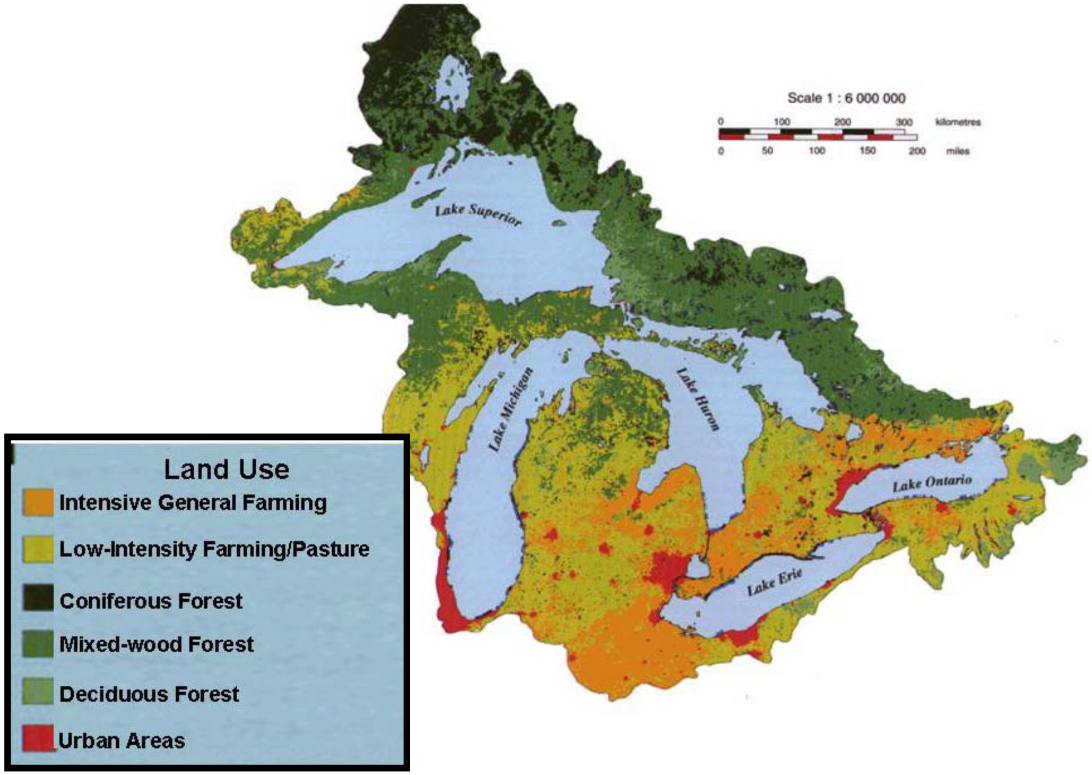
OHIO SEA GRANT AND STONE LABORATORY

Understanding the History and Current State of Lake Erie and How to Fix It

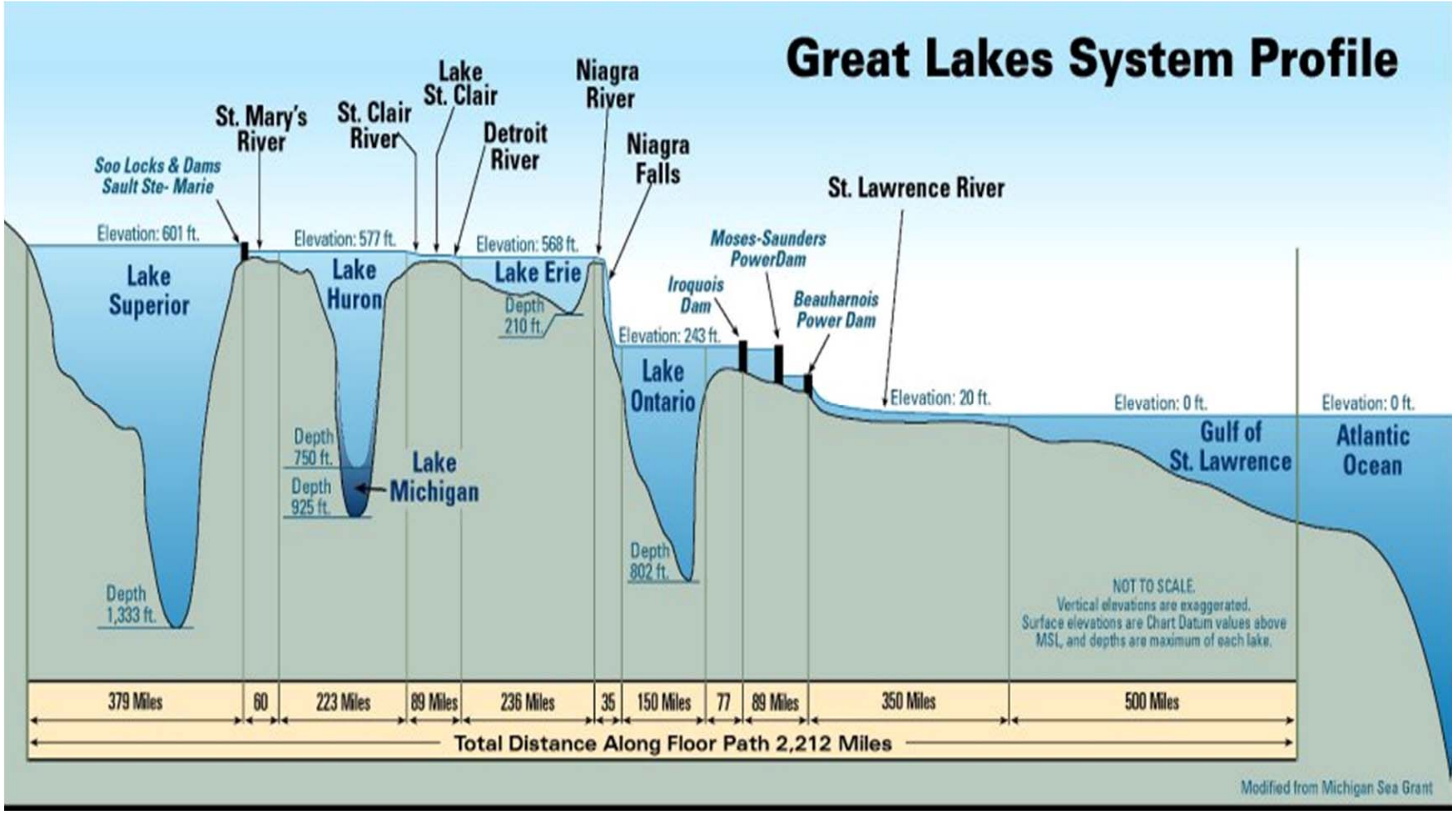
Dr. Jeffrey M. Reutter

Special Advisor, Ohio Sea Grant College Program

Southernmost

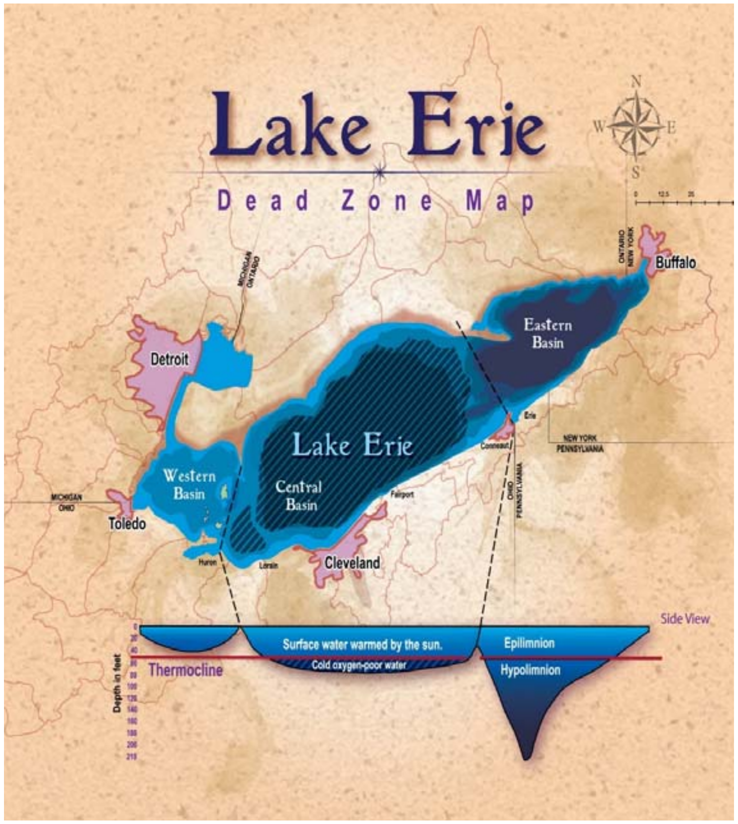


Shallowest and Warmest

