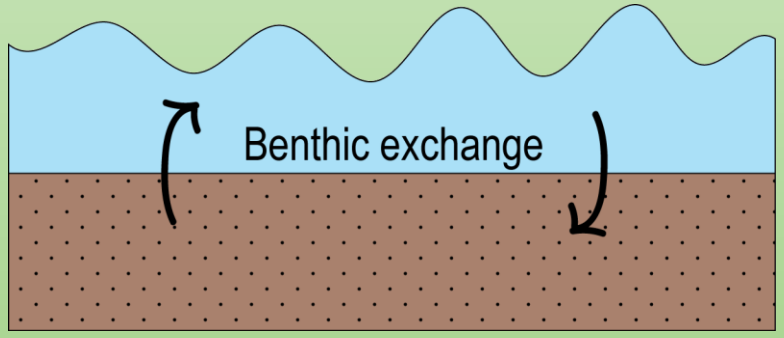
# FATE OF MICROCYSTIN IN COASTAL SEDIMENT: WAVE TANK EXPERIMENTS AND MODELS

Audrey Sawyer – The Ohio State University School of Earth Sciences
Kelsey Danner – The Ohio State University School of Earth Sciences
Megan Mave – The Ohio State University School of Earth Sciences
Jiyoung Lee – The Ohio State University College of Public Health

Sea Grant
Ohio Sea Grant College Program

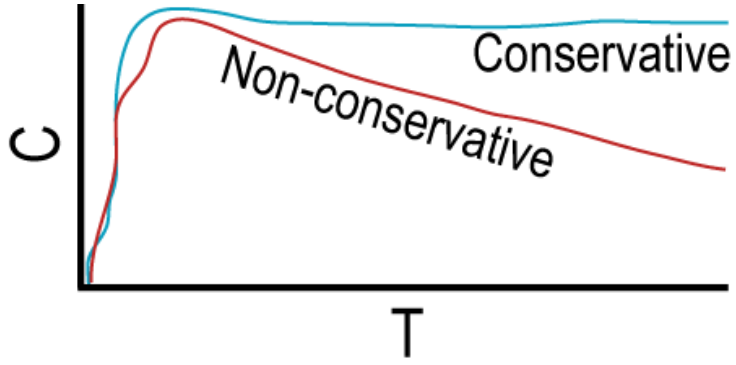
# Project Overview

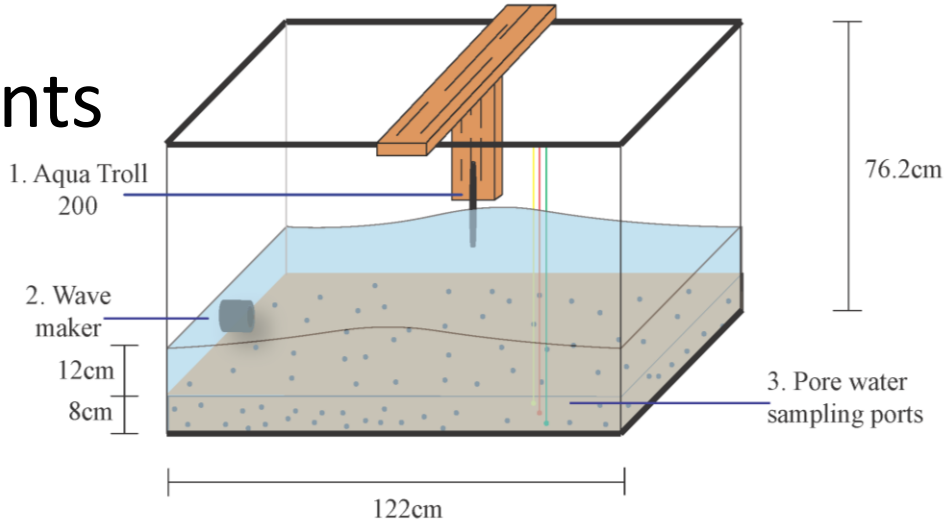
- Fate of microcystin in coastal sediment: Wave tank experiments and models
- Kelsey Danner, Megan Mave, Audrey Sawyer, Jiyoung Lee (The Ohio State University)
- Ohio Sea Grant Small Grant
- OSU computational hydrogeology lab (2015-2016)
- Hypothesis: Sediment-water interactions accelerate microcystin removal



