

River Raisin Watershed Council - 2018 Spring Semi-  
Annual Delegate Meeting

OHIO SEA GRANT AND STONE LABORATORY

# Lake Erie Algae, Nutrient Loading and Current Research Efforts

Dr. Christopher J. Winslow, Director

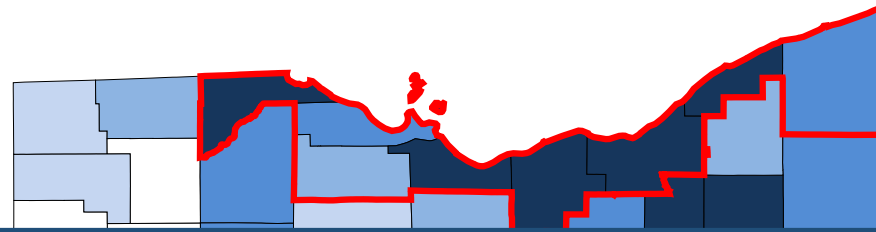
Ohio Sea Grant and Ohio State University's Stone Lab

April 26<sup>th</sup>, 2018



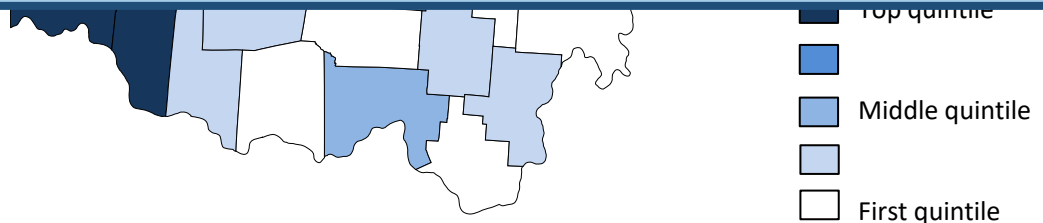
# The Economic Impact of Tourism in the Lake Erie Region of Ohio

Total Tourism Impact Lake Region	
Sales	\$14.1 billion

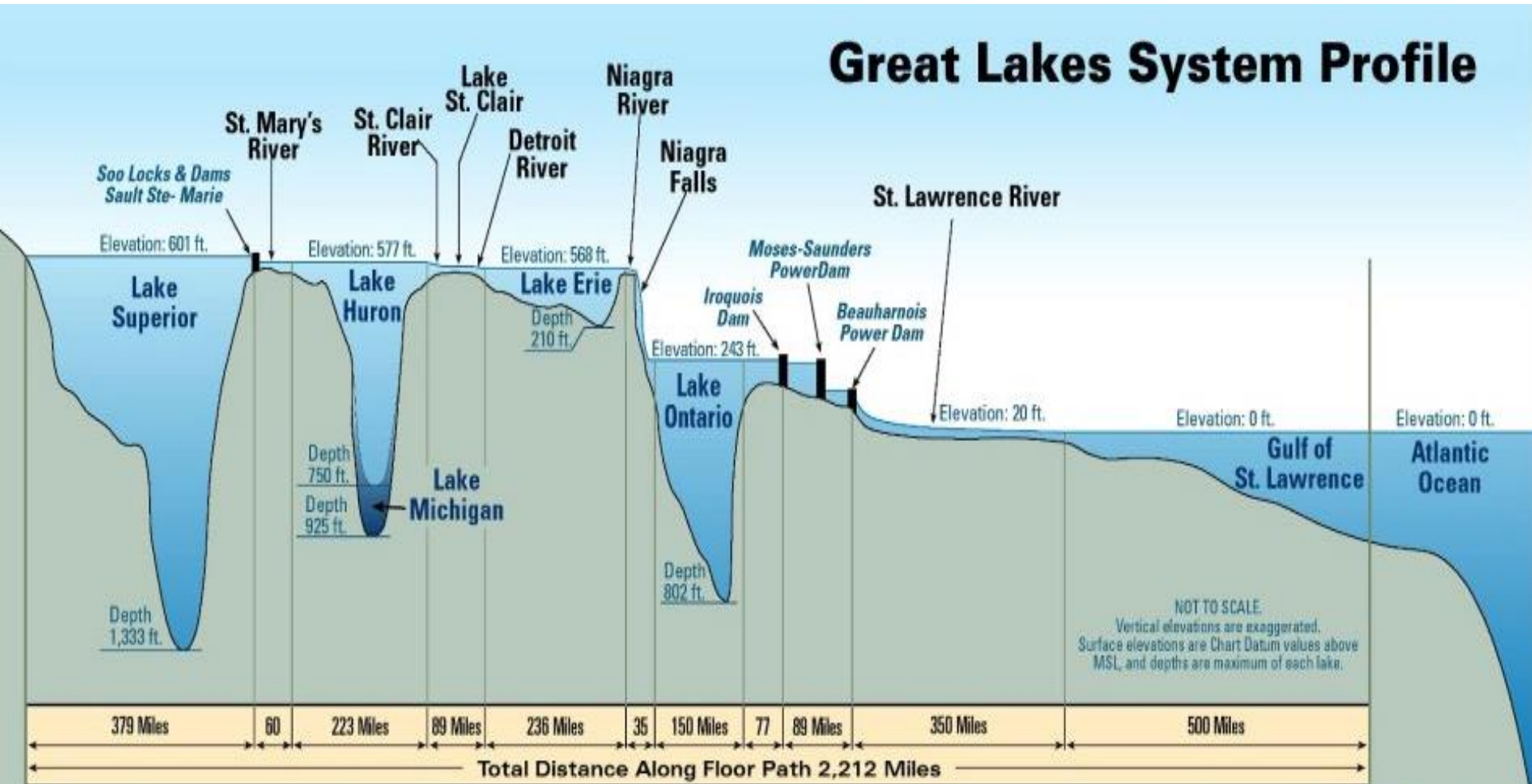


Other economic factors to consider:

- Cost of removing toxins from drinking water
- Cost to communities w/ drinking water advisory
- Charter captain and marina industry
- Jobs and revenue brought into state b/c of agriculture