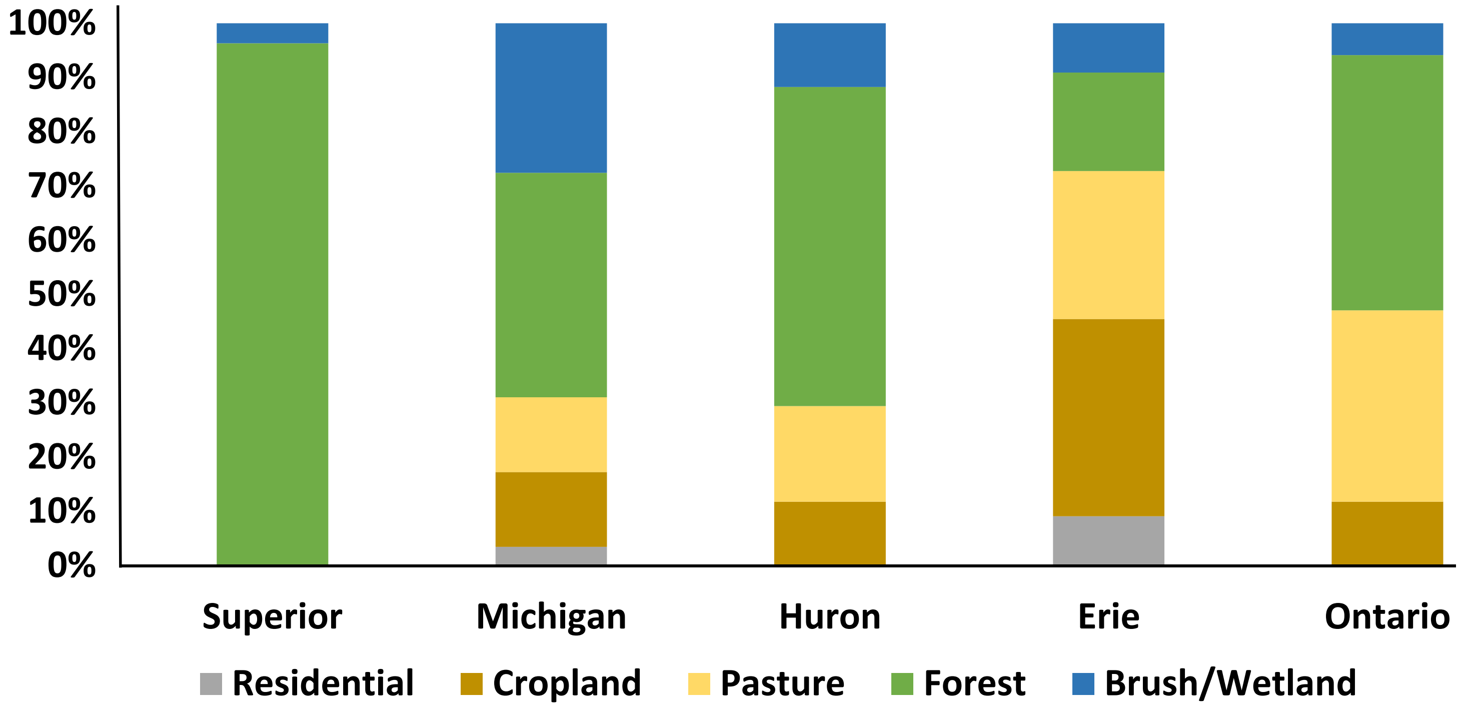


Lake Erie Stats

- Lake Erie
  - 9,906 sq. miles
  - 11th in area 17th volume
  - 241 miles long 57 wide
- Western Basin
  - Ave. depth 24 ft.
  - 13% area, 5% volume
- Central Basin
  - Ave. depth 60 ft.
  - 63% area and volume
- Eastern Basin
  - Ave. 80 ft., Max 210 ft.
  - 24% area, 32% volume

