--- Operator Training Committee of Ohio ---

OHIO SEA GRANT AND STONE LABORATORY

Lake Erie Algae, Research Efforts, Nutrient Loading, and Farmer Decision Making

Dr. Chris Winslow, Director

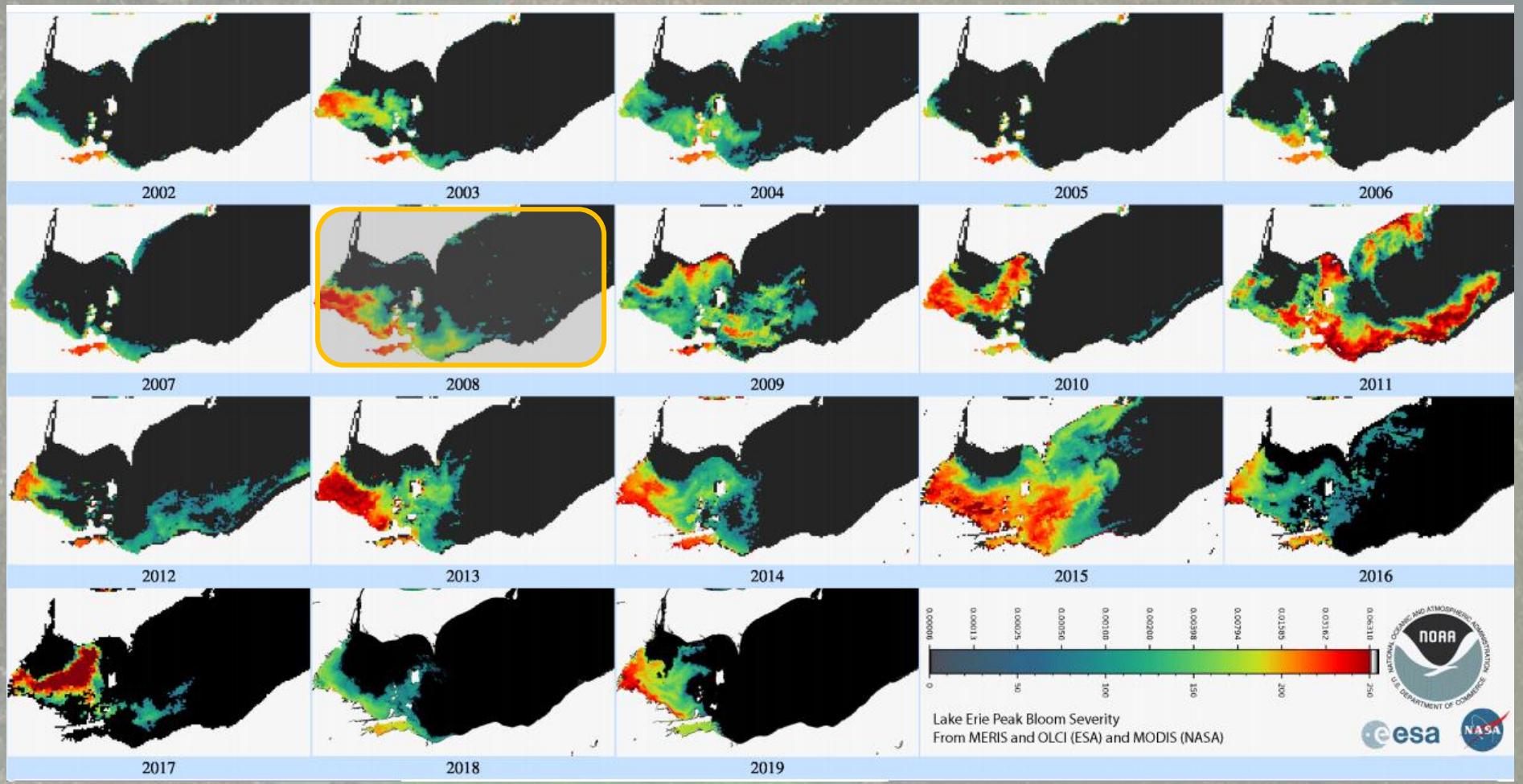
Ohio Sea Grant and Ohio State University's Stone Lab

May 11th, 2021

NOAA

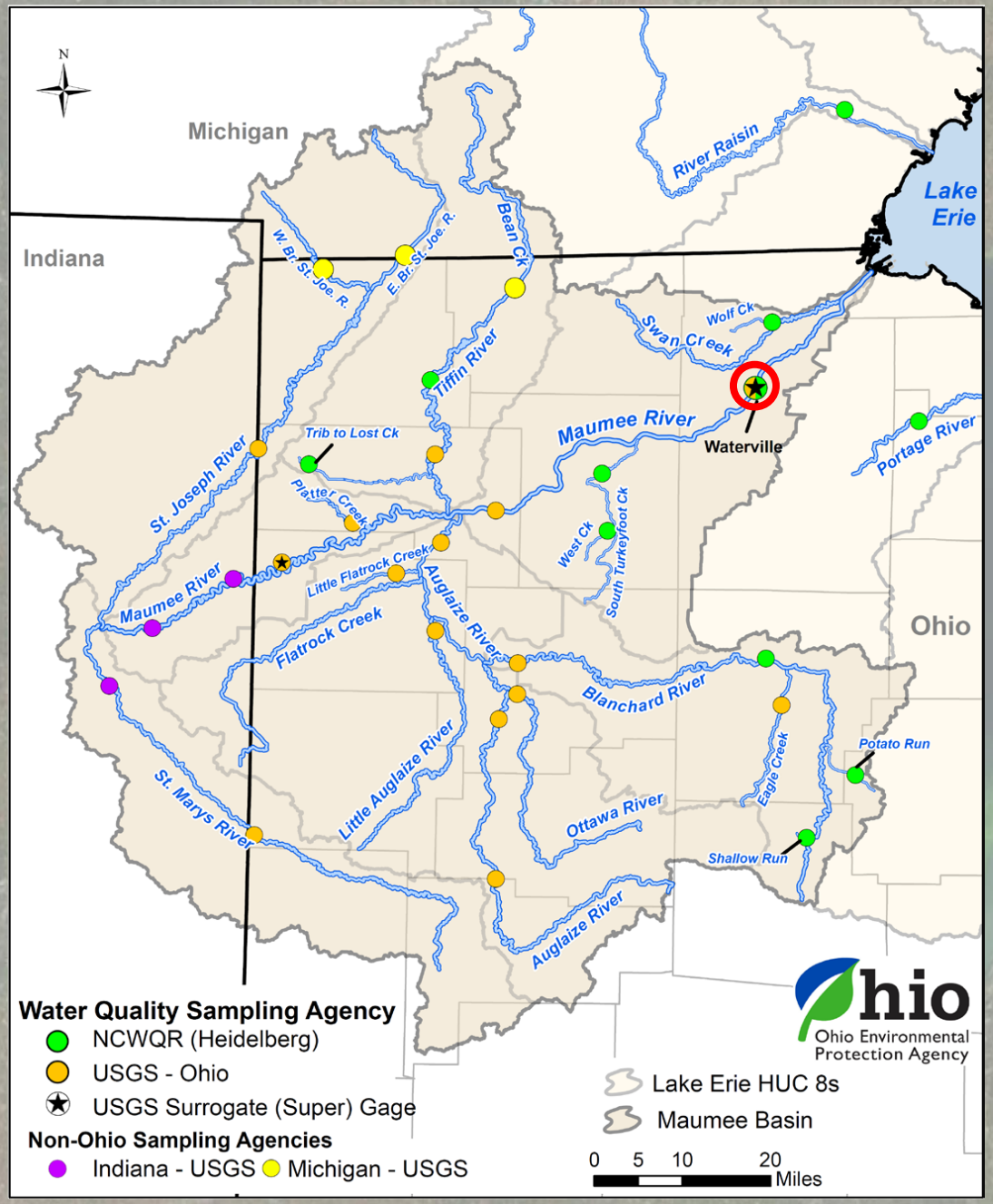
THE OHIO STATE UNIVERSITY

Sea Grant
Ohio Sea Grant College Program



Our Recent History of Blooms

Maumee River in Waterville



- One of 28 stations in Maumee Watershed
- Samples collected 3x/day, year-round
- Sampled since 1975 for all major nutrients and sediments (45 years!!)

courtesy of….