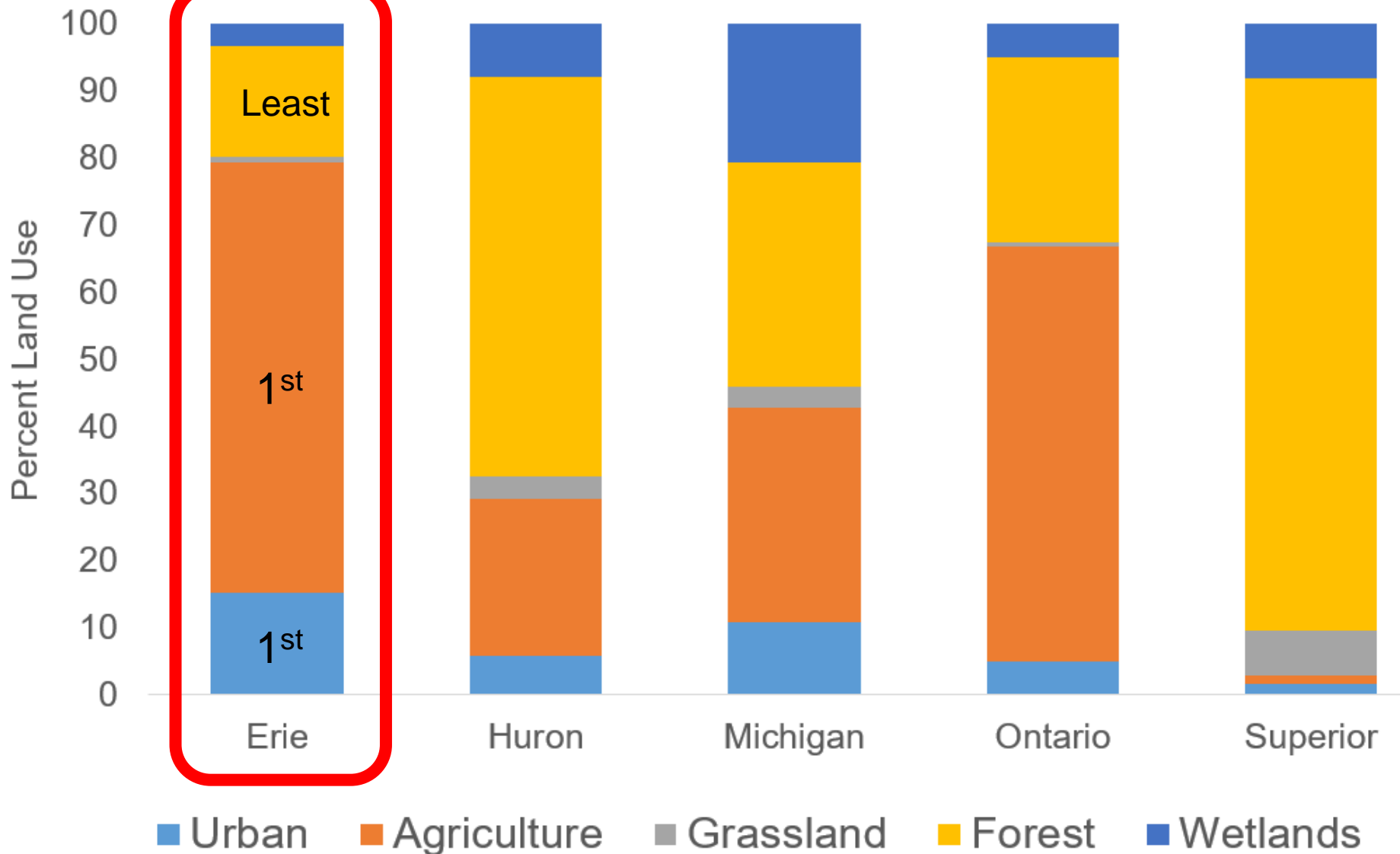


# Setting the Stage for Lake Erie HABs

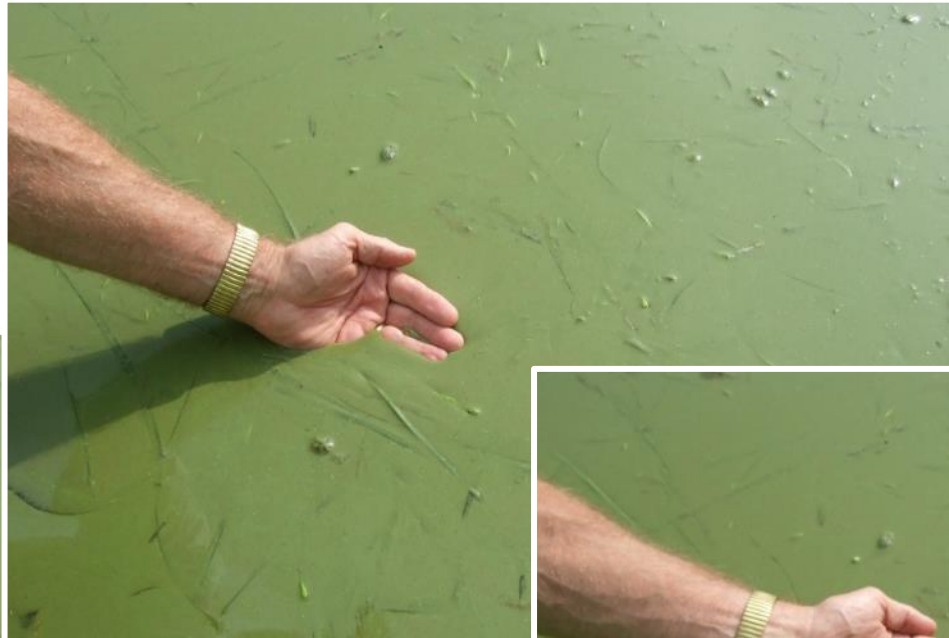


10%

# Great Lakes Watershed Land Use



# Microcystis at Stone Lab (8/10/10)





September 11<sup>th</sup>, 2011

October 9<sup>th</sup>, 2011



Photo: Richard Kraus, United States Geological Survey

# Microcystis near Marblehead



# Just Western Basin Problem?

An aerial satellite image of Lake Erie, showing a large, irregular white plume of sediment or snow in the western basin. The plume is concentrated in the western part of the lake, extending from the western shore towards the center. The surrounding land is green and brown, indicating vegetation and agricultural fields. The water in the lake is dark blue and green.