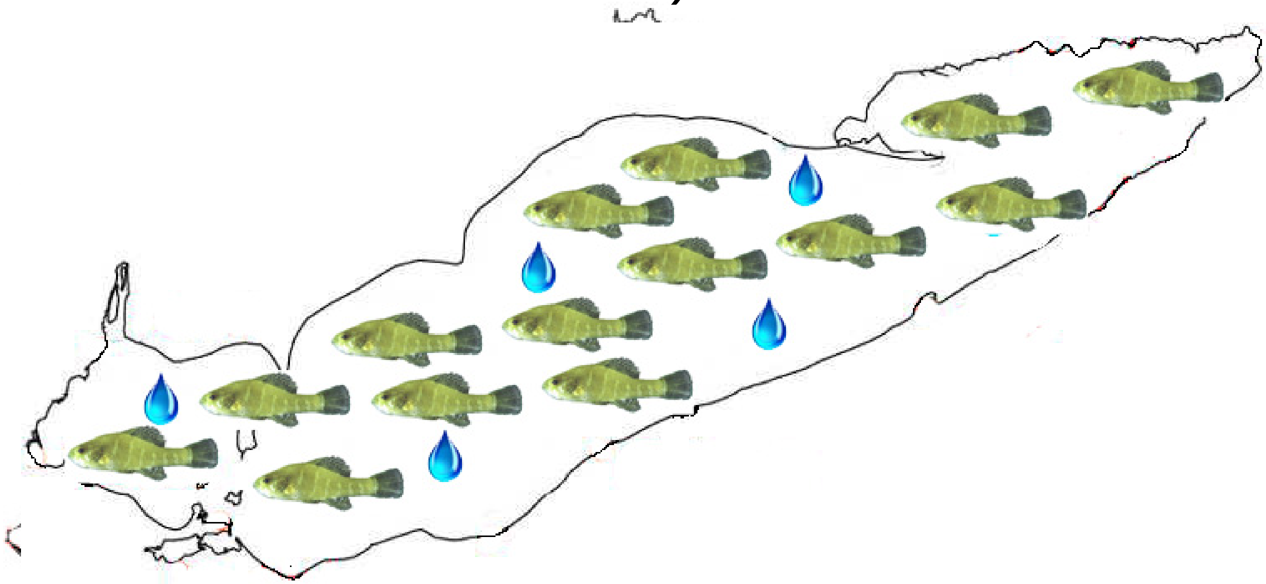


Major Land Uses in The Great Lakes



50:2 Rule

(Not exact, but instructive)



Lake Erie:
2% of the water and 50% of the fish

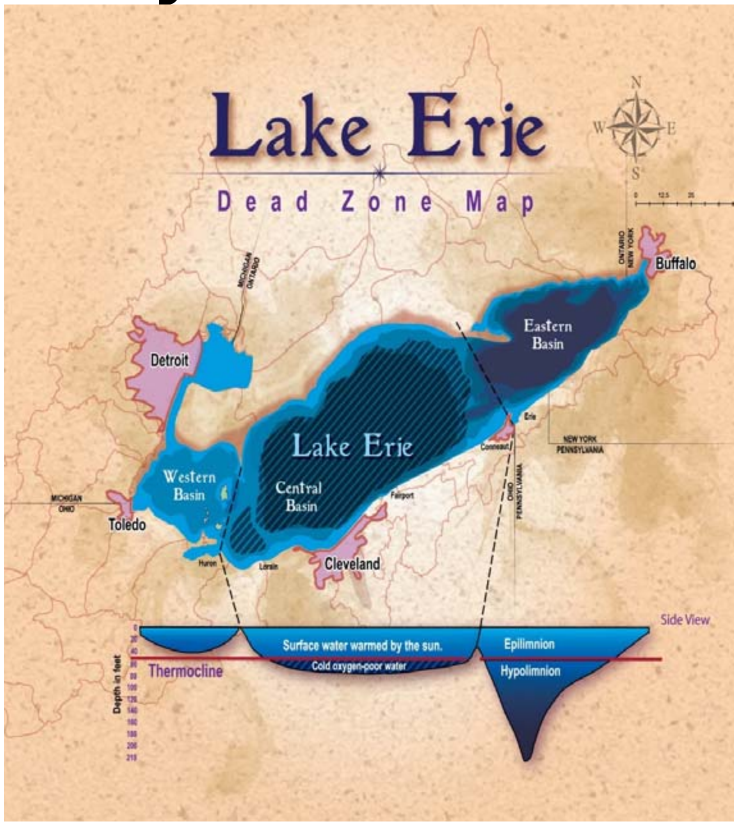
Lake Superior:
50% of the water and 2% of the fish

80:10:10 Rule

- 80% of water from upper lakes
- 10% direct precipitation
- 10% from Lake Erie tributaries
  - Maumee
    - Largest tributary to Great Lakes
      - Drains 4.2 million acres of ag land
    - 3% of flow into Lake Erie

Expect Rapid Recovery in Lake Erie, but must act quickly

- Due to rapid flush out rate
  - Lake Erie = 2.7 years
  - Western Basin = 20-50 days
- Other Great Lakes could be over 100 years