National Center for Water Quality Research
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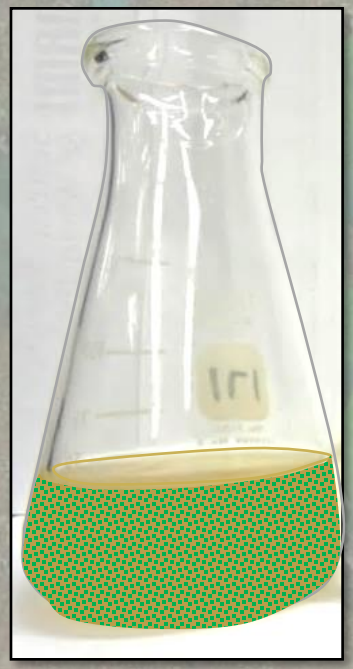
TP = DRP + TPP

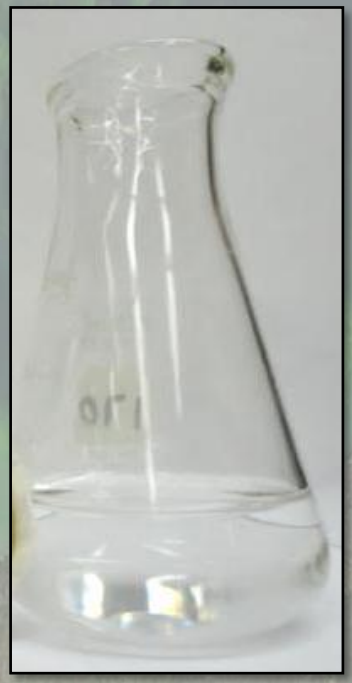
What is TBP? Portion of P available to algae that doesn't settle between Waterville and Erie

TBP = DRP + 0.08(TPP)

Total **B**ioavailable **P**



Dissolved **R**eactive **P**



Total **P**articulate **P**

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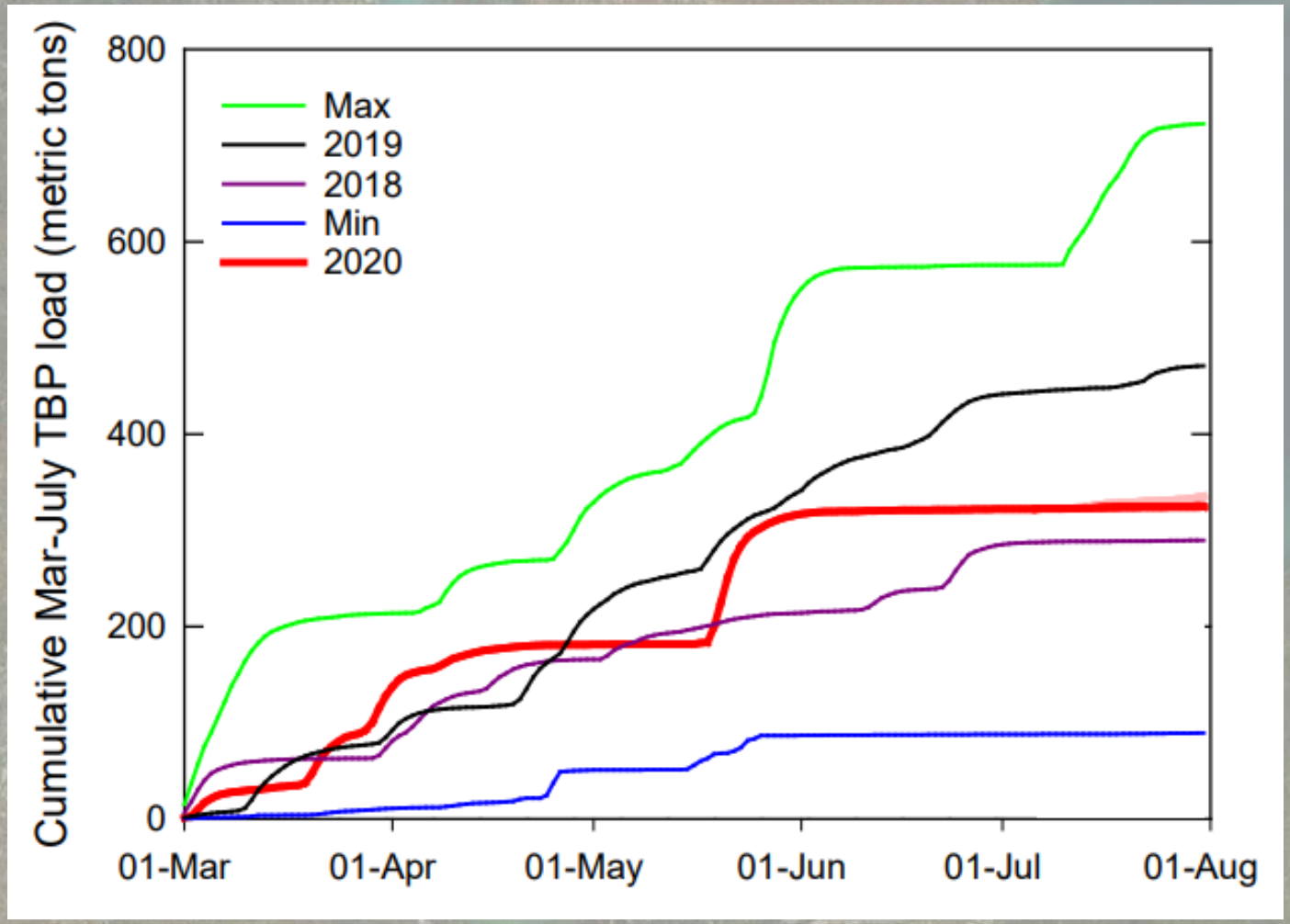
Maumee River Nutrient Loading: Drives Bloom Severity



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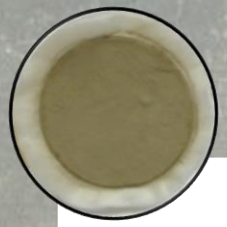
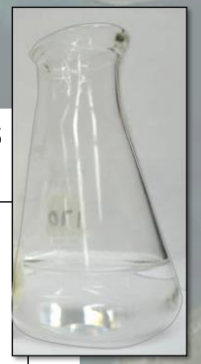
Maumee River in Waterville
March-July **F**low-**W**eighted **M**ean **C**oncentrations