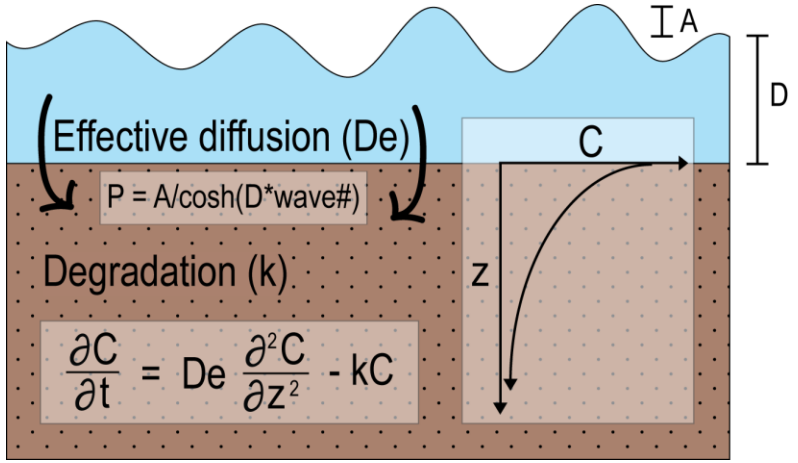
# Approach

- Wave tank experiments



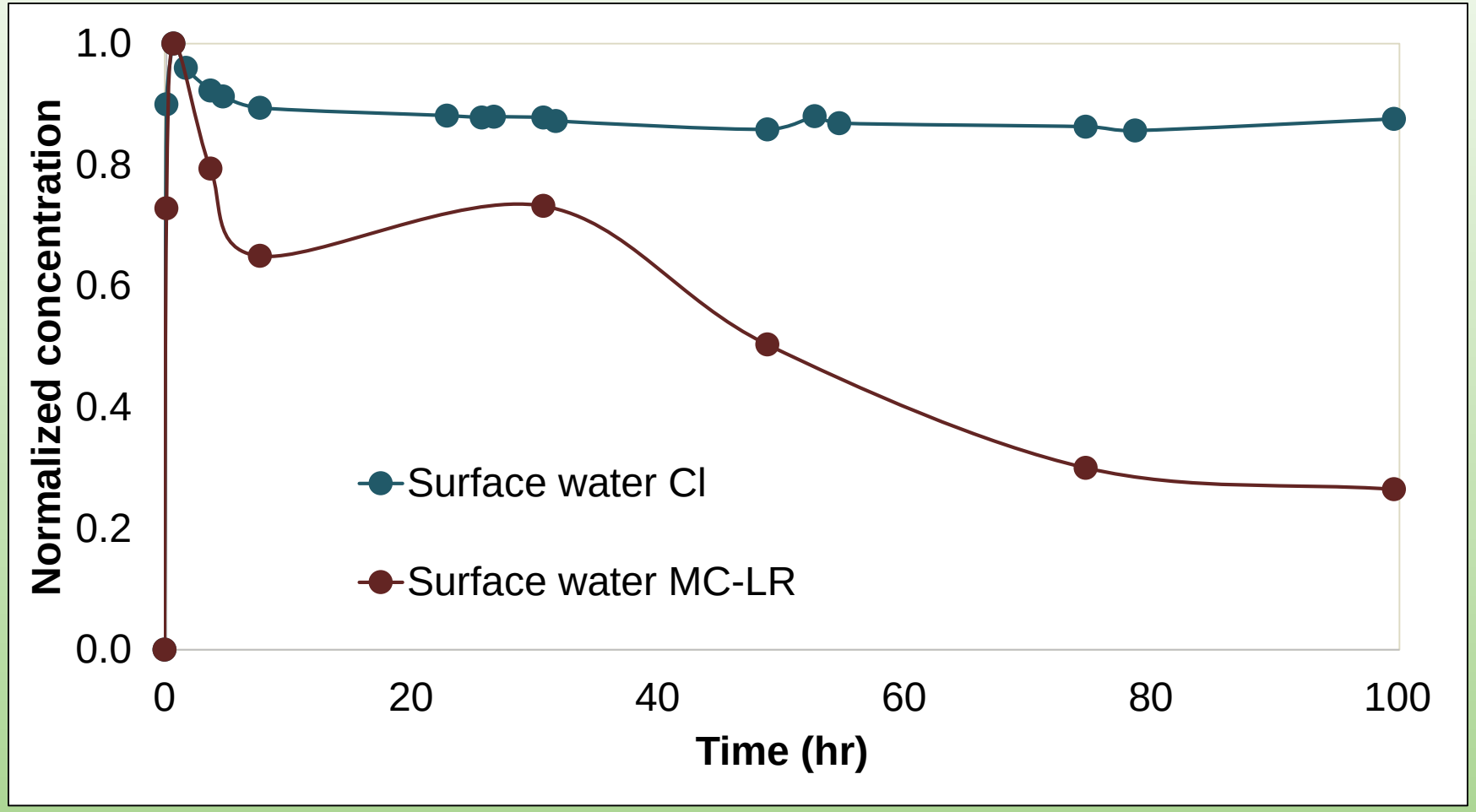




- 1D reactive transport models



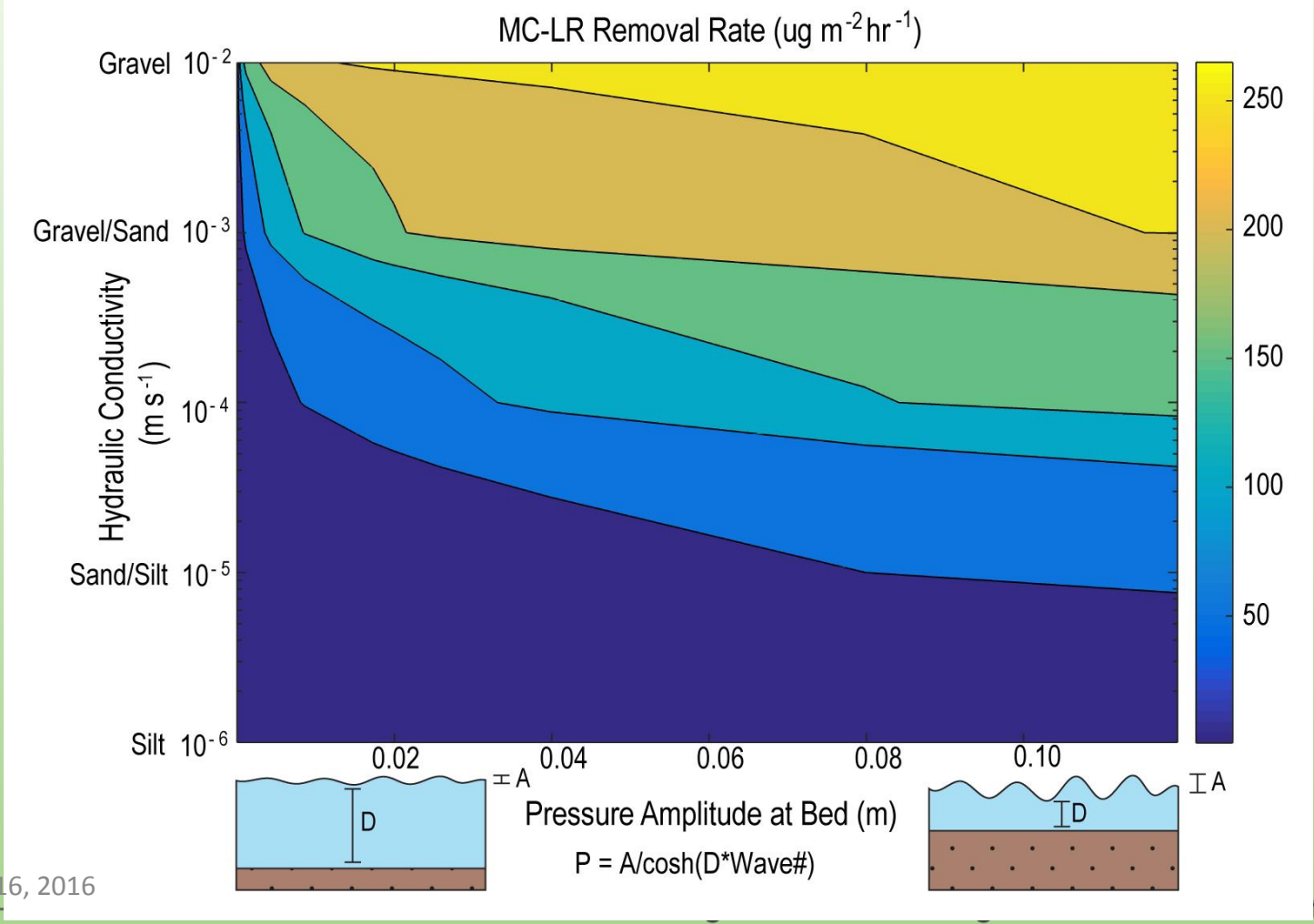
# Summary of Findings

- Lessons: Microcystin rapidly attenuated with waves and sediment.



# Summary of Findings

- Lessons: More removal with more waves, shallower water, and higher permeability.



# Summary of Findings

- Lessons: Benthic exchange can remove significant amounts of microcystin in shallow, high-energy coastal zones; permeability is one of the most important factors.
- Unexpected: anomalous loss of microcystin in trials without sediment?
- Conclusions for water quality managers: simple 1D models do a pretty good job predicting removal rates.