OHIO SEA GRANT AND STONE LABORATORY


OSU's Island Campus

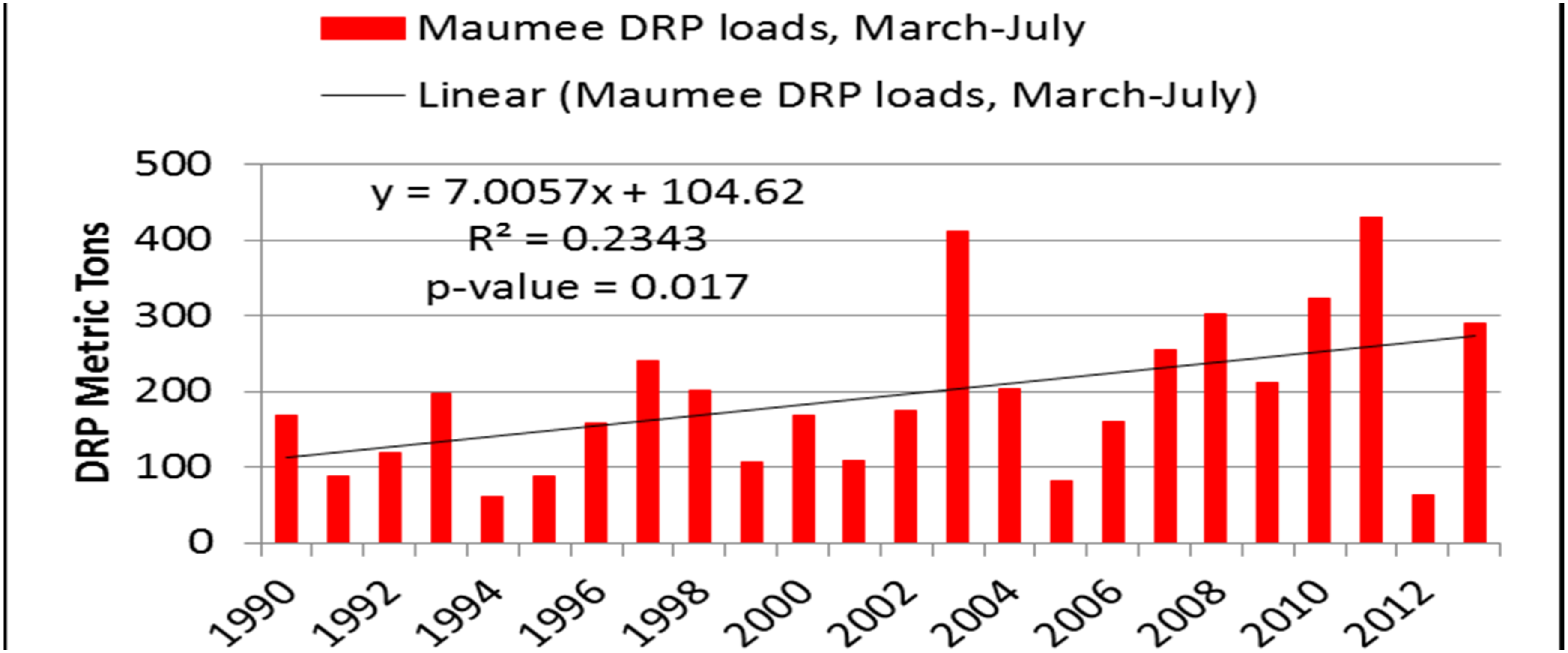
Blue-green Algae Bloom circa 1971, Lake Erie

Photo: Forsythe and Reutter

What brought about the rebirth (dead lake to Walleye Capital)?

- <u>Phosphorus reductions</u> from point sources (29,000 metric tons to 11,000).

144% Increase in DRP



Nutrient Loading

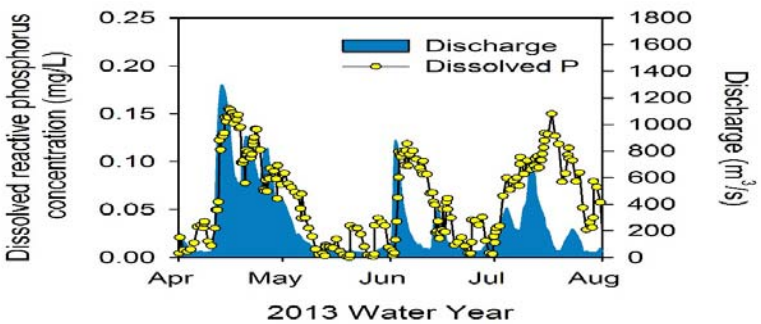
- P discharges from sewage treatment plants vary little from year to year
- P discharges from ag tributaries vary greatly from year to year depending on rainfall
- Majority of P loading occurs during storm events
- 80-90% of P loading occurs 10-20% of time

Where did the dissolved phosphorus come from?

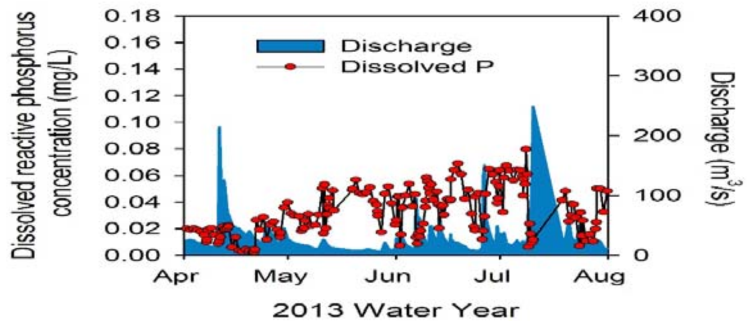
Dissolved phosphorus is highly bioavailable to algae

Indicators of non-point sources	Indicators of point sources
e.g., land runoff	*e.g., effluent*
Example: Maumee River	Example: Cuyahoga River