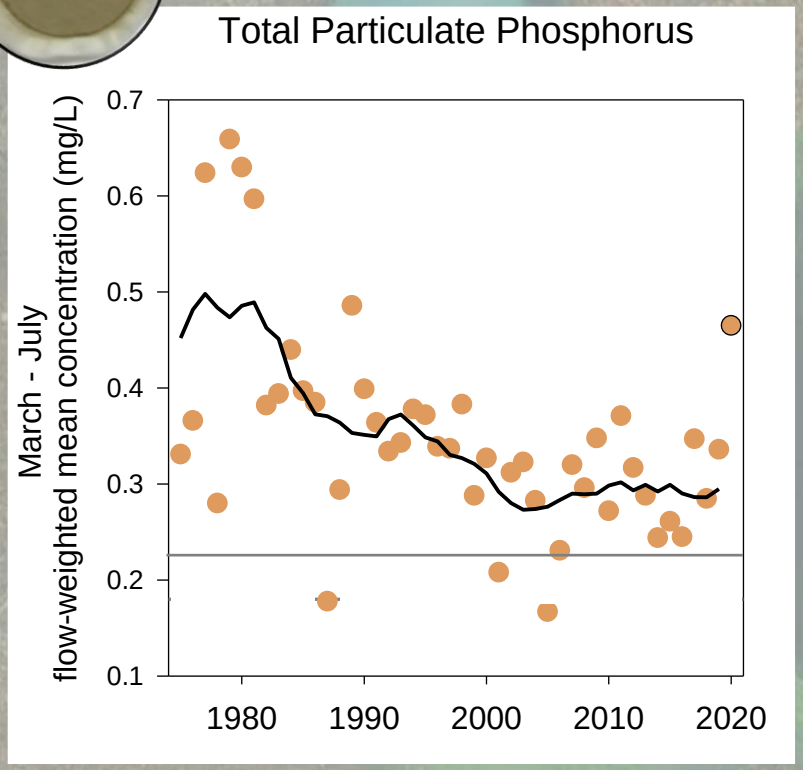


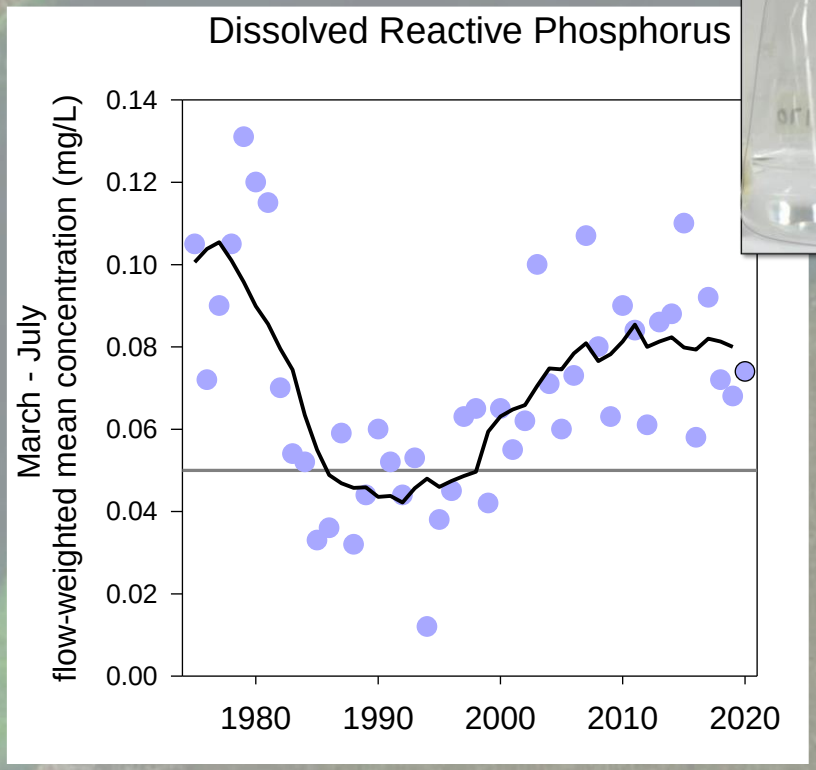
Load/streamflow = FWMC

5 year running average

Concentration Target







Currently → 0.47 mg/L
(0.23 mg/L)

Currently → 0.075 mg/L
(0.05 mg/L)

courtesy of....

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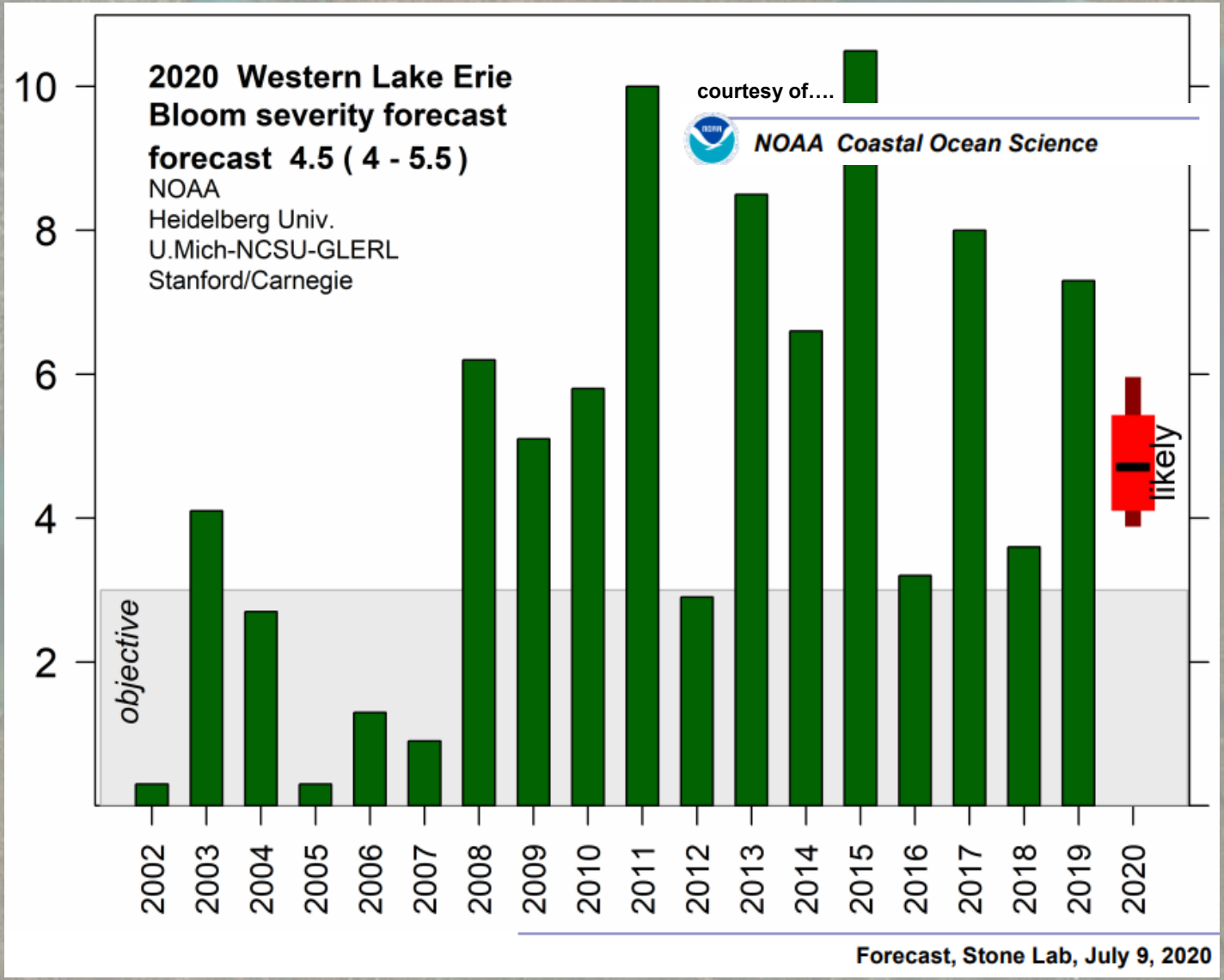
Western Basin Lake Erie Bloom Severity Forecast



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

Total Tourism Impact Lake Region, Ohio	
Sales	$15.1 billion
Wages	$4 billion
Taxes	$1.9 billion
Employment	127,852

TOURISM ECONOMICS
AN OXFORD ECONOMICS COMPANY

Oher economic factors to consider:

- Cost of removing toxins from drinking water
- Cost to communities w/ drinking water advisory
- Charter captain and marina industry
- Impact on fishery and tie to “deadzone”?
- Jobs and revenue brought into state b/c of agriculture