# HABs Collaboratory

- How important are sediment-water interactions in the water column?
- Role of sediment-water interactions in life cycle of microcystis?
- Collaboration opportunities: field monitoring

# AGRICULTURAL PRACTICES FROM REMOTE SENSING

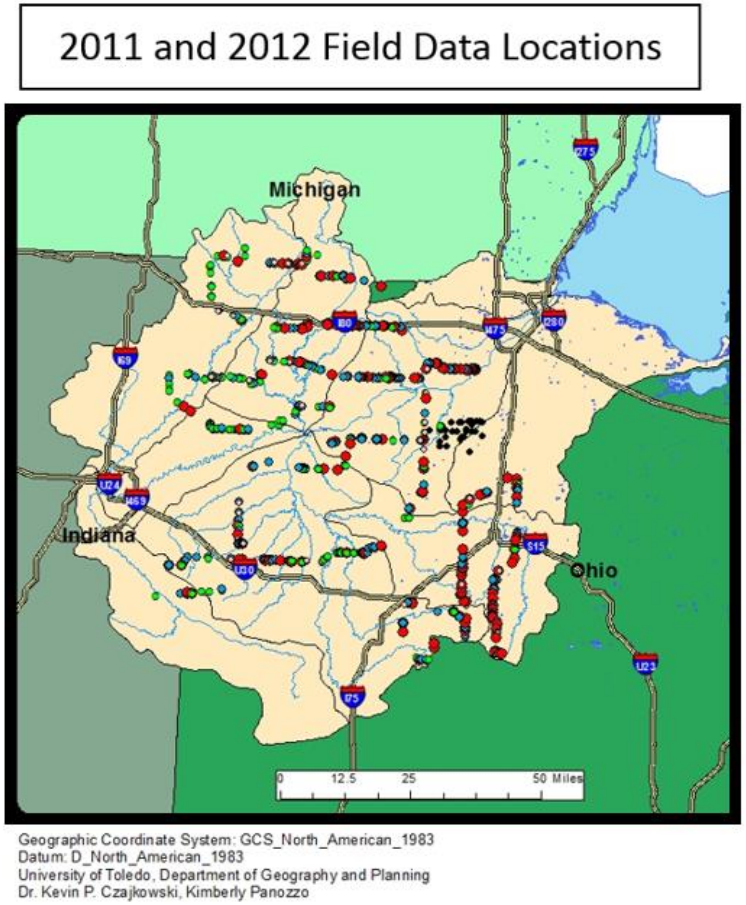
Kevin Czajkowski– Department of Geography and Planning
University of Toledo

# Project Overview

- Agricultural Practices from Remote Sensing
- Kevin Czajkowski[1], Patrick Lawrence[1], April Ames[2], Kimberly Panozzo[1] and many other students
  - [1]Department of Geography and Planning
  - [2]Department of Public Health and Preventative Medicine
- Funding Source: USDA and Ohio Sea Grant
- Project Location: Maumee River Watershed
- Study years: 2006-2016
- Extract GIS layers of agricultural practices using remote sensing – crop type, tillage practice and tile lines

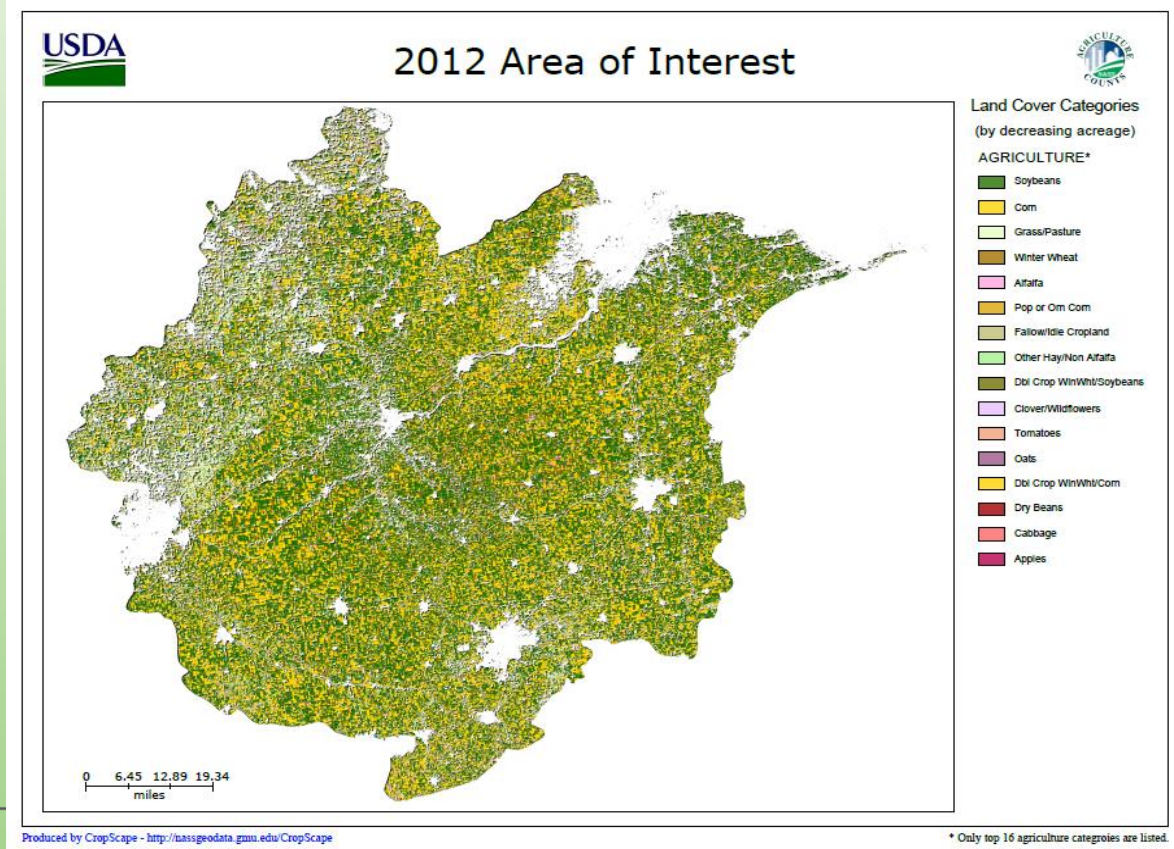
# Approach

- Collected field observations – windshield surveys of crop type/tillage practice 2006-2015
- Used Landsat imagery to map Maumee Watershed – compared to survey data
- Used aerial photographs – map tiles lines