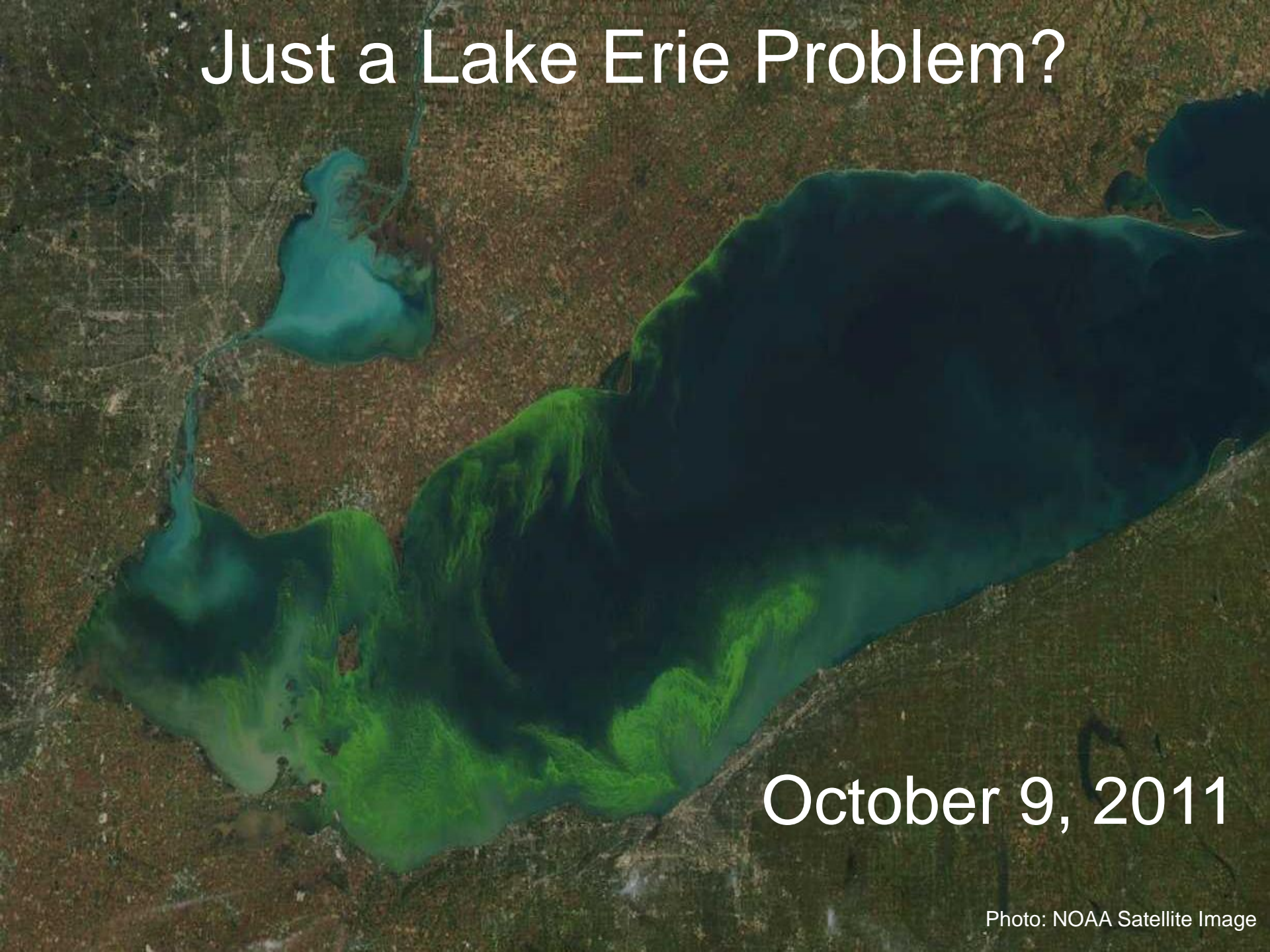
September 24<sup>th</sup>, 2013



# Just a Lake Erie Problem?

October 9, 2011

Photo: NOAA Satellite Image



# State, Country, and Global Problem



Muddy Creek  
Photo: Ohio EPA



Lake Hope  
Photo: Ohio EPA



Buckeye Lake  
Photo: Columbus Dispatch



Burr Oak  
Photo: Ohio EPA



Caesar Creek Lake  
Photo: Ohio EPA



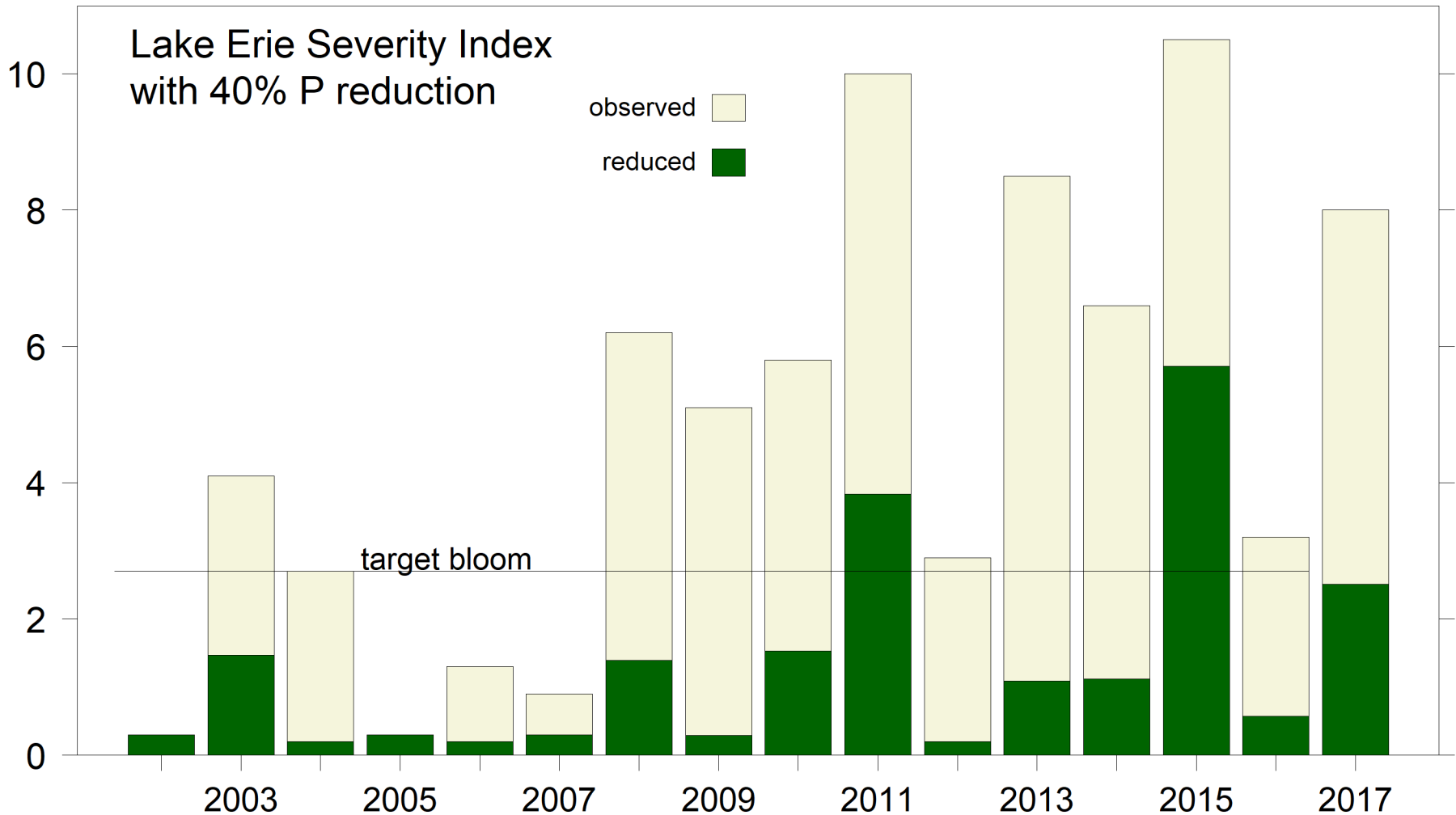
Ohio River  
Photo: Ohio EPA



Grand Lake St. Marys  
Photo: Ohio EPA



# What Might Phosphorus Reduction Do?



# HAB Research Initiative has .....


- Provided new answers and practical guidance about **producing safe drinking**
- Started to fill critical knowledge gaps about the risks that ~~algal toxins present for human health~~
- > **\$3mil spent, ~\$3mil ongoing,**
- Identified **how blooms behave** and how to address **nutrient runoff into aquatic ecosystems** **and more to come....**
- Driven **information sharing and priority setting** between universities and agencies, positioning Ohio to better prevent and manage future crises

# Truly Collaborative



# OHIO SEA GRANT AND STONE LABORATORY

## A R



**YEAR 2  
PROJECT UPDATE**

**Introduction**

Ohio's Harmful Algal Bloom Research Initiative (HABRI) is a multi-agency effort to understand the causes of harmful algal blooms (HAB) in Lake Erie and to develop strategies to prevent and manage them. With over 500,000 people in the state dependent on Lake Erie for drinking water, the health and economic issues associated with HAB are significant. The Ohio Department of Health (ODHE) and Ohio's universities are working together to fill gaps from state agencies.

**HABRI: What We'll Do**

Thirty-three science teams will directly help state agencies understand this emerging problem.

**Product**

One of the most direct products of HABRI is the development of drinking water crises like those that have given public health and water supply agencies a headache when water supplies are threatened.