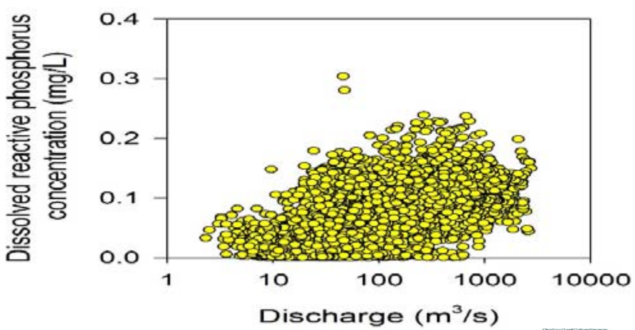
1) Concentration increases during storms



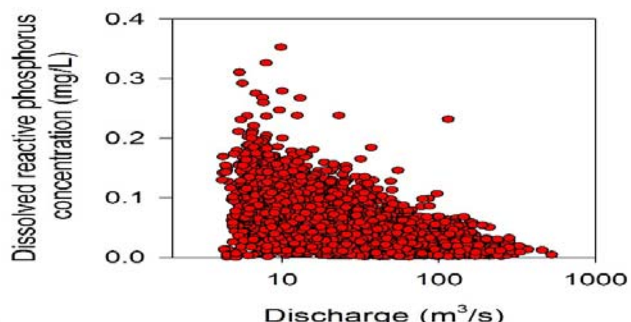
1) Concentration increases during low flow



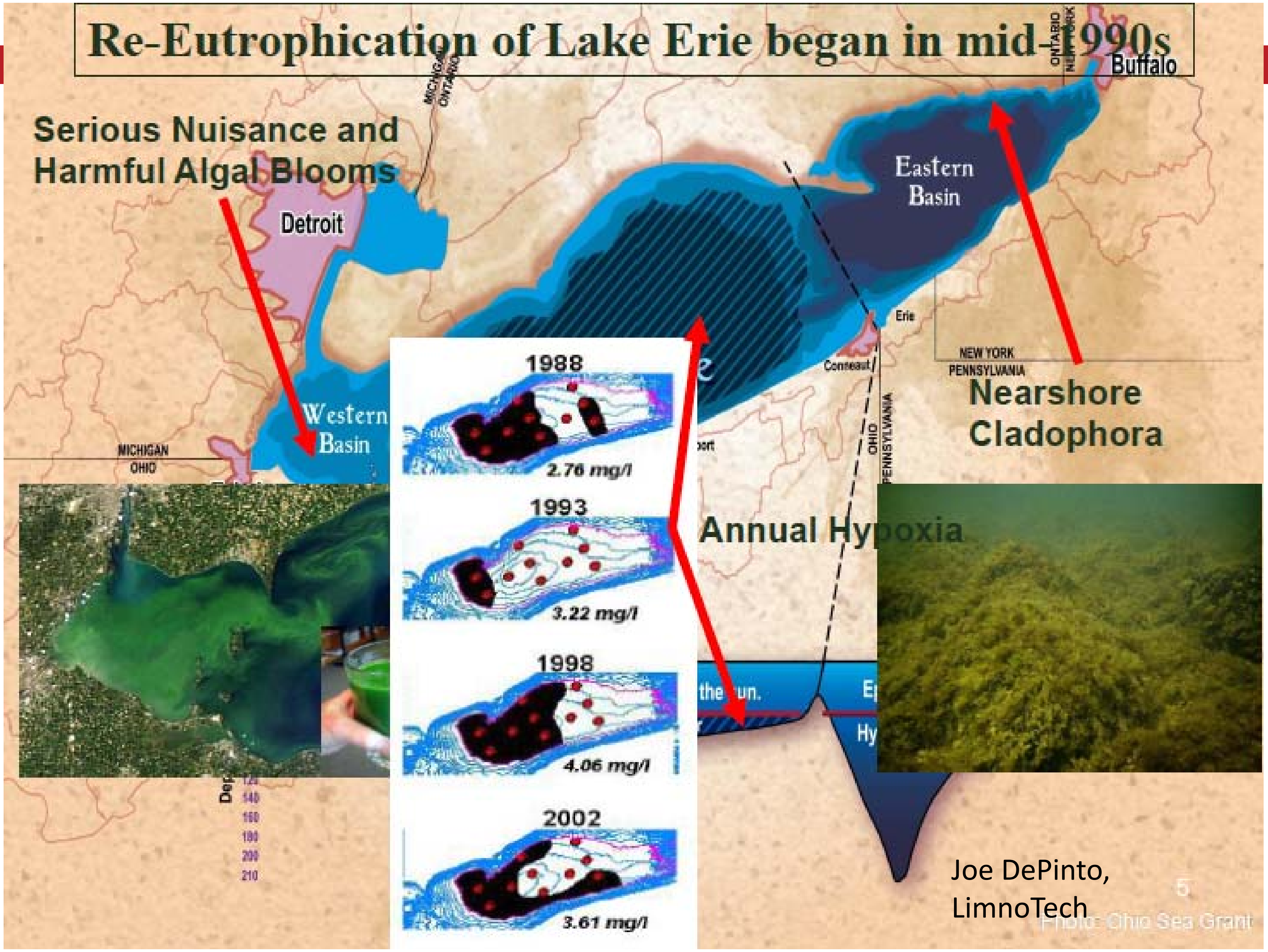
2) Concentration increases with flow



2) Concentration decreases with flow

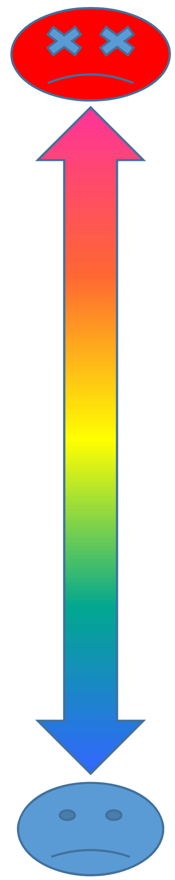


The Ohio State University


Re-Eutrophication of Lake Erie began in mid-1990s
Serious Nuisance and
Harmful Algal Blooms
Detroit
Western
Basin
Eastern
Basin
Buffalo
Erie
Conneaut
NEW YORK
PENNSYLVANIA
MICHIGAN
OHIO
Nearshore
Cladophora
Annual Hypoxia
1988
2.76 mg/l
1993
3.22 mg/l
1998
4.06 mg/l
2002
3.61 mg/l
Joe DePinto,
LimnoTech
Photo: Ohio Sea Grant
5