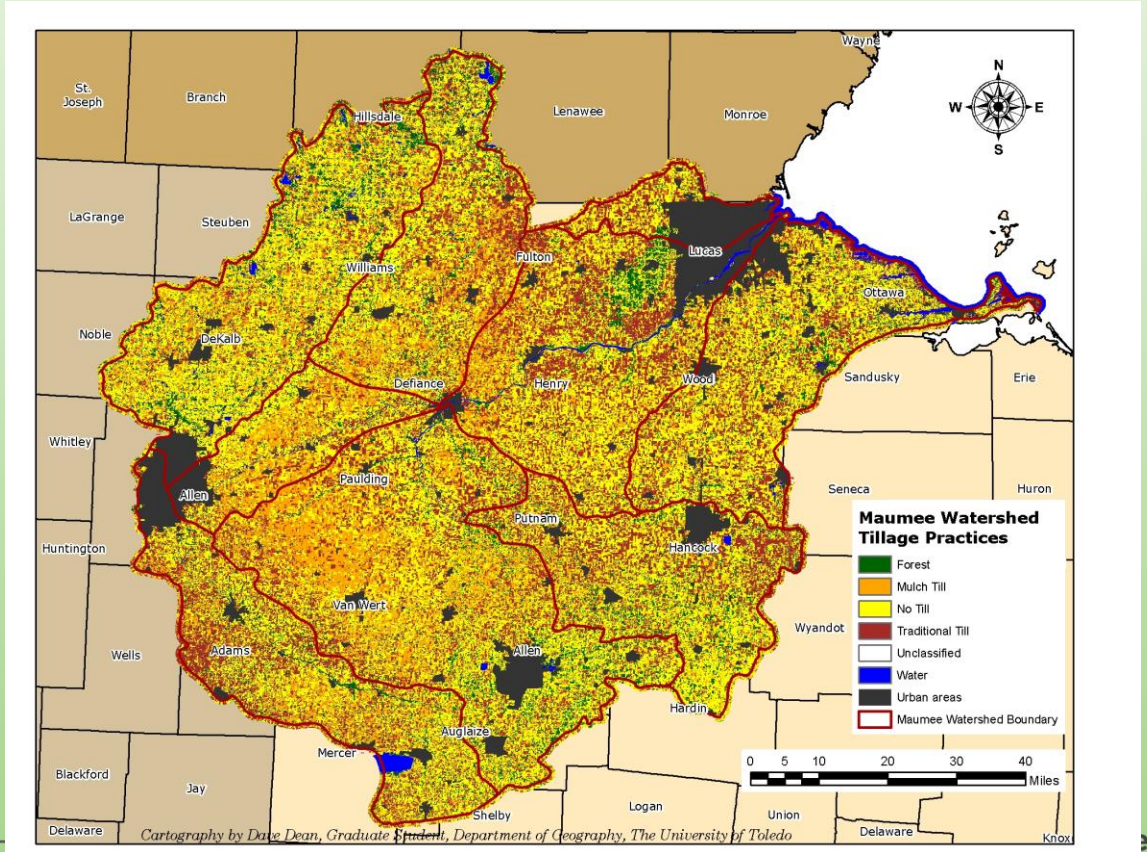
# NASS Crop Type

- Kim Panozzo found that NASS (National Agricultural Statistics Service) crop type maps are quite accurate (>90%) – can be used with watershed modeling.



# Tillage Practice

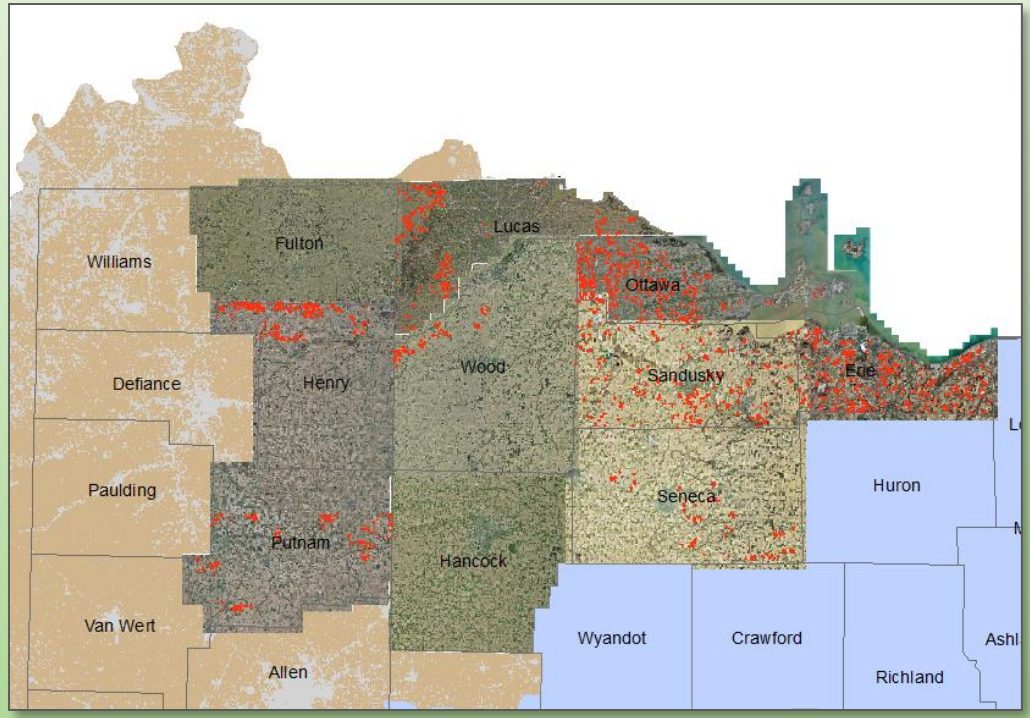
- Landsat can detect tillage practice: no till, conservation tillage, traditional tillage



# Tile Drains

- Tile drains can be mapped from aerial photographs

Fields hand digitized

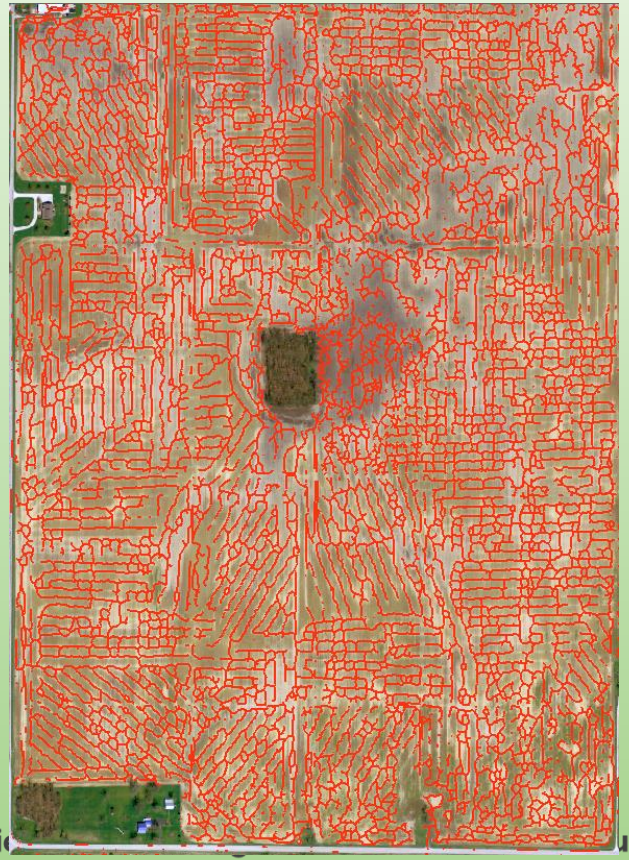


# Tile Drains

- Automated technique shows promise in capturing tile lines over large areas.