ROUND	FOCUS AREA
Round 1	Track blooms from the source
Round 2	Produce safe drinking water
Round 3	Protect public health
	Engage stakeholders

**Projects in this Focus Area**

**ROUND 1**  
Transport and Fate of Cyanobacteria in Drinking Water Distribution Systems  
Lead: University of Toledo

**Investigation of Water Treatment Alternatives in the Removal of Cyanotoxins**  
Lead: University of Toledo

**Identifying Bacterial Isolates for Bioremediation of Microcystin-Contaminated Waters**  
Lead: Kent State University

**Guidance for Powdered Activated Carbon Use to Remove Cyanotoxins**  
Lead: The Ohio State University

**Prevention of Cyanobacterial Biofilm Formation Using Cyanophages**  
Lead: The Ohio State University

**TRACK BLOOMS FROM THE SOURCE: ROUND 2**

## 2016 report on 2015 efforts



**Research Project Title:**  
HAB Avoidance: Vertical Movement of Harmful Algal Blooms in the Water Column

**Principal Investigator:** Tom Bridgeman, University of Toledo  
**Partners:** NOAA, Bowling Green State University, Sinclair Community College

**PROJECT SUMMARY**

Researchers from the University of Toledo, along with scientists from NOAA, Bowling Green State University and Sinclair Community College, are working on ways to understand the vertical movement of different types of algae—such as green algae, cyanobacteria and diatoms—through the water column to help water treatment plants better prepare for and reduce the amounts of algae that are taking into their system over the course of a day.

During the 2016 harmful algal bloom season, water samples from boats, automated sensors, buoys and autonomous underwater vehicles (small robot-like machines essentially) combined to provide a profile of how algae were moving through the water column during two separate days and nights. In a related project, a drone equipped with a specialized camera developed by NASA scanned the lake surface for floating cyanobacteria.

The results left the investigators "pretty puzzled." During rough lake conditions that should lead to an even mixing of algae types, green algae were still somewhat concentrated near the surface, while cyanobacteria (which produce the problematic toxin in harmful algal blooms) were more evenly spread out. Only at night were all types of algae distributed evenly in the water column.

In calm conditions, the expected mid-day surface scum of cyanobacteria did not appear. Instead, green algae were again denser near the surface, while at night the even distribution of algae types was only disrupted by diatoms,

which sank closer to the bottom of the lake. The confusing results may have been due in part to the unusually small HAB caused by near-drought conditions in 2016.

A planning meeting before the next field season will bring together a number of related research groups to work out details for additional sampling trips during the 2017 bloom season. In addition to this scientific expedition for this year's bloom season, the researchers have a little planned milestones as expected, and they have ironed out a number of kinks, from flight permits to sampling equipment to data downloads, that will make this year's field season more efficient.

**AGENCY PRIORITIES ADDRESSED**

- Movement of HABs within water column: improve understanding of movement of cyanobacteria that contain buoyancy regulating aerotopes

**THE BOTTOM LINE**  
Scientists are developing methods to help water treatment plants decide on the best times of day and weather conditions for collecting drinking water during harmful algal bloom season.

Pictured above: Autonomous underwater vehicles provide part of the data used in tracking how algae move through the water column during typical days and nights.

3

6

10

20

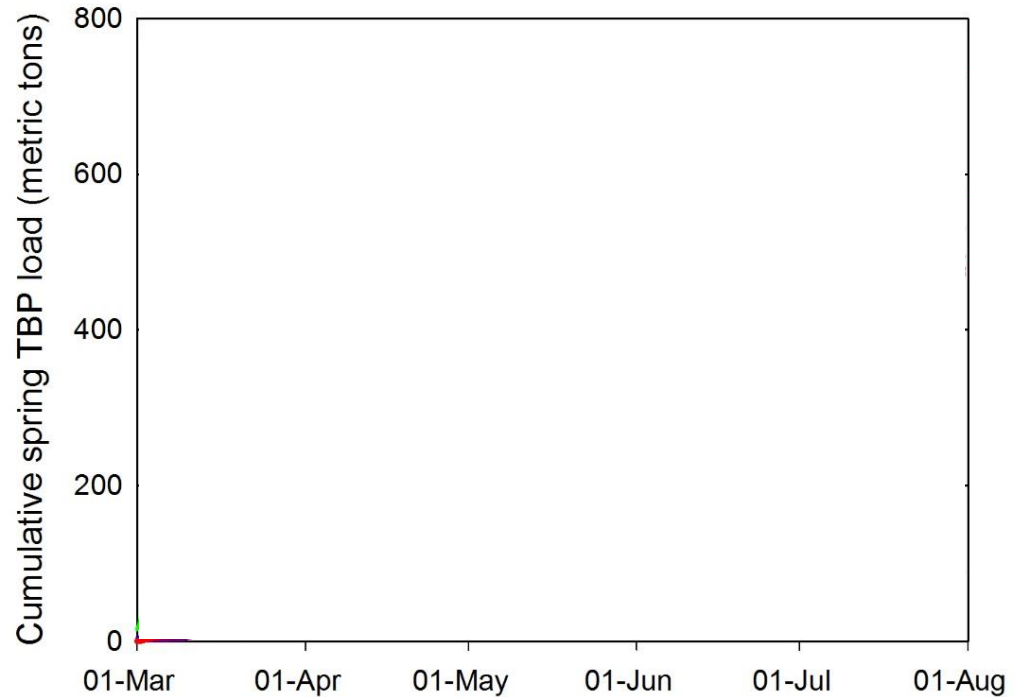
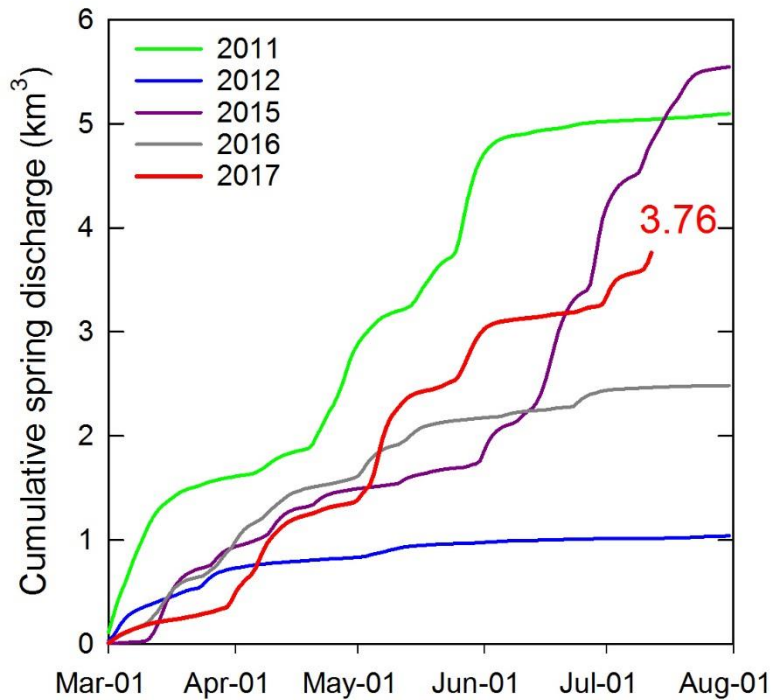
Harmful Algal Bloom Research Initiative Year 2 Project Update

# Nutrient Sources Today

- Maumee and Sandusky Rivers largest Phosphorous loaders
  - 87% of Phosphorous from nonpoint sources
  - Agri. is dominant land use in these watersheds (>70%)
- Between 2002 and 2013, 70-90% of Phosphorous loads occurred during highest 20% of flows
  - i.e., most loading occurred during ~10 storm events/year (Baker et al., 2014)



# 70-90% of Loading 20% of Time



# Nutrient Sources Today

- >75% reduction in Phosphorous from WWTPs; contribute <9% of Phosphorous today
- CSOs: Long Term Control Plans in place (i.e., by 2020, 40 of 62 communities will have addressed)
  - 2013, CSOs in Maumee contributed <1% of Phosphorous
- In Maumee, septic systems contribute ~4% Phosphorous
  - Recent state regulations will continue to reduce
- Scott's Miracle-Gro removed Phosphorous from lawn care products
  - 95% market followed Scott's lead
- Internal loading of Phosphorous ~3-7% of total load