Toxicity of Algal Toxins Relative to Other Toxic Compounds found in Water

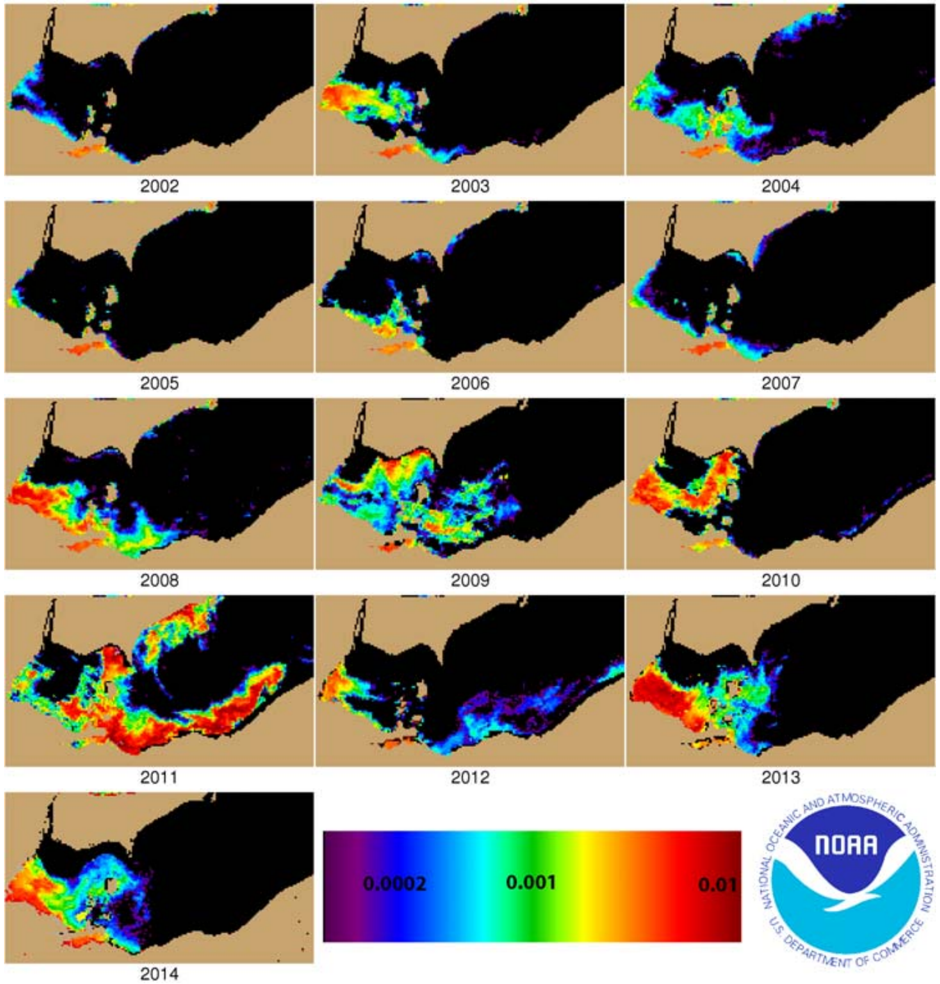
- **Reference Dose = amount that can be ingested orally by a person, above which a toxic effect may occur, on a milligram per kilogram body weight per day basis.**