Hand Digitized

Automated Approach



# Tile Drains

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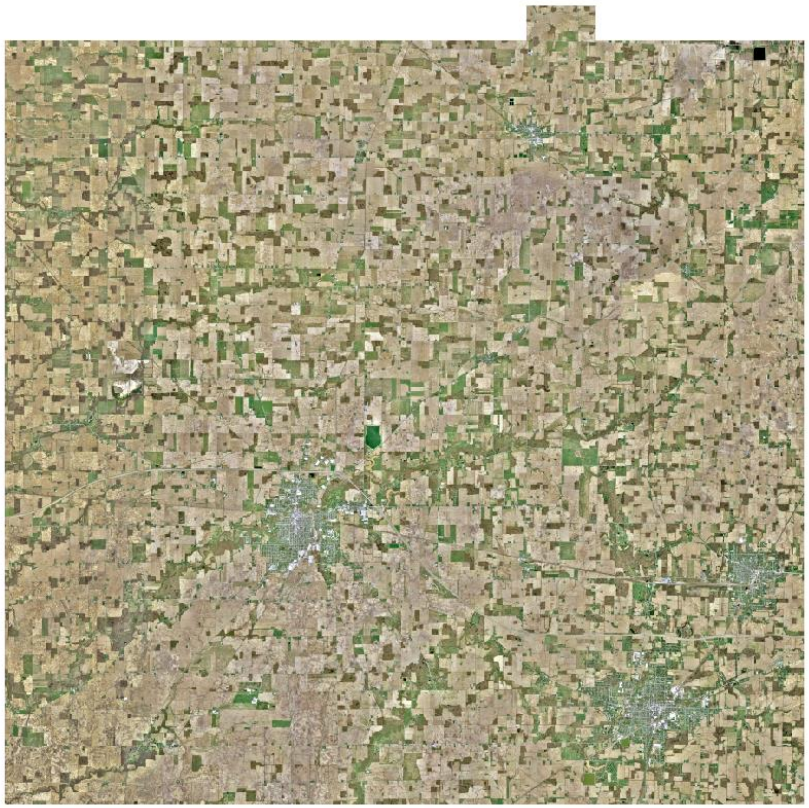
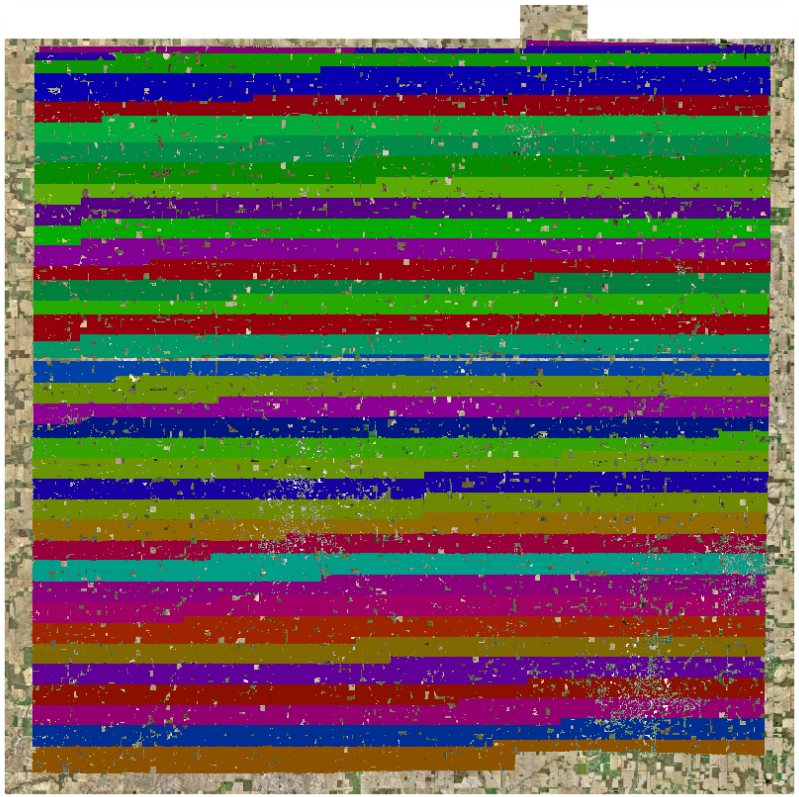


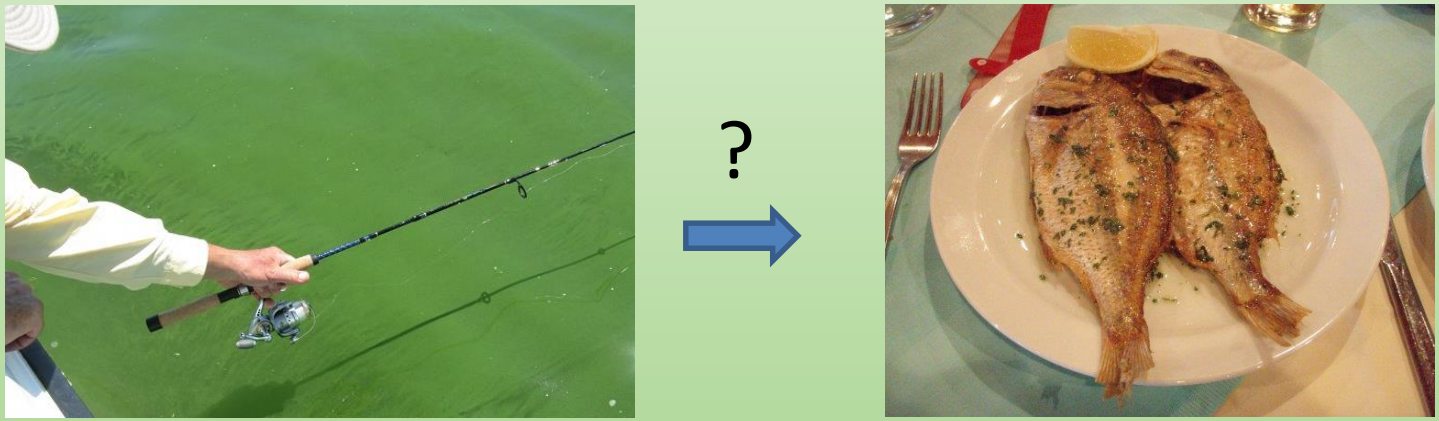


# HABs Collaboratory

- We would like to collaborate with modelers to utilize our land cover information.
- Need funding to continue 10+ year data set of tillage practice in the Maumee watershed through field and remote sensing work.

# METABOLISM OF MICROCYSTINS IN FISH

Gregory Boyer – Department of Chemistry. State University of New York
College of Environmental Science and Forestry. Syracuse NY 13210




Graphical Abstract

# Project Overview

## Metabolism of Microcystins in Fish

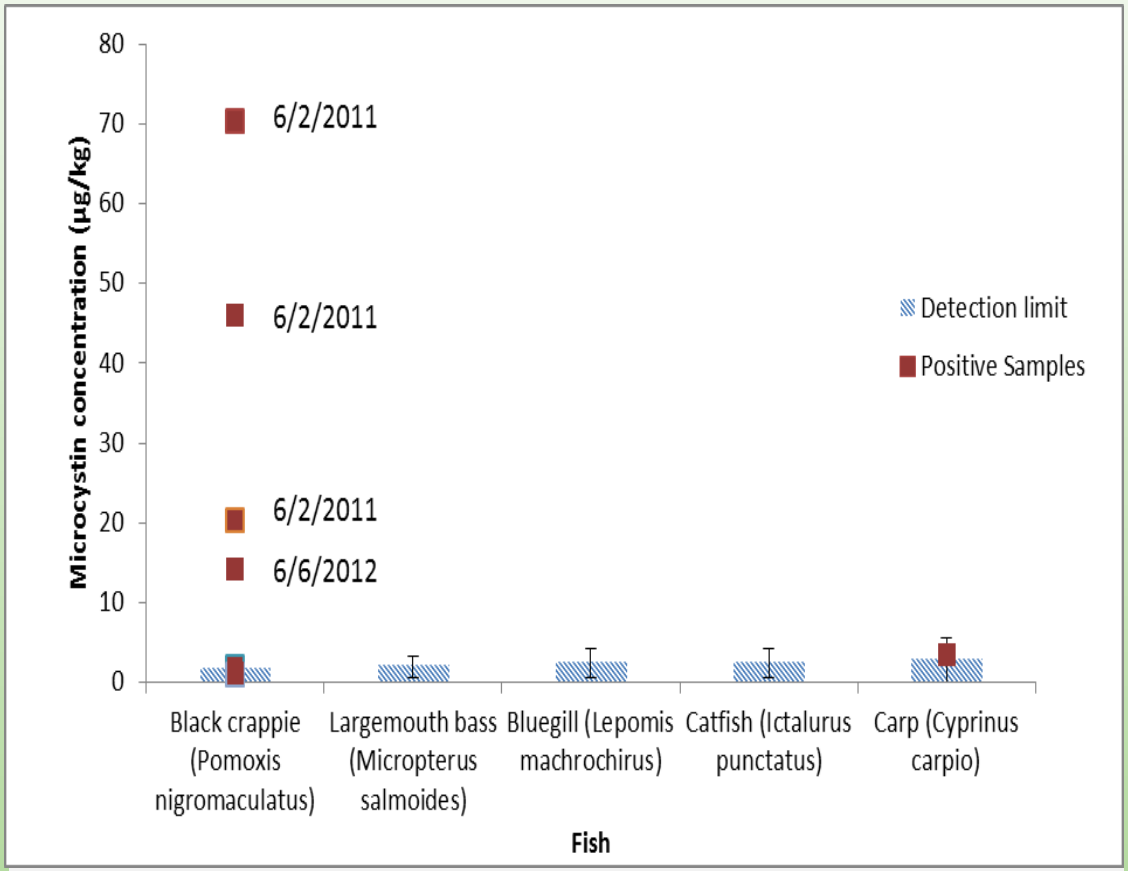
- Greg Boyer (SUNY-Environmental Science and Forestry, Syracuse)
  - Kristen Slodysko (MS student)