# Understanding Agricultural Nutrient Loss

- 70s to mid-1990s, Phosphorous applied at 10-40 lbs.  $P_2O_5$  above crop removal rates, resulting in accumulation
- Since the mid-1990s, **Phosphorous being applied:**
  - at ~5 lbs  $P_2O_5$  below crop removal rates (Mullen 2013)
  - on average, 5.5 lbs  $P_2O_5$  above removal rates while 58% of fields have Phosphorous applied at or below crop removal rates (NRCS 2016)
- NRCS (2016) found that 42% of acres accounted for 78% of Phosphorous runoff and 80% of sediment loss

# We are Directionally Correct

- Avoiding frozen (fall/winter) **application** of fertilizer and manure (SB1)
- No fertilizer when rain is in **forecast** and **saturated** soils (SB1)
- 4R Nutrient Program (SB 150):
  - Right fertilizer source (i.e., manure)
  - Right rate (i.e., amount)
  - Right time (i.e., rain/frozen ground)
  - Right place (i.e., needed)
- Eliminate **broadcast application** and **incorporate** fertilizer (i.e., subsurface placement; band/inject)
- **Soil testing** of all fields to prevent application of too much Phosphorous
  - Do not apply Phosphorous above agronomic need (Tri-state Reco.)
- **Drainage water management:**
  - Disconnect hydrologic pathways; drain tiles vs. wetlands & blind inlets
  - Good portion of Phosphorous leaving fields is going through tiles

# What Other Levers Can We Turn?

- **Lawn Care Recommendations:**
  - Follow Scott's lead.....all lawn care fertilizer sellers and lawn care applicators meet the zero P goal
- Reduce **property runoff** (e.g., rain barrels, terraces, porous surfaces, etc.)
- Sewage Treatment Plant Recommendations:

## Immediate Needs:

- – Arm water treatment plants with tools, technology, and training to remove toxins
- – Reduce load of P into Lake Erie by 40%
  - Water management
  - Soil testing (<30ppm)



# “New” White Paper

- “Summary of Findings and Strategies to Move Toward a 40% Phosphorus Reduction”
- Numerous relevant sections:
  - “Introduction and Goal”
  - “Background and History”
  - “Nutrient Sources Today”
  - “Understanding Agricultural Nutrient Loss”
  - “Identifying Effective BMPs”
  - “Understanding Farmer Decisions”
  - “Information Gaps and Research Needs”

Summary of Findings and Strategies to Move Toward a 40% Phosphorus Reduction

A White Paper<sup>1</sup>

By

Kristen Fussell, Gail Hesse, Laura Johnson, Kevin King, Greg LaBarge, Jay Martin, Jeffrey Reutter, Robyn Wilson, and Christopher Winslow