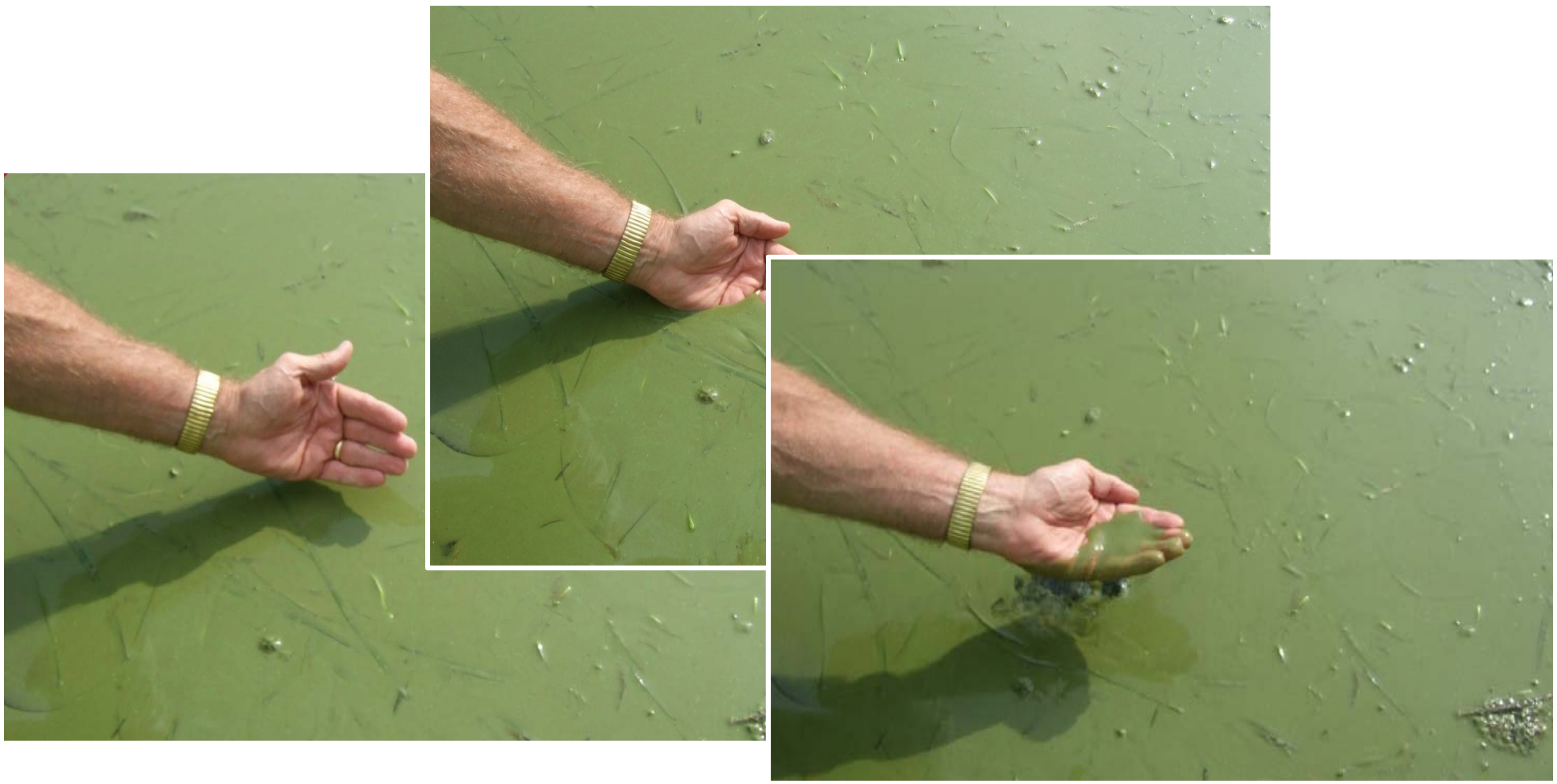
Toxin Reference Doses

- Dioxin (0.000001 mg/kg-d
- Microcystin LR (0.000003 mg/kg-d)
- Saxitoxin (0.000005 mg/kg-d)
- PCBs (0.00002 mg/kg-d)
- Cylindrospermopsin (0.00003 mg/kg-d)
- Methylmercury (0.0001 mg/kg-d)
- Anatoxin-A (0.0005 mg/kg-d)
- DDT (0.0005 mg/kg-d)
- Selenium (0.005 mg/kg-d)
- Botulinum toxin A (0.001 mg/kg-d)
- Alachlor (0.01 mg/kg-d)
- Cyanide (0.02 mg/kg-d)
- Atrazine (0.04 mg/kg-d)
- Fluoride (0.06 mg/kg-d)
- Chlorine (0.1 mg/kg-d)
- Aluminum (1 mg/kg-d)
- Ethylene Glycol (2 mg/kg-d)

13 Years of Satellite Bloom Data



Microcystis, Stone Lab, 8/10/10



Photos: Jeff Reutter


October 9, 2011
Photo: NOAA Satellite Image

Microcystis, Stone Lab, 9/20/13

Timing of Phosphorus Load

- HABs
  - Primary Cause is phosphorus load from 1 March-31 July from Maumee River
  - DRP is most important
  - Can be forecast by load from Maumee River
  - Cannot be forecast by load from Detroit River
- Dead Zone and Cladophora
  - Annual phosphorus load is more important than spring load