- Unfunded project with assistance from Lake Champlain Basin Program, Ohio EPA and NYS DEC.
- Currently have fish from Grand Lake St Mary's & Lake Champlain, I want to expand to include Lake Erie.
- **Simple Question: If a fish lives in bloom-infested waters – Is it safe to eat?**

# Approach

- Collect fish from bloom-infested waters.
- Analyze the tissues and livers for microcystins/metabolites using LC-MS/MS.
  - ELISA overestimate “free toxins” in fish tissues
  - 80% Methanol extraction protocol (no SPE)
  - Synthesize the “known” GSH-pathway metabolites
  - Optimize the MMPB method for protein-bound MC
- Ideally would have water-column toxicity data.

# Summary of Findings




| # Fish: | 7(69) | 0(15) | 0(15) | 0(15) | 1(15) |
|---|---|---|---|---|---|

Grand Lake St Marys

- 129 Fish
- 8 positive (7%):
- 2 unconfirmed:
- MDL: 0.1 ug/kg

100x range in toxicity within a given body of water. Has Important considerations for health advisories.

(Schmidt et al, 2013 Toxins 5:992-1009;

# HABs Collaboratory

- BIG QUESTION: What is the human health risk from eating fish.
  - How fast do fish remove the toxins?
  - Do we have to worry about toxicity of metabolites?

- WE NEED FISH! (actually fish tissues and livers – no whole fish please!)
  - Fish collected from sites of active blooms.
  - Supporting water chemistry/ toxicology data.
    - We can analyze your samples.

- We can talk about how to use data and other species (aka clams) involved in food-web transfer.

# DEVELOPING A MICROCYSTIN ELISA FOR USE ON AN ENVIRONMENTAL SAMPLE PROCESSOR IN WESTERN LAKE ERIE

Timothy Davis – NOAA Great Lakes Environmental Research Laboratory

# Project Overview

**Greg Doucette, Tina Mikulski**– NOAA-NCCOS

**Tom Johengen, Alicia Ritzenthaler**– University of Michigan/CILER

**Don Anderson, Mindy Richlen**– Woods Hole Oceanographic Institution

**Chris Scholin, Jim Birch, Roman Marin, Brent Roman**- Monterey Bay Aquarium Research Institute

**John Mickett** – University of Washington

**Justin Chaffin** – OSU Stone Lab

**Funding:** EPA-Great Lakes Restoration Initiative, NOAA

**Location funding years:** Western Lake Erie, 2014 – present

**Research hypothesis:** Finer-scale resolution of microcystins concentrations will aid in the development of toxicity forecasting products

# Approach

- First ESP to be deployed in freshwater – three major challenges

## 1. Deployment in shallow water (western Lake Erie ~8m)

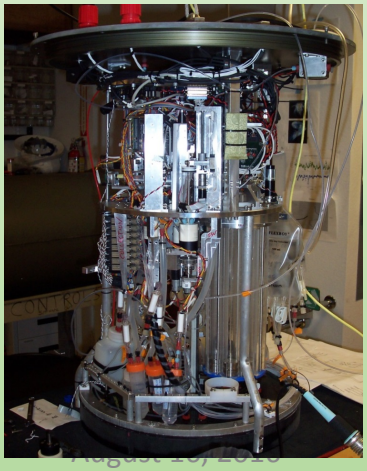
- Most other ESP deployed in much deeper water (> 25m)
- Ability to sample at surface or depth

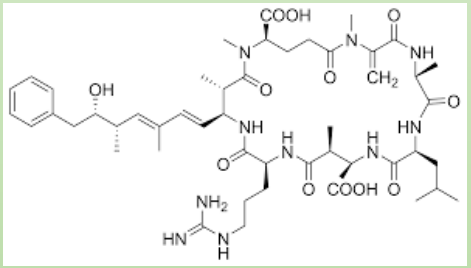
## 2. Extraction of microcystins

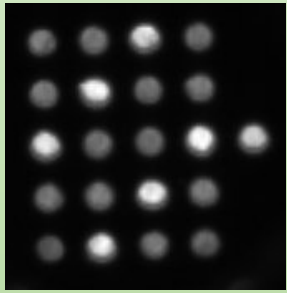
- Extraction efficiency (only can use chemicals, heat and pressure)
- Reagent stability

## 3. Assay development

- Each toxin presents unique challenges (e.g. many congeners of MCs)
- Linear range





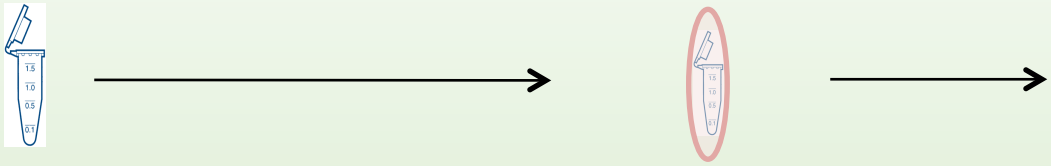



# Summary of Findings

## Methanol Extractions

Add solution with
___% MeOH and 0.01% Tween20

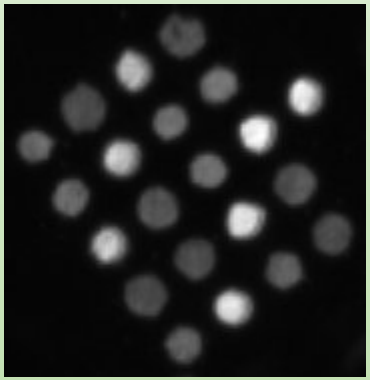
Heat for 10 minutes at 60°C



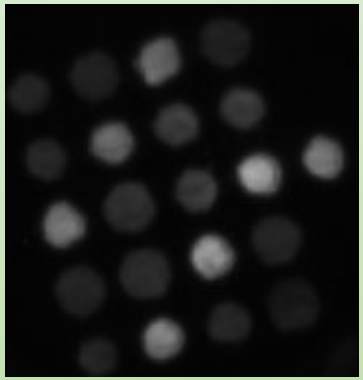
**Methanol:** 5%, 10%, 20%, 30%, 40%, 50%

**Pros:**
- Single reagent
- Low cost and stable

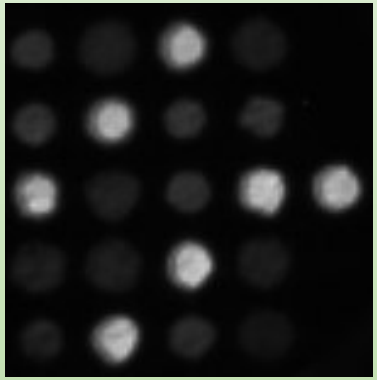
**Cons:**
- Low extraction efficiency
- Replication on ESP