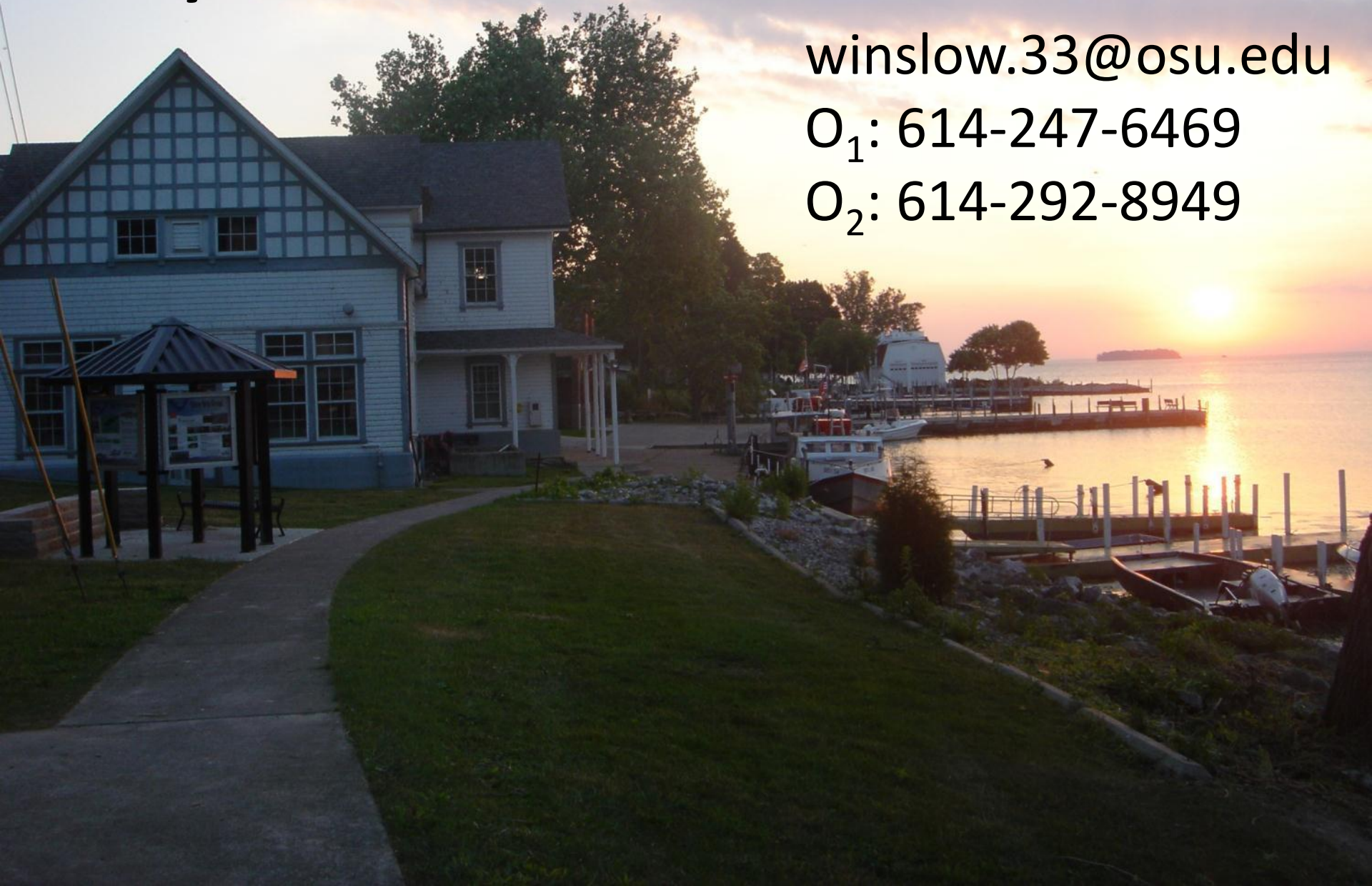
25 September 2017

# Any Questions?

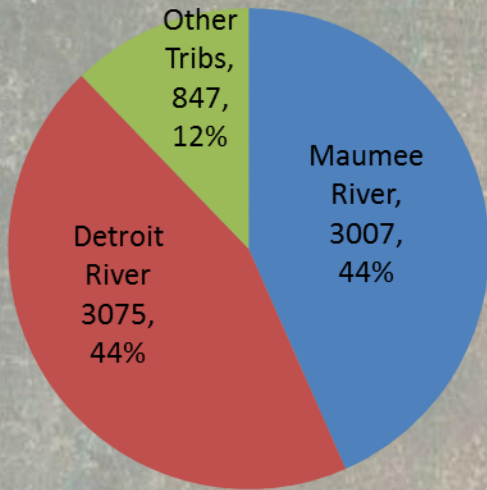
winslow.33@osu.edu

O<sub>1</sub>: 614-247-6469

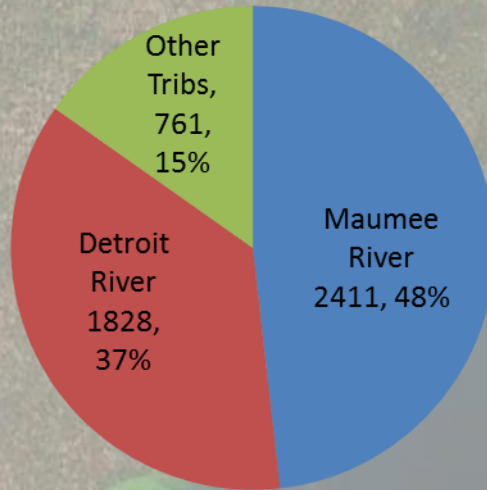
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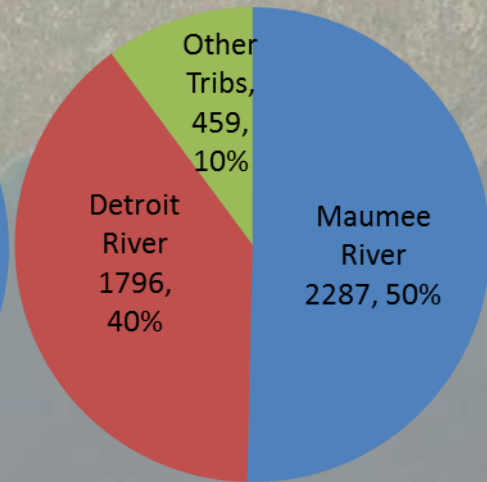
**2011 - TP (MTA)**



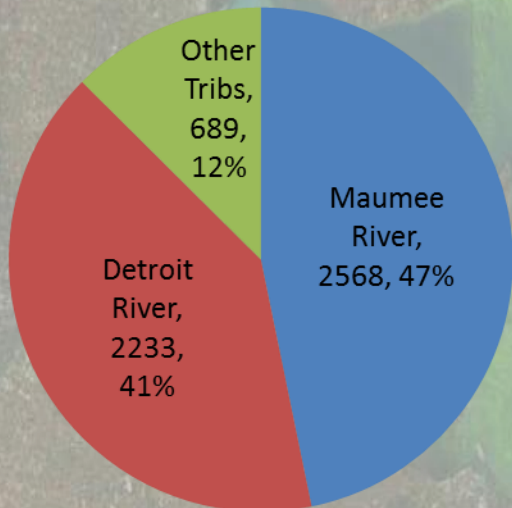
**2012 - TP (MTA)**



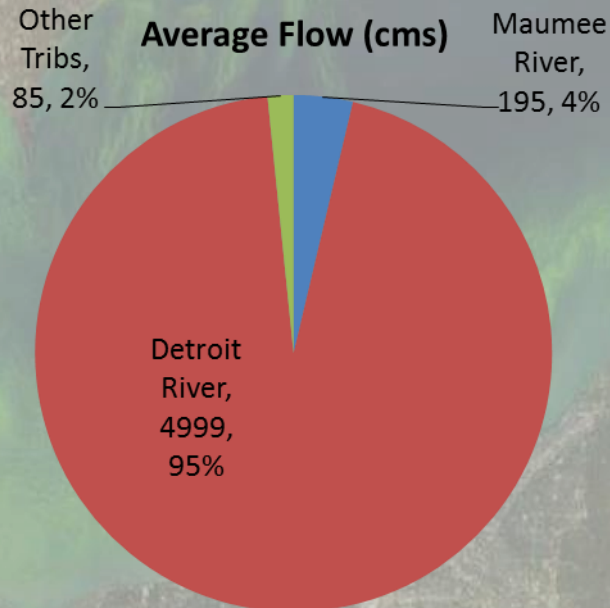
**2013 - TP (MTA)**



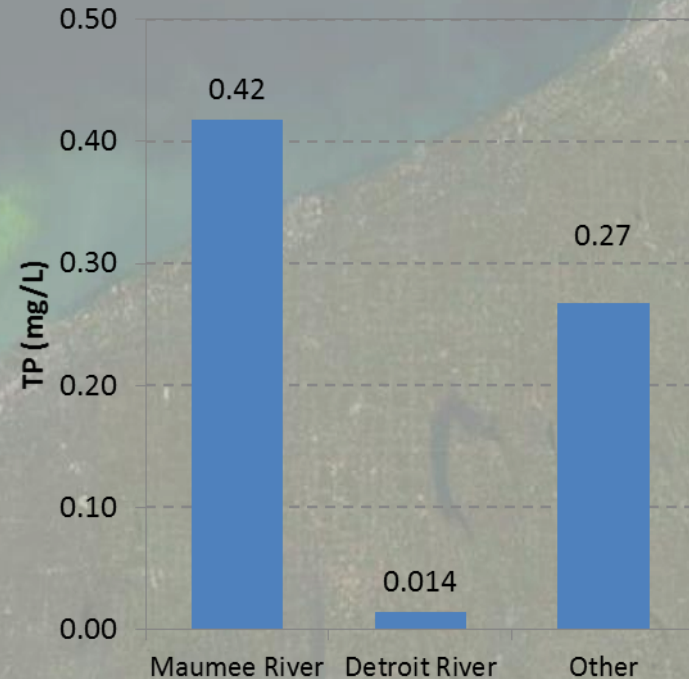
**Average -TP (MTA)**



**Average Flow (cms)**



**Average Flow-Weighted TP Conc.**



**FWMC of 0.23 mg/L TP**





# Track Blooms From the Source



Monitoring tributaries for nutrients that cause algal blooms

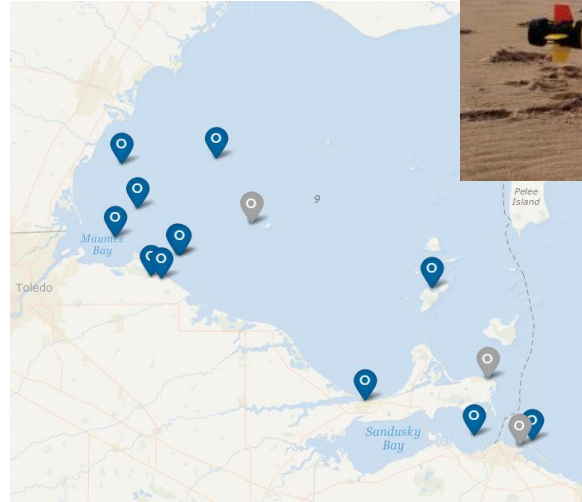
Early warning systems for bloom activity