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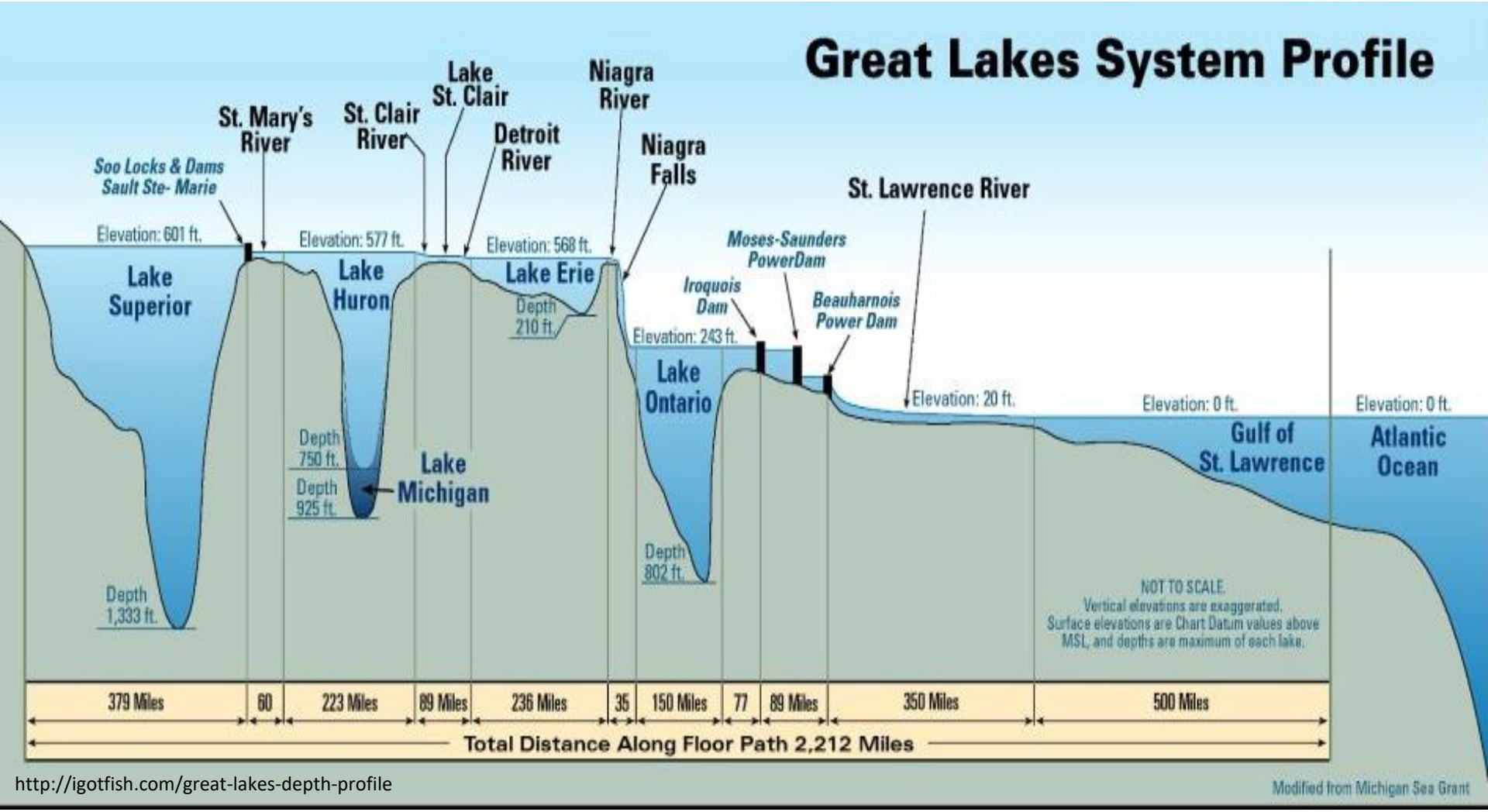
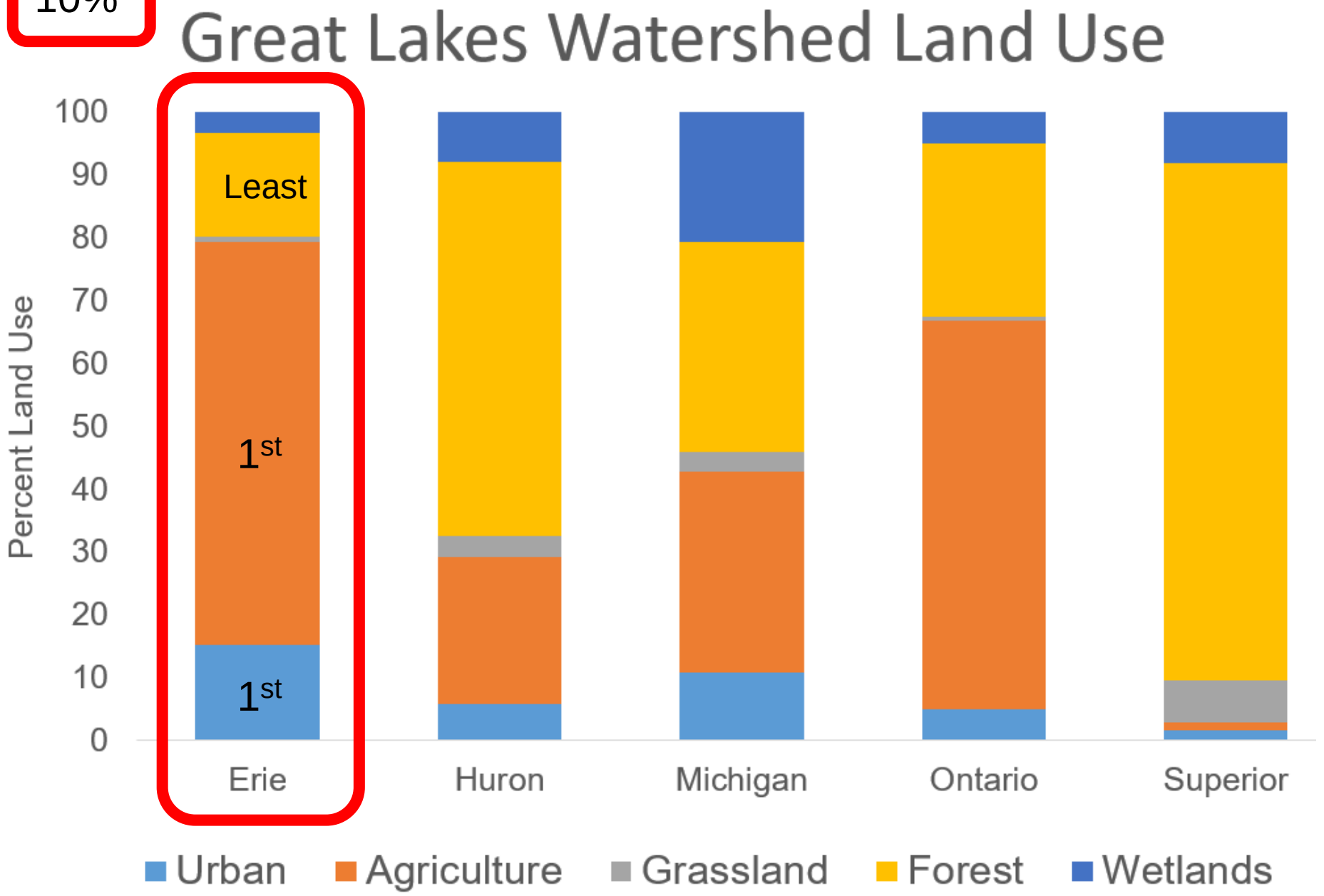
Setting the Stage for Lake Erie HABs



http://igotfish.com/great-lakes-depth-profile

10%


Great Lakes Watershed Land Use
Percent Land Use
100
90
80
70
60
50
40
30
20
10
0
Least
1st
1st
Erie
Huron
Michigan
Ontario
Superior
Urban
Agriculture
Grassland
Forest
Wetlands