0.2 ng/mL MCLR



2.0 ng/mL MCLR



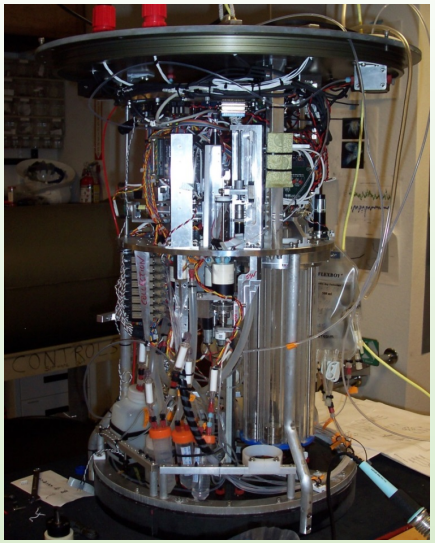
20.0 ng/mL MCLR

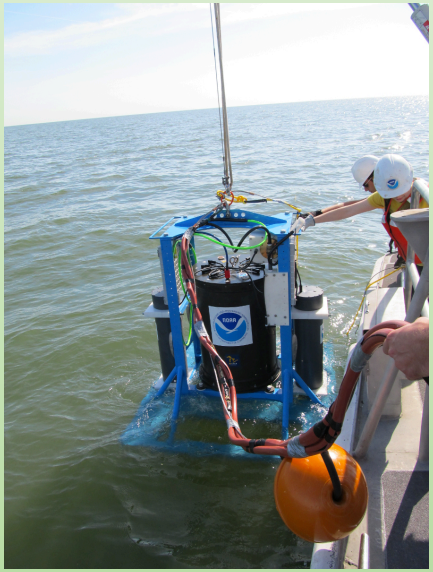
200.0 ng/mL MCLR

- Compatible with extraction solvent
- Good range of detection and intensity on benchtop "mimic"

# HABs Collaboratory

- How frequently do other toxins that have been previously measured appear in Lake Erie and who is producing them?
- Developing a multiplex STX,CYN,MC ELISA for ESP





# EFFECTS OF NUTRIENTS ON MICROCYSTIN VARIANT COMPOSITION IN LAKE ERIE AND LAKE ONTARIO SURFACE WATERS

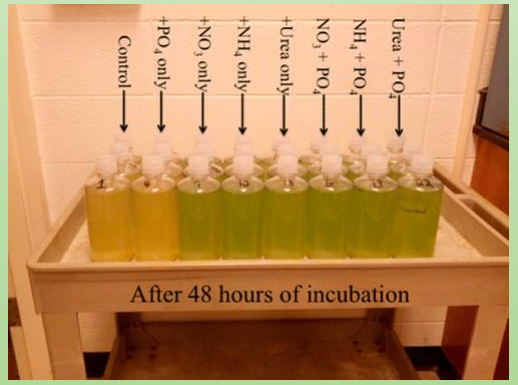
Zastepa, Arthur – Environment and Climate Change Canada, Burlington

# Project Overview

- Arthur Zastepa and Sue Watson – Environment and Climate Change Canada
  - Greg Boyer, State University of New York
  - Tim Davis, NOAA GLERL
- Funded by the Great Lakes Nutrient Initiative
- Lake Erie and Lake Ontario, 2014-2015
- Could increased N loading and rising $CO_2$ influence microcystin variant composition?

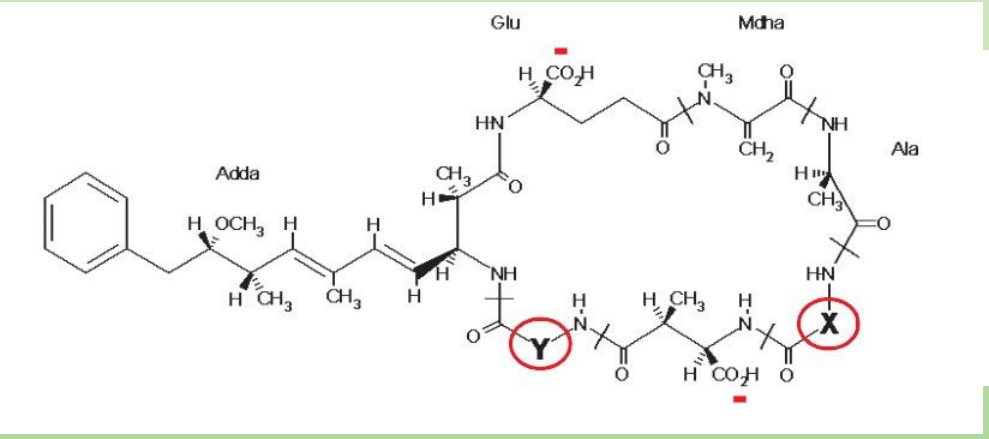
# Approach

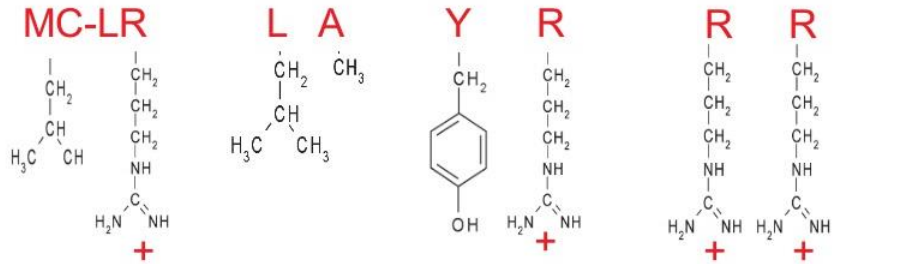
- Test spatial and temporal relationships between nutrients and microcystin variant composition
  - Spatial: *CCGS Limnos* Lake Erie and Ontario
  - Temporal: Small boats in Lake Ontario AOCs (HH, BQ), WB of LE (NOAA GLERL)
- Amendment Experiments
  - PO4, NH4, NO3, Urea, $CO_2$ additions akin to Davis et al 2015