Understanding blooms better for smarter management



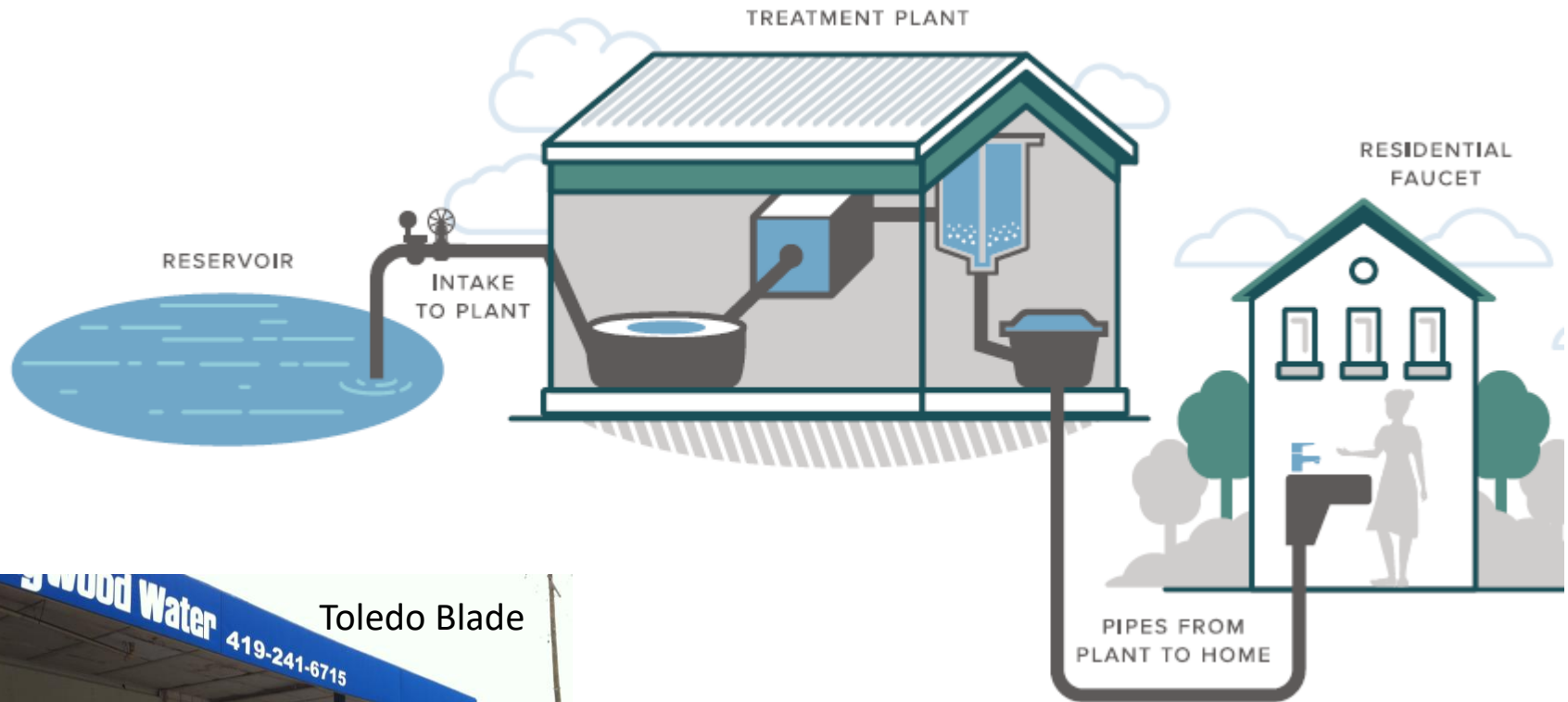
# The Bottom Line:

- Event warnings (x2)
  - GLOS
- Rock and Honey Creeks
- Fingerprinting
- Vertical movement
- Shifts between toxic and non-toxic blooms
- Central Basin blooms
- Multi-Model collaboration
- The winter piece





# Produce Safe Drinking Water

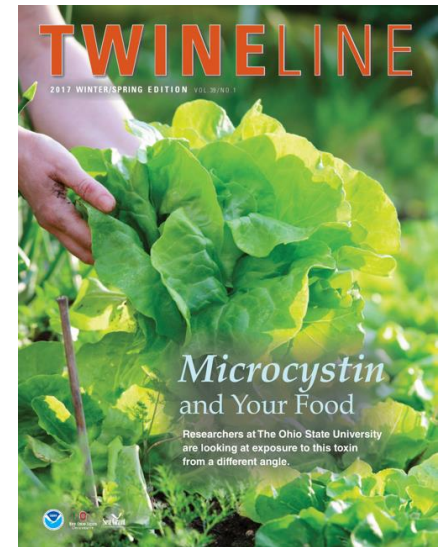
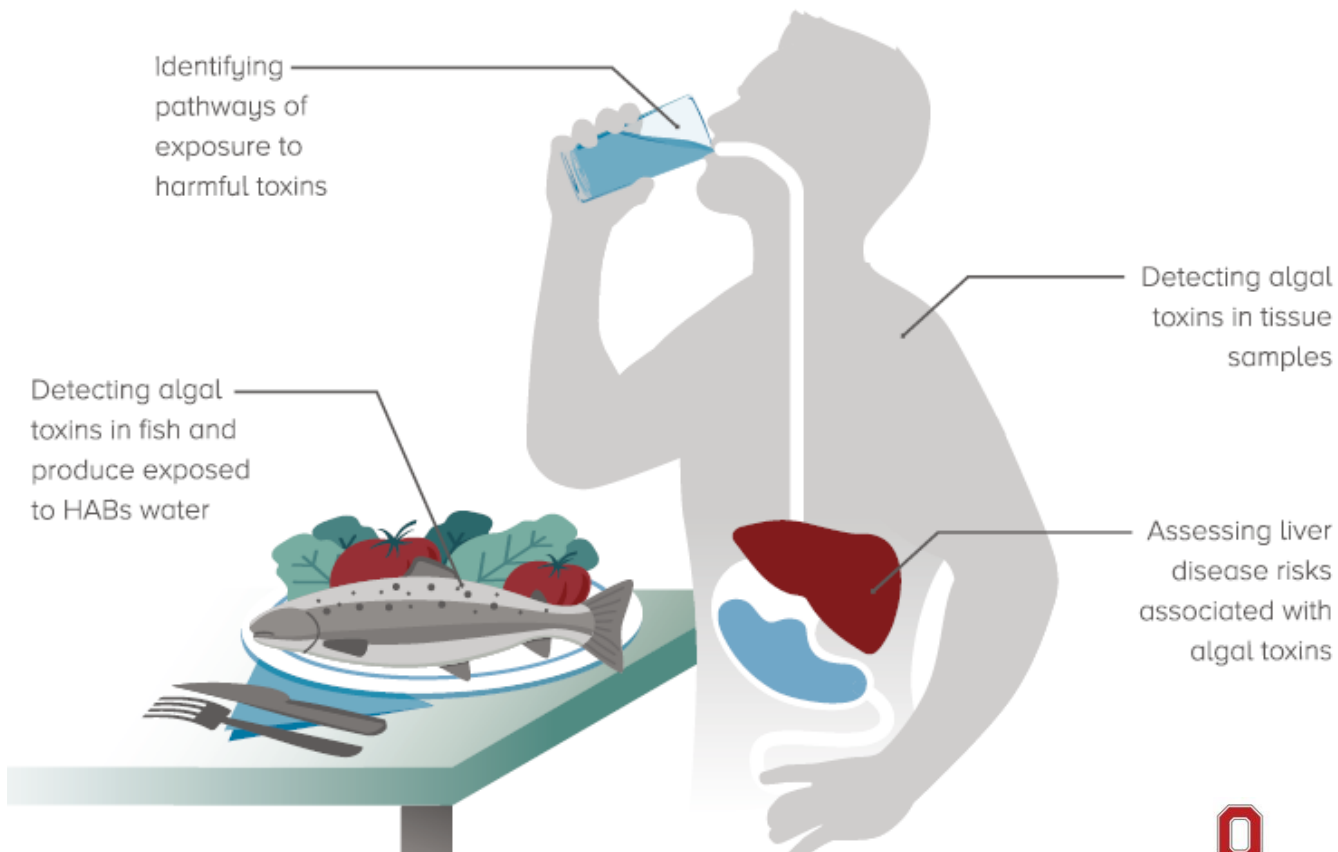


# The Bottom Line:



- Distribution system (fate of toxins)
- Biofilters and potassium permanganate
- Bioremediation (toxin eating and phages)
- PAC *and* algaecide; type and dose
- ELISA vs. LC-MS
- Ozone vs. UV
- Enzyme pathway for treatment
- Point-of-use reverse osmosis