September 11th, 2011

Microcystis near Marblehead

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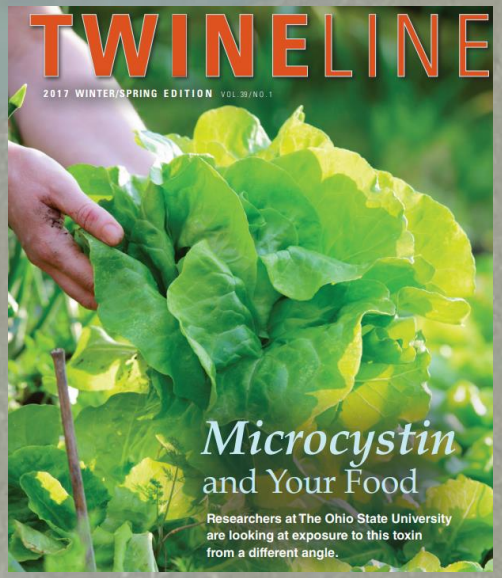
HAB Research Initiative …….

- Has provided solutions and practical guidance about **producing safe drinking**
- Has filled critical knowledge gaps about the risks that algal toxins present for **human health**
- Has identified **how blooms behave**
- Is addressing **nutrient runoff** into aquatic ecosystems

Truly Collaborative

Real Impact

- HABRI has expanded quality and frequency of collaborations (researchers and agencies)
- Early warning systems in Maumee and Sandusky bays and researchers are working directly with plant operators
- ODNR has changed fish sampling protocol; i.e., more frequently and across a larger range
- OEPA has modified its permitting for water treatment residuals



Nutrient Sources Today

- Maumee and Sandusky Rivers are largest phosphorus loaders
  - 87-93% of phosphorus from nonpoint sources (***N 89-96%***)
  - Agri. is dominant land use in watersheds (>70%)

- 70-90% of phosphorus loads occur during highest 20% of flows (2002-13)
  - Most loading occurs during ~10 storm events/year (Baker et al., 2014)

Nutrient Sources Today

- Since mid 70's, >75% reduction in phosphorus from WWTPs; contribute <7% of Phosphorus 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 Phosphorus
- In Maumee, septic systems contribute ~3% Phosphorus
  - Recent state regulations will continue to reduce
- Scott's Miracle-Gro removed Phosphorus from lawn care products (since 2013)
  - 95% market followed Scott's lead
- "Internal loading" of Phosphorus ~3-7% of total load (**vs.**)

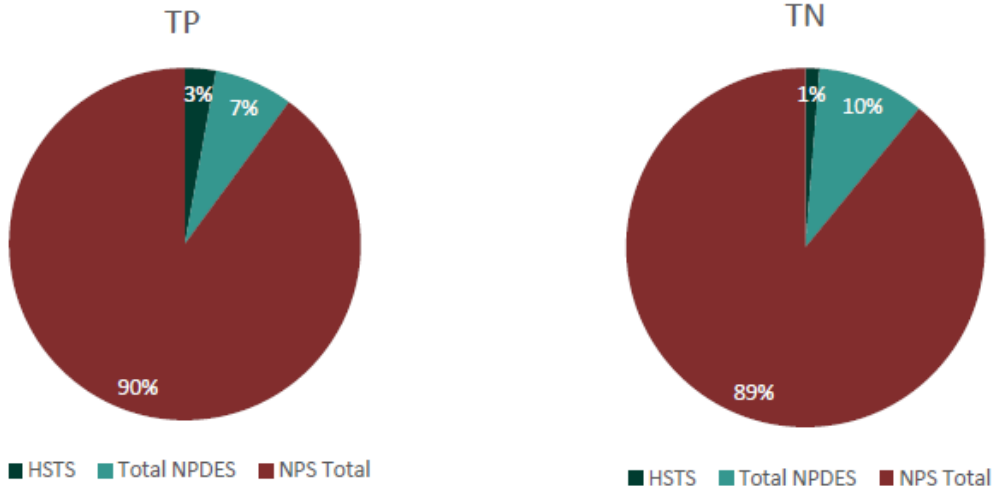


Figure 12 — Proportion of total phosphorus and nitrogen load from different sources for the Maumee watershed, average of five years (wy15-wy19).

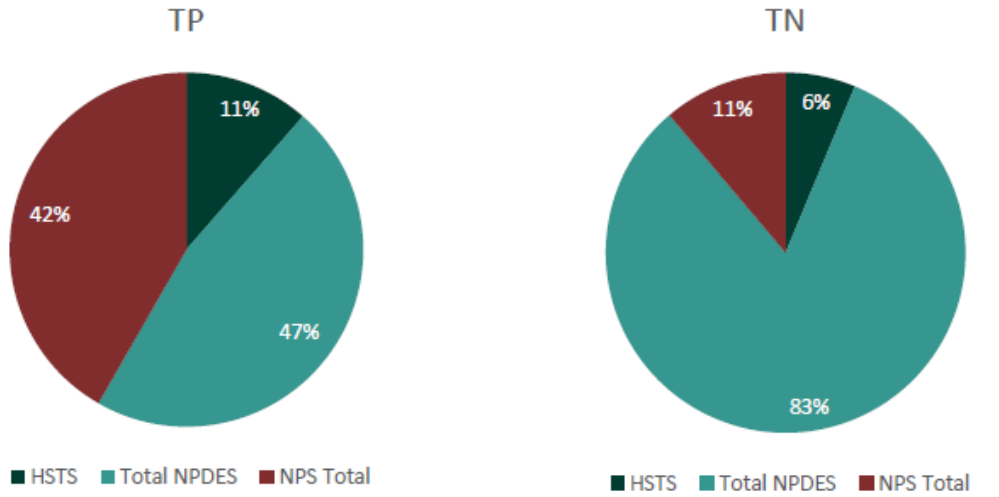


Figure 59 — Proportion of total phosphorus and nitrogen load from different sources for the Cuyahoga watershed, average of 5-years (wy15-wy19).

Ohio Environmental Protection Agency

Nutrient Mass Balance Study for Ohio's Major Rivers 2020

Understanding Agricultural Nutrient Loss

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

We are Directionally Correct

- 4R Nutrient Program (SB 150):
  - Right fertilizer **source** (i.e., manure)
  - Right **time** (i.e., rain/frozen ground)
  - Right **rate** (i.e., amount)
  - Right **place** (i.e., needed)
- Avoiding **frozen application** of fertilizer and manure (SB1)
- No “fertilizer” when rain is in **forecast** and on **saturated** soils (SB1)
- Eliminate **broadcast** application and adopt **subsurface** placement
- **Soil testing** of all fields to prevent application of excess phosphorus
- Need for **water management** (Disconnect hydrologic pathways)
- Non-Agriculture:
  - **Lawn Care** recommendations
  - Reduce **property runoff**
  - **WWTP** recommendations
  - **Septic tanks**

Plus ……

cover crops, DWCS, buffers, bioreactor, drainage H_2O recycling

H_2Ohio's "Top Ten" BMPs

H2Ohio Phosphorus Reduction Impact

1 Soil testing: Testing results give farmers information on where to place fertilizer and fertilizer application rate.

2 Variable-rate fertilization: Applying specific fertilizer levels based on the need of each sub-acre to reduce fertilizer application without risk of losing yield.