# Summary of Findings

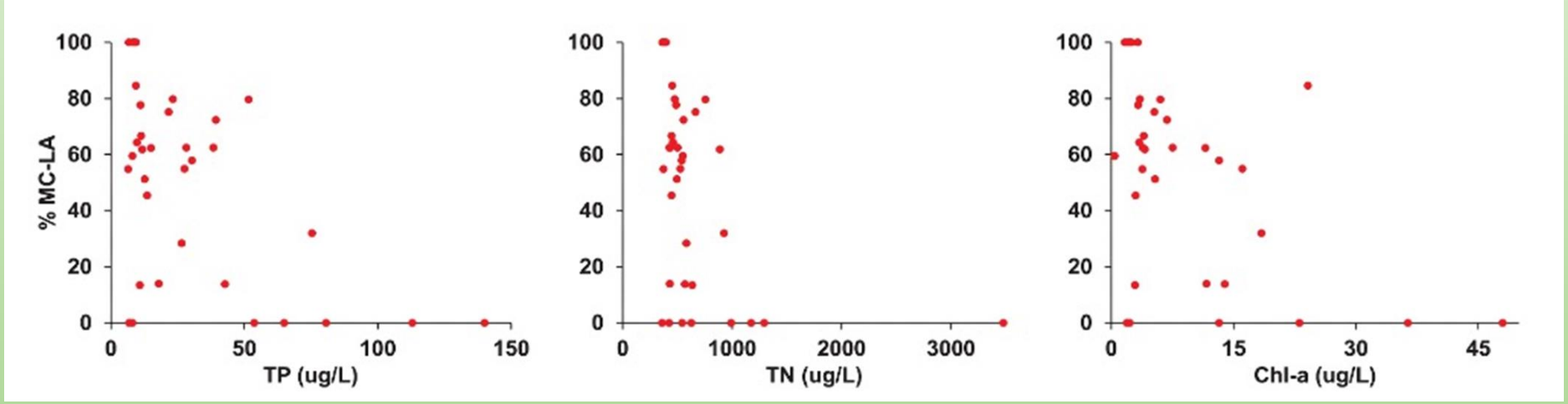
- MC-LR, -RR, and –LA dominant in both lakes but MC-LR not necessarily most prevalent
  - analytical detection methods
  - efficacy of water treatment processes



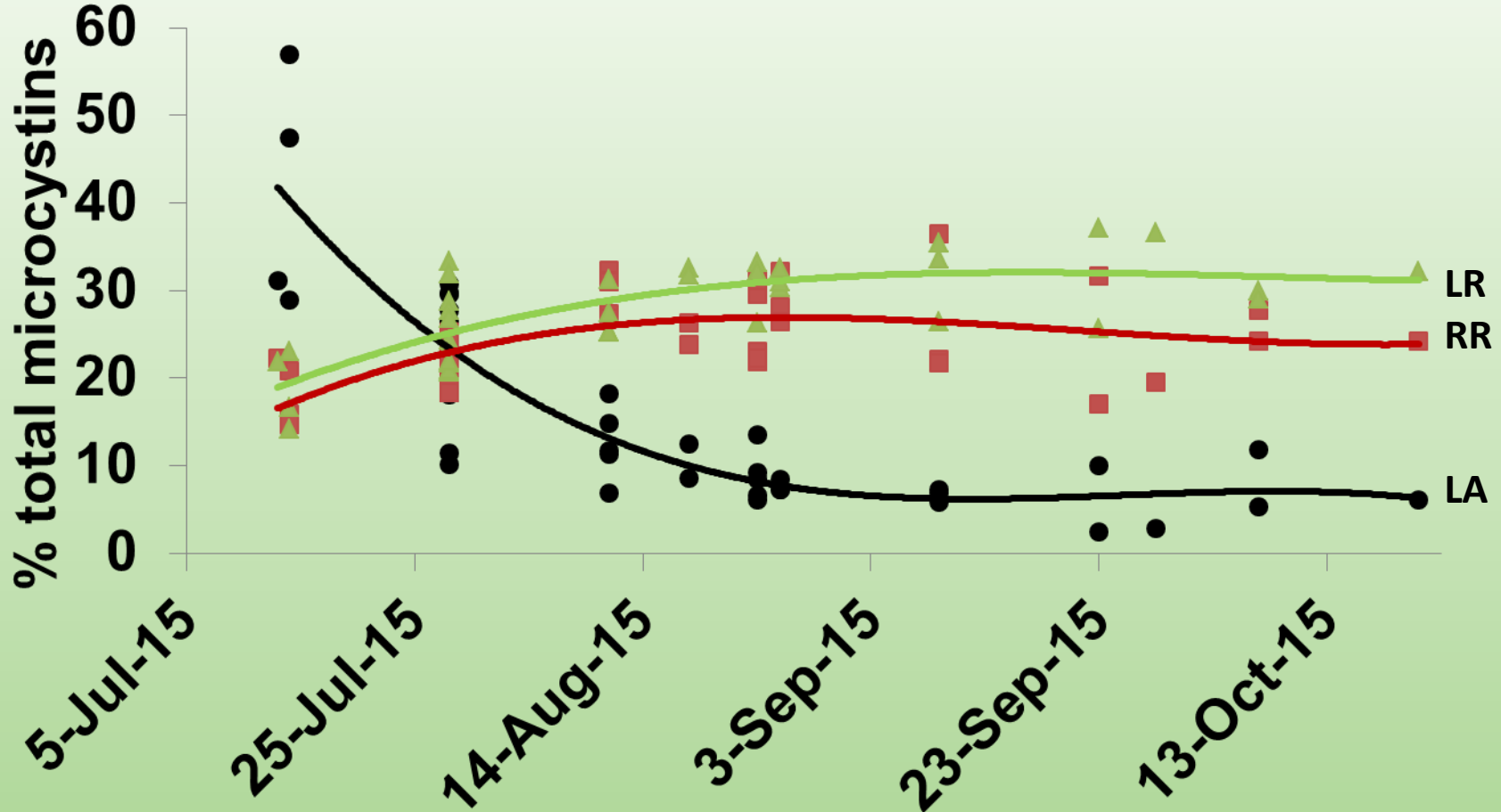



# Summary of Findings

- More toxic MC-LA dominant at lower TP, TN, chl-a, and total MC
  - MC-LR equivalents underestimate risks

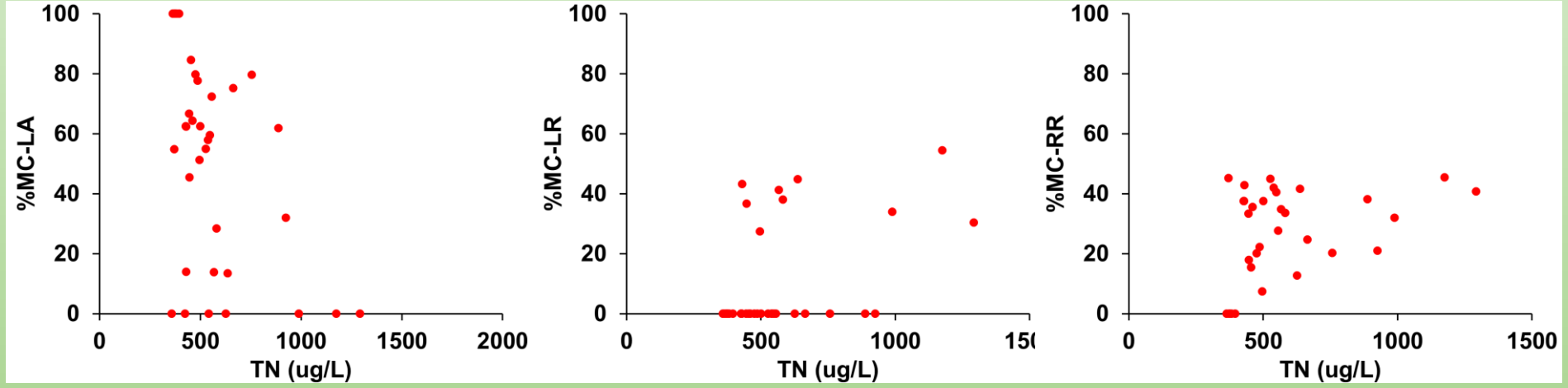


# Changes in variant composition through season



# HABs Collaboratory

- Increase in N-rich variants with increasing TN?
- What about different N-forms (NH4, NO3, Urea)?
- What about $CO_2$?



# HABs Blooms Sources & Toxicity


In partnership with:

# Coming up next:

## 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/