# Protect Public Health



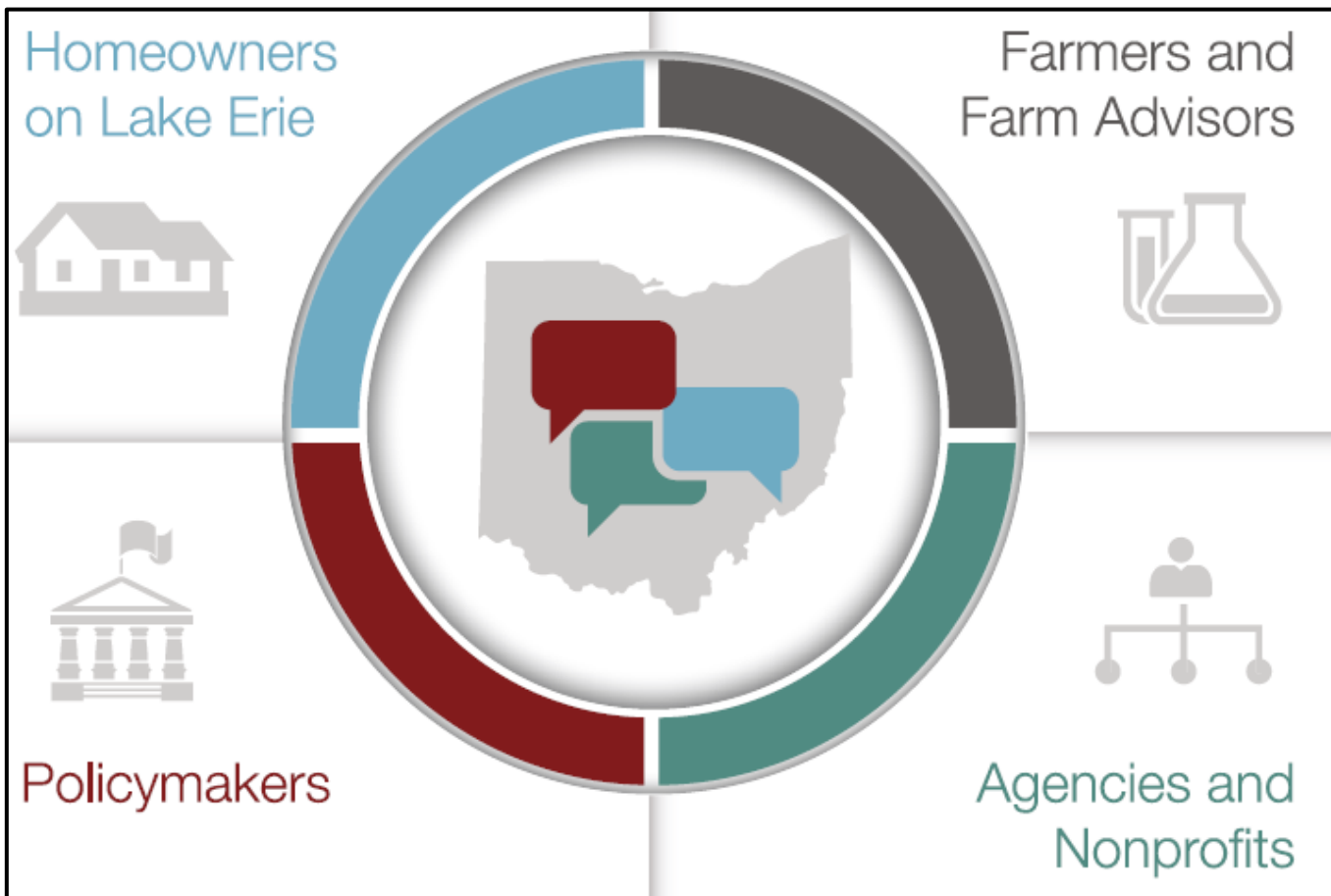
# The Bottom Line:

- Fish flesh and fresh produce
- People who are predisposed to or already have liver damage may be more susceptible
- Detecting toxins in biological samples



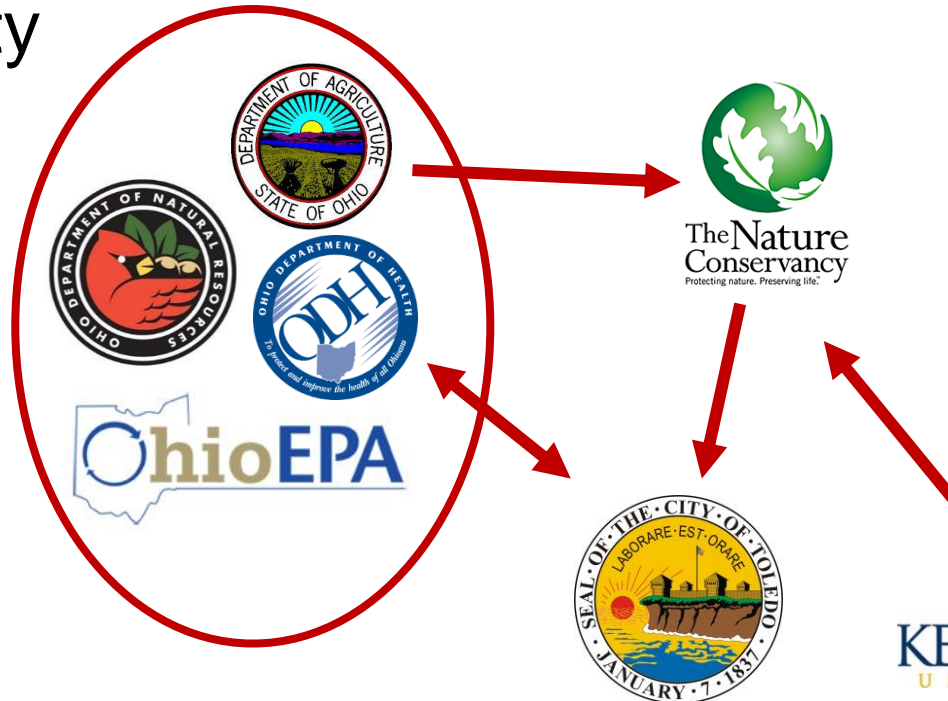


# Engage Stakeholders



# The Bottom Line:

- Social network analysis
- Stakeholder-Informed decision-making support system
- 56 on 80; BMPs to optimize agriculture outputs and water quality





# Identify Effective BMPs

- Soil-test-informed application rates (??%, 60%, then 30%)
- Adopt subsurface placement (25%, 36%, then 29%)
- Cover crops (27%, 20%, then 38%)
- Other BMPs:
  - Blind inlets (Phosphorous reduction by 60%)
  - Water management (1% increase = .75" rain)
  - Majority of farmers are concerned and know issue...but are not convinced that proposed BMPs are effective (either feasible or ability to reduce P loss)

# What is Causing the Harmful Algal Blooms in Lake Erie?

Clean Air Act

Climate change

Commodity prices

Cropping systems

Crop uptake

Equipment size

Ethanol

Fertilizer placement

Fertilizer rates

Fertilizer source

Fertilizer timing

Glyphosate

GMOs

Increased soil pH

Ignoring amounts of P loss

Larger farm size

Lower levels of sediment in the water

Manure

Misconceptions about P by researchers

Conservation Tillage (No-till & reduced till)

Nitrogen

Rental agreements

Products sold to increase P solubility in soil

Soil biology alterations

Soil testing and analysis

Stratification of P

Tile drainage

Zebra mussels, “near-shore shunt”