3 Subsurface nutrient application: Applying specific fertilizer below the surface to reduce nutrient loss.

4 Manure incorporation: Mixing manure into the soil to keep it in place and minimize nutrient loss.

5 Conservation crop rotation: Planting certain crops that reduce erosion and enrich the soil thus reducing runoff and sediment delivery.

6 Cover crops: When planted after the main harvest, cover crops reduce erosion, hold nutrients in the soil, and improve soil health.

7 Drainage water management: Slowing down runoff to give phosphorus more time to settle back in the soil.

8 Two-stage ditch construction: Creating modified drainage ditches to slow water flow and allow the phosphorus to settle.

9 Edge-of-field buffers: When trees, shrubs or strips of grass are planted along farm fields in the right place, the plants hold on to phosphorus and prevent its release into the water.

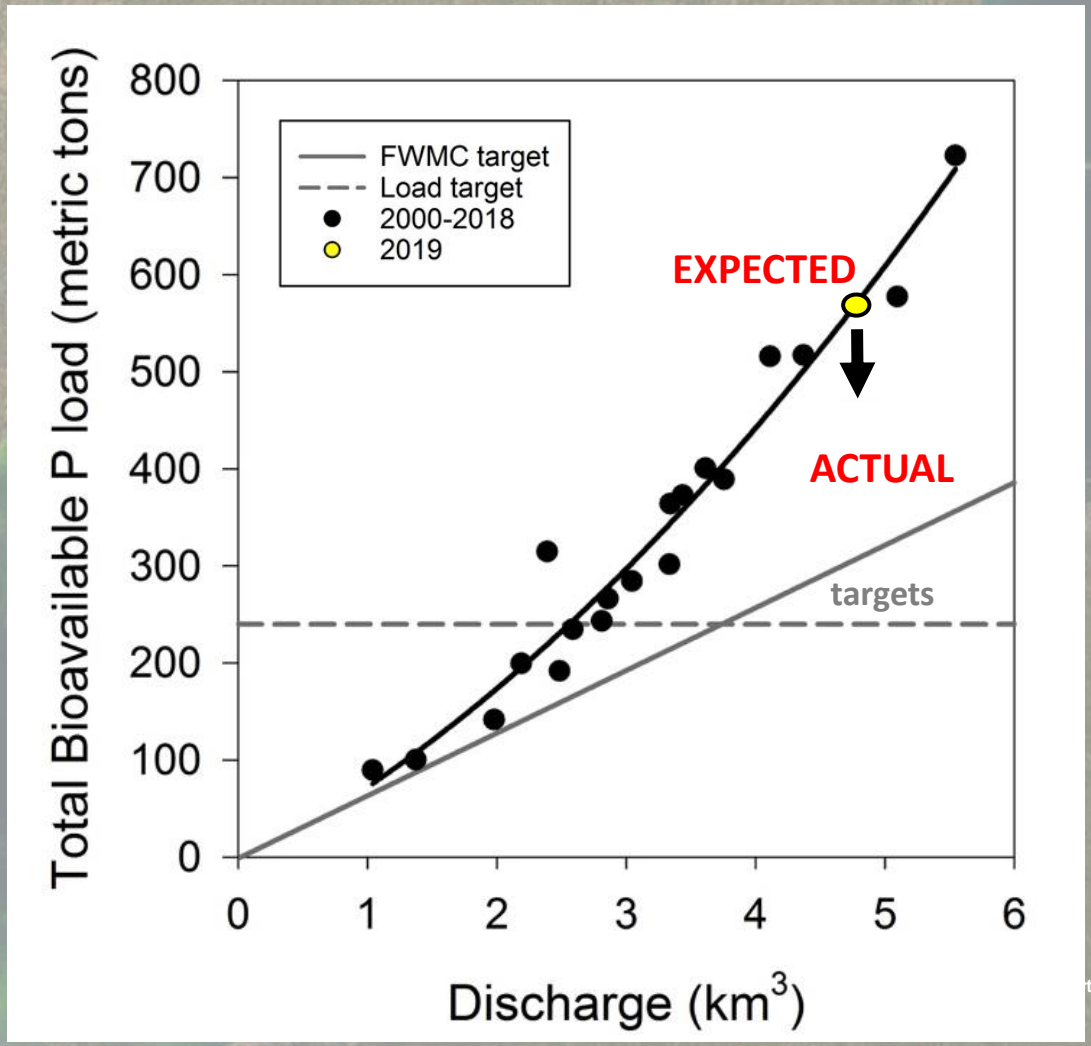
10 Wetlands: Wetland vegetation and soils absorb phosphorus, slow down the movement of water, offer a natural filtering process, and allow phosphorus to settle.


H2Ohio
Why are Wetlands Important?
THE ISSUE
During extreme rain and flooding, without wetlands, excessive nutrient levels pollute rivers and lakes.
WETLANDS FILTER
EXCESSIVE LEVELS OF NUTRIENTS IN WATER
NATURAL FILTERS
Wetlands, such as marshes and bogs, help filter commercial, agricultural, and landscaping nutrients from our rivers and lakes.
These wetlands help provide clean water for drinking, recreation, and quality habitats for plants and animals.
WETLANDS FILTERED WATER
IMPACTS
High amounts of nutrients in waterways contribute to harmful algal blooms.
Poor water quality affects recreation, fishing, wildlife, tourism and property values.

“Legacy P” and what we learned from 2019

TBP loads were 24% lower than expected based on flow

Why ?



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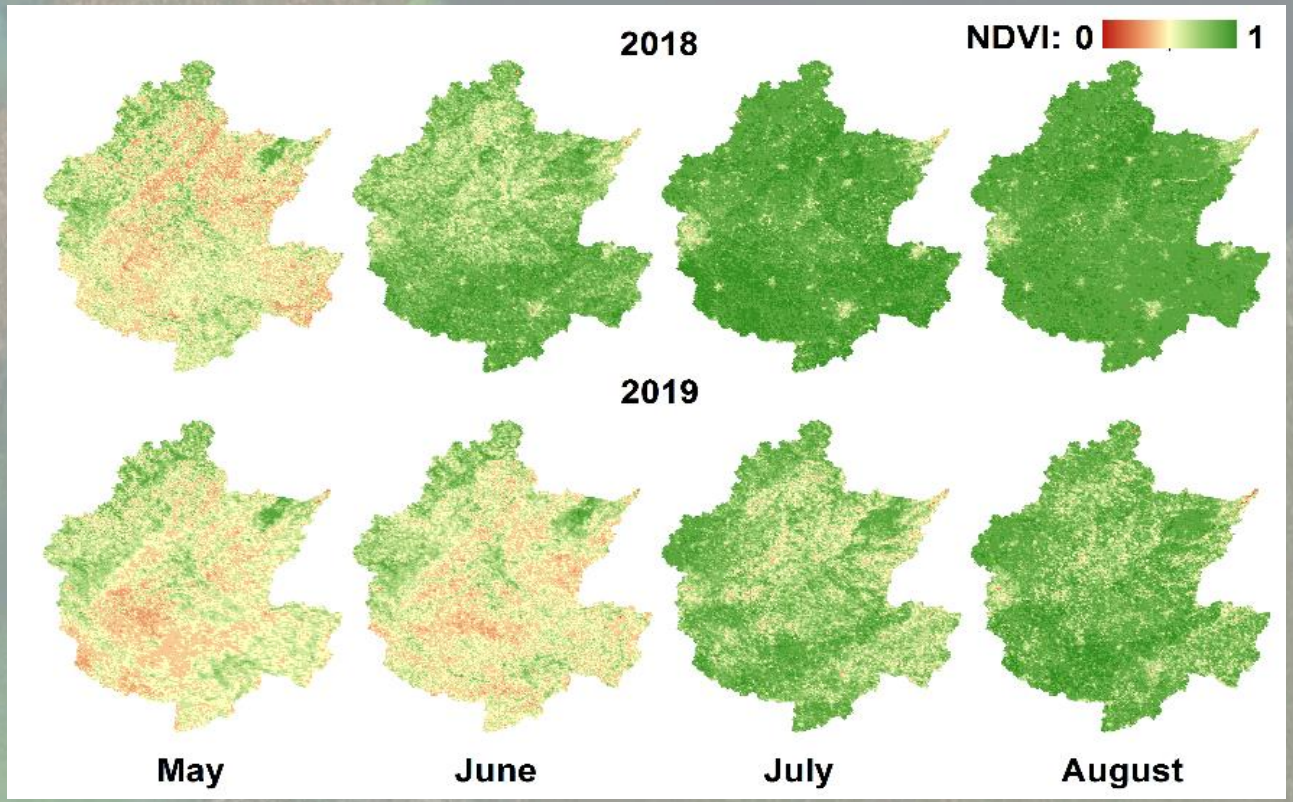
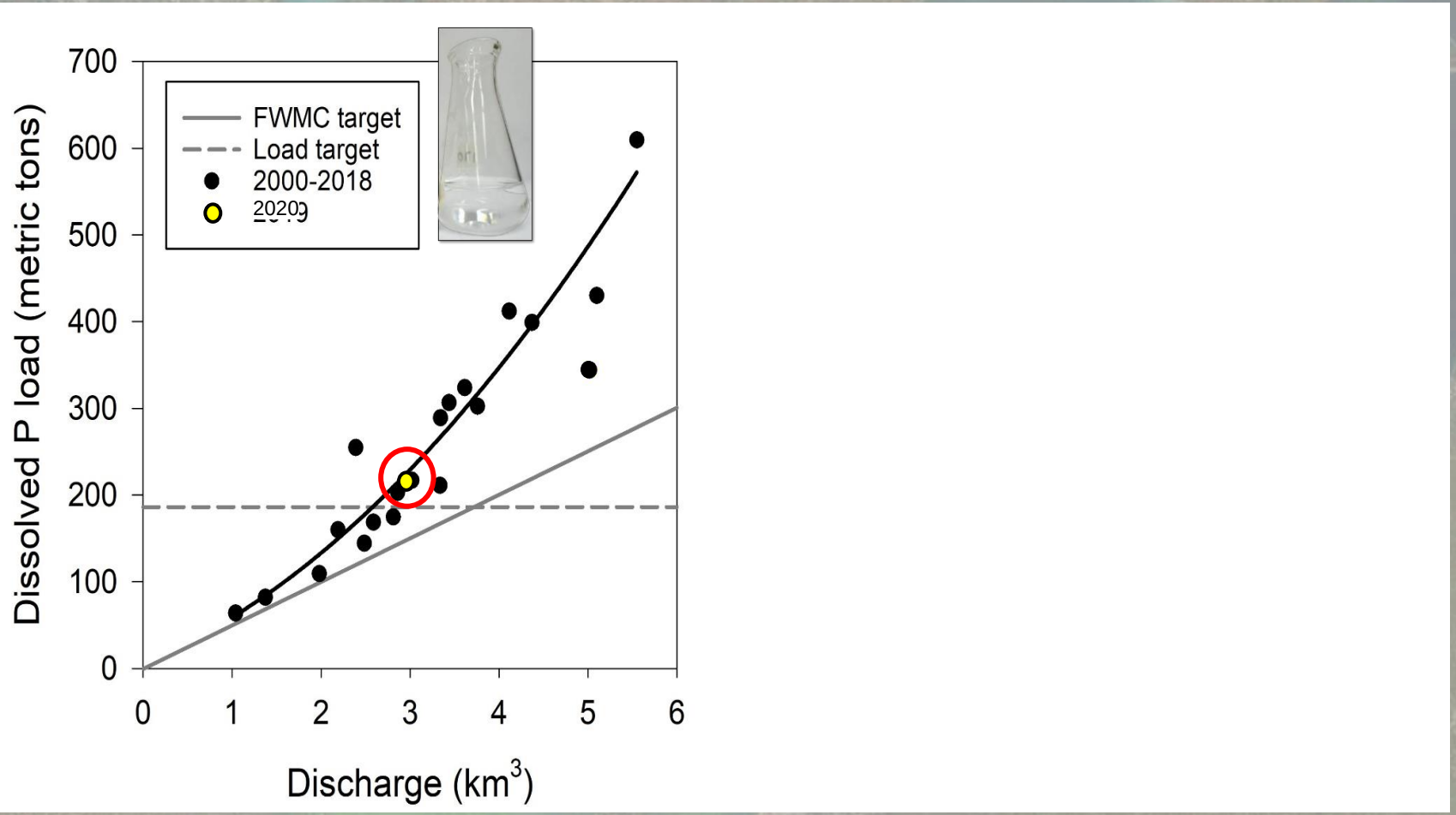
Maumee Watershed **N**ormalized **D**ifference **V**egetation **I**ndex

- 41% of land unplanted in 2019 (5% in 2018)
- ~46% of typical commercial P amounts were sold
- ~15% of typical manure application from March-May



2019 vs. 2020



Dissolved P loads as expected in 2020

Particulate P loads higher than expected

Estimating Source Contributions From the Maumee

Inorganic + Manure

"Legacy"

Year	Fraction of total TP (DRP) load (%) from each source				
	Point Sources	Inorganic P Fertilizer +	Manure P Fertilizer	Land Applied	Soil Sources
2005	20 (38)	28 (32)	4 (4)	32 (35)	49 (28)
2006	12 (26)	32 (37)	5 (6)	36 (42)	53 (33)
2007	5 (17)	34 (43)	5 (8)	38 (49)	57 (34)
2008	5 (14)	36 (47)	6 (9)	41 (54)	54 (32)
2009	7 (20)	34 (42)	5 (7)	39 (46)	55 (34)
2010	7 (16)	36 (45)	6 (8)	41 (51)	52 (33)
2011	3 (9)	39 (55)	7 (9)	44 (61)	53 (30)
2012	15 (33)	35 (38)	6 (7)	40 (43)	46 (25)
2013	5 (15)	40 (49)	7 (9)	45 (55)	50 (30)
2014	4 (13)	41 (53)	8 (13)	47 (61)	49 (26)
2015	4 (12)	43 (56)	7 (10)	48 (62)	47 (25)
Average	8 (19)	36 (45)	6 (8)	41 (51)	51 (30)

Kast et al. 2021 Journal of Env. Magt

Order of DRP contributions: 1) Inorganic Fertilizers 2) Legacy 3) Point Sources 4) Manure

Order of TP contributions: 1) Legacy 2) Inorganic Fertilizers 3) Point Sources 4) Manure

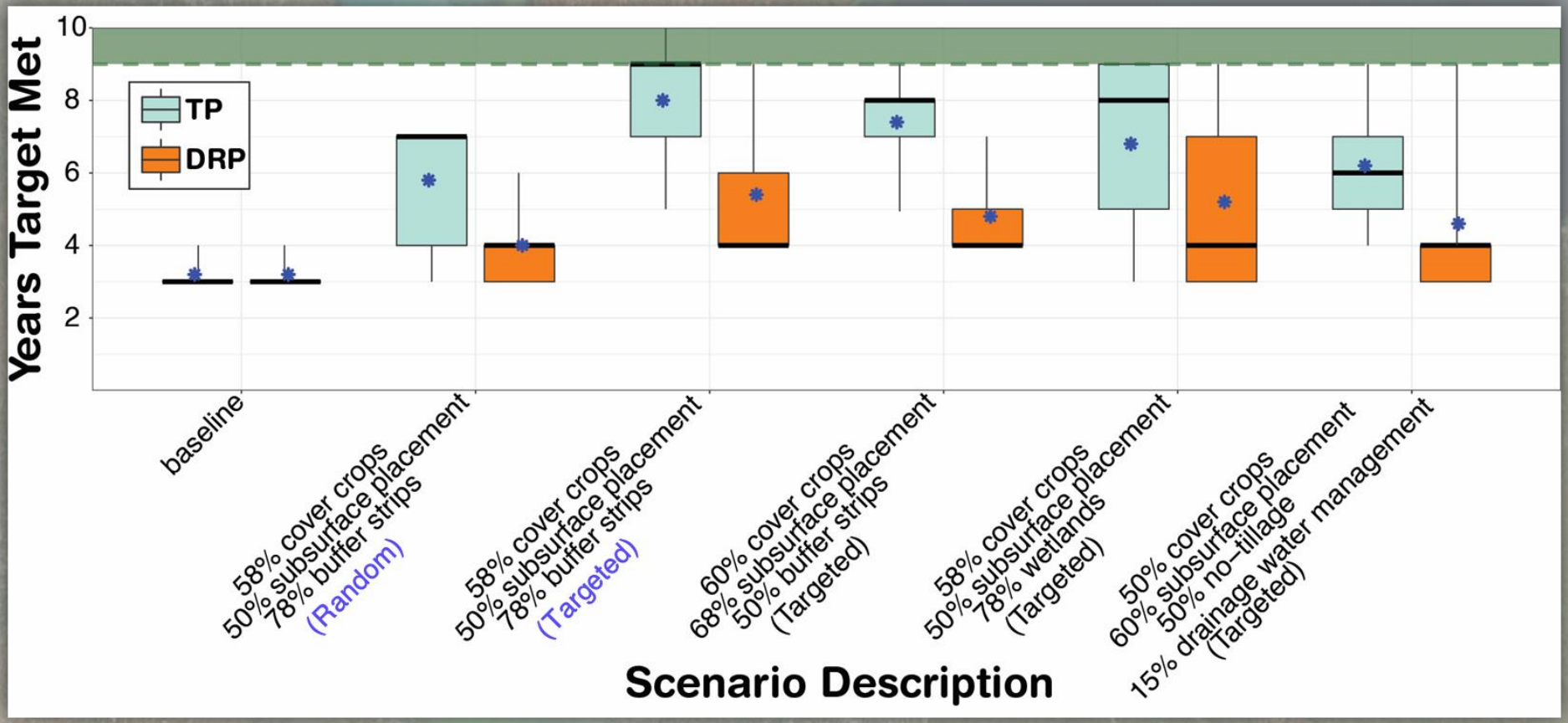
Why Legacy Sources Matter

- Legacy P can serve as a chronic source of pollution to surface waters for decades
- Untreated sources of legacy P can mask the effects of present-day conservation efforts
- P management strategies will vary depending on the primary source of P (legacy vs. contemporary, in-field vs. instream)

Year	Soil Sources
2005	49 (28)
2006	53 (33)
2007	57 (34)
2008	54 (32)
2009	55 (34)
2010	52 (33)
2011	53 (30)
2012	46 (25)
2013	50 (30)
2014	49 (26)
2015	47 (25)
Average	51 (30)

Fraction of total TP (DRP) load (%) from each source

Legacy “Tools” Are Going to Be Critical



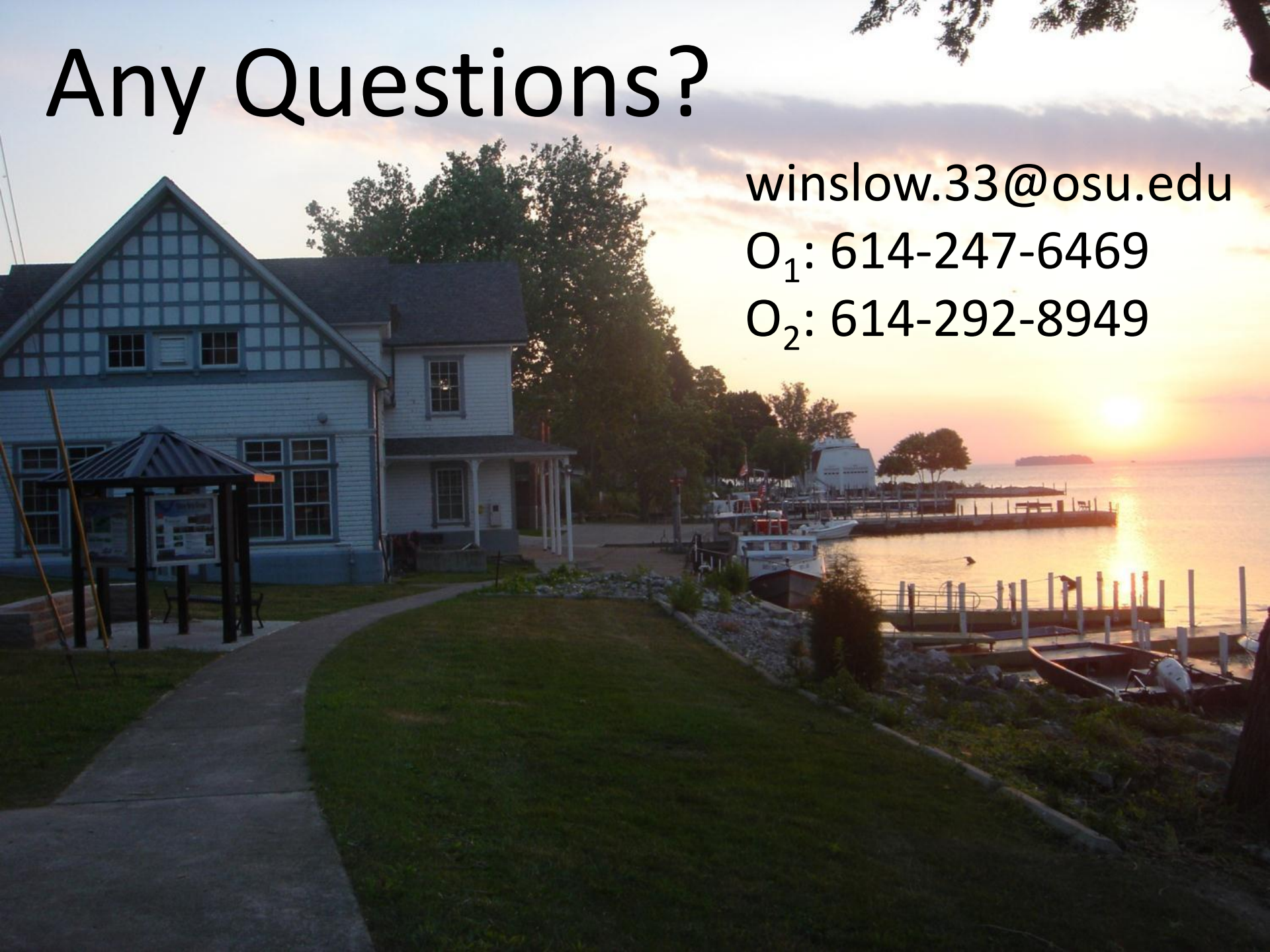
Farmer Decisions

- Not all BMPs are equally promising from a farmer **behavior standpoint**:
  - Likely: soil tests at sufficient frequency to inform nutrient application (94%)
  - Likely: timing related practices (94%)
  - Likely: subsurface placement (**74%**)
  - Difficult: incentives to off-set short-term cost and risk

Farmer Decisions Continued…

- "Barriers" linked to legitimate logistical issues:
  - Access to needed equipment or supplies (e.g., subsurface placement)
  - Limited windows for application (SB1 and real-time weather)
- Why "barrier": Self efficacy and response efficacy
  - Self: can appropriately perform/implement practice
  - Response: BMP effective at reducing P loading

Any Questions?



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