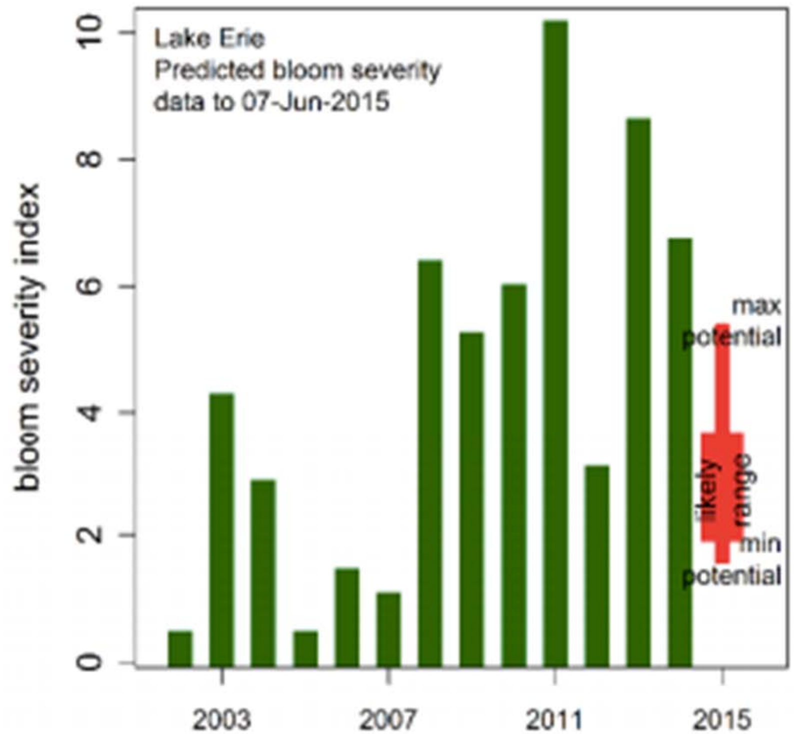


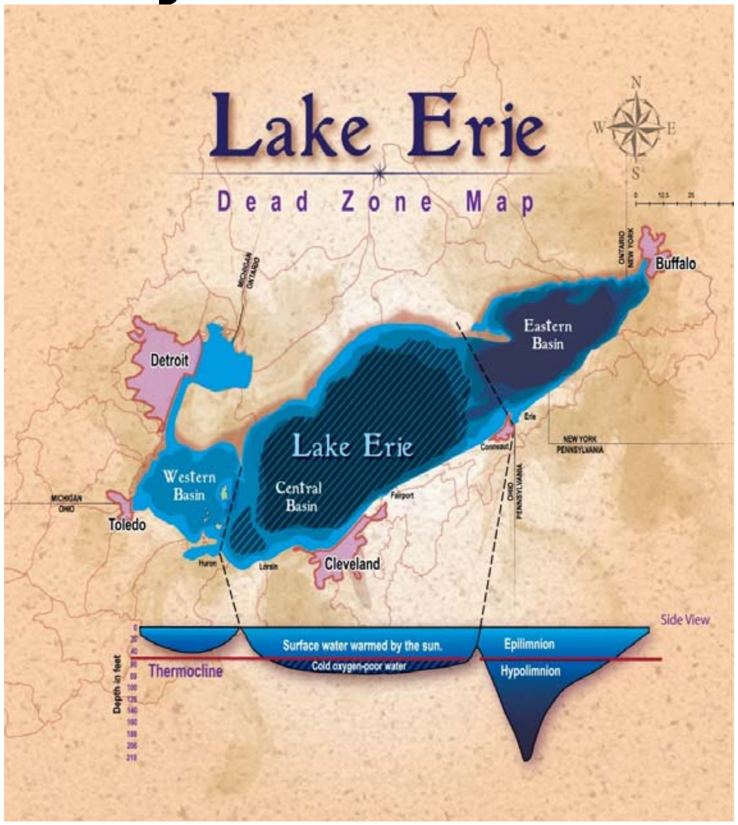
Figure 1. Projected bloom compared to previous years. The wide bar is the likely range of severity based on data from the last 15 years. The narrow bar is the potential range of severity, indicating that a bloom of severity of 6 remains possible (as occurred in 2008-2010). While a non-bloom year is unlikely, the projection still remains below the severe blooms of the last few years.

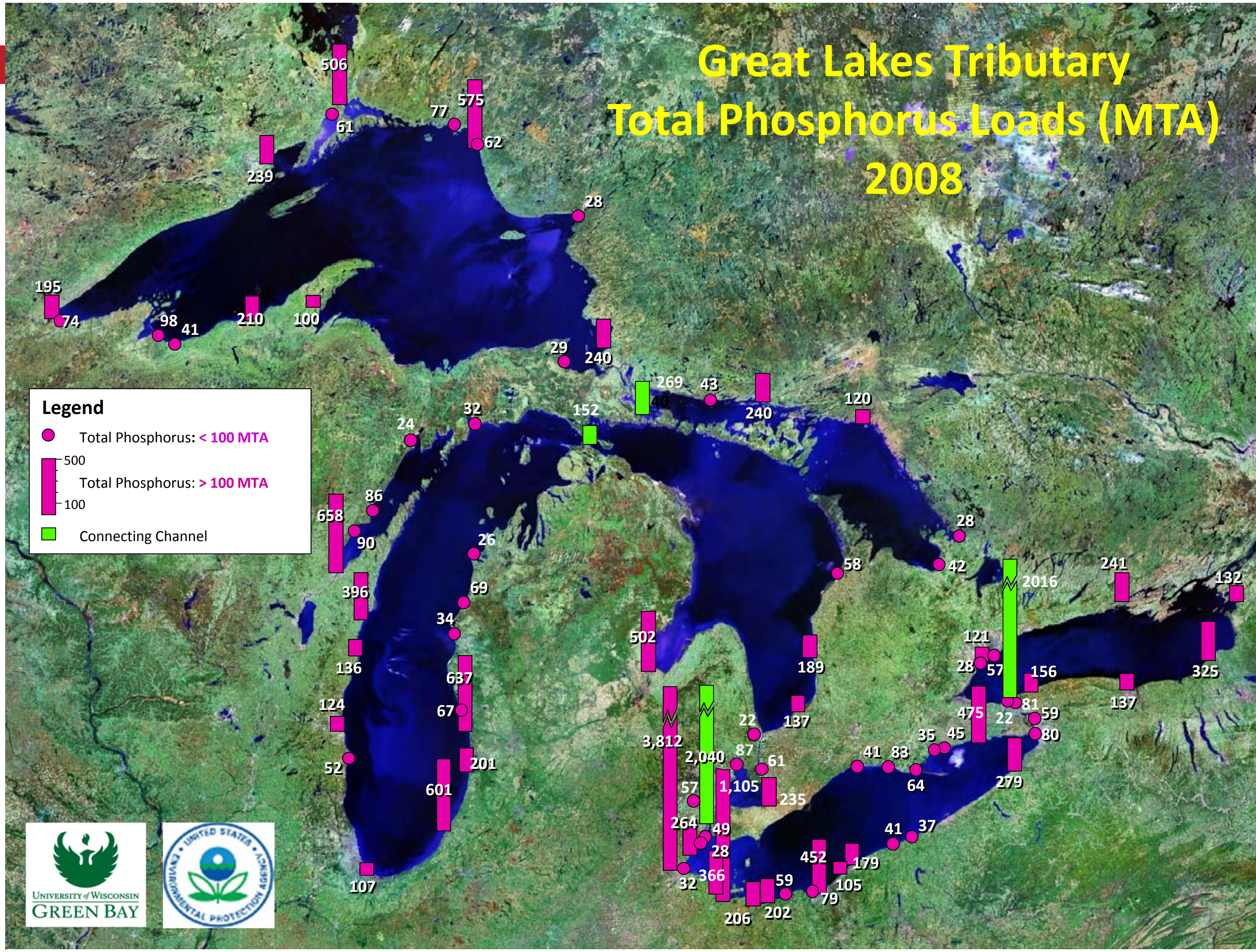
Target Loads to Solve Problem

- Chaired subcommittee of Ohio Phosphorus Task Force to identify target P loads to prevent or greatly reduce HABs
- Target is 40% reduction (Ohio Phosphorus Task Force II, 3/14/13)
- US Co-Chair Annex 4 Loading Task Team
  - Report released soon

Expect Rapid Recovery in Lake Erie, but must act quickly

- Due to rapid flush out rate
  - Lake Erie = 2.7 years
  - Western Basin = 20-50 days
- Other Great Lakes could be over 100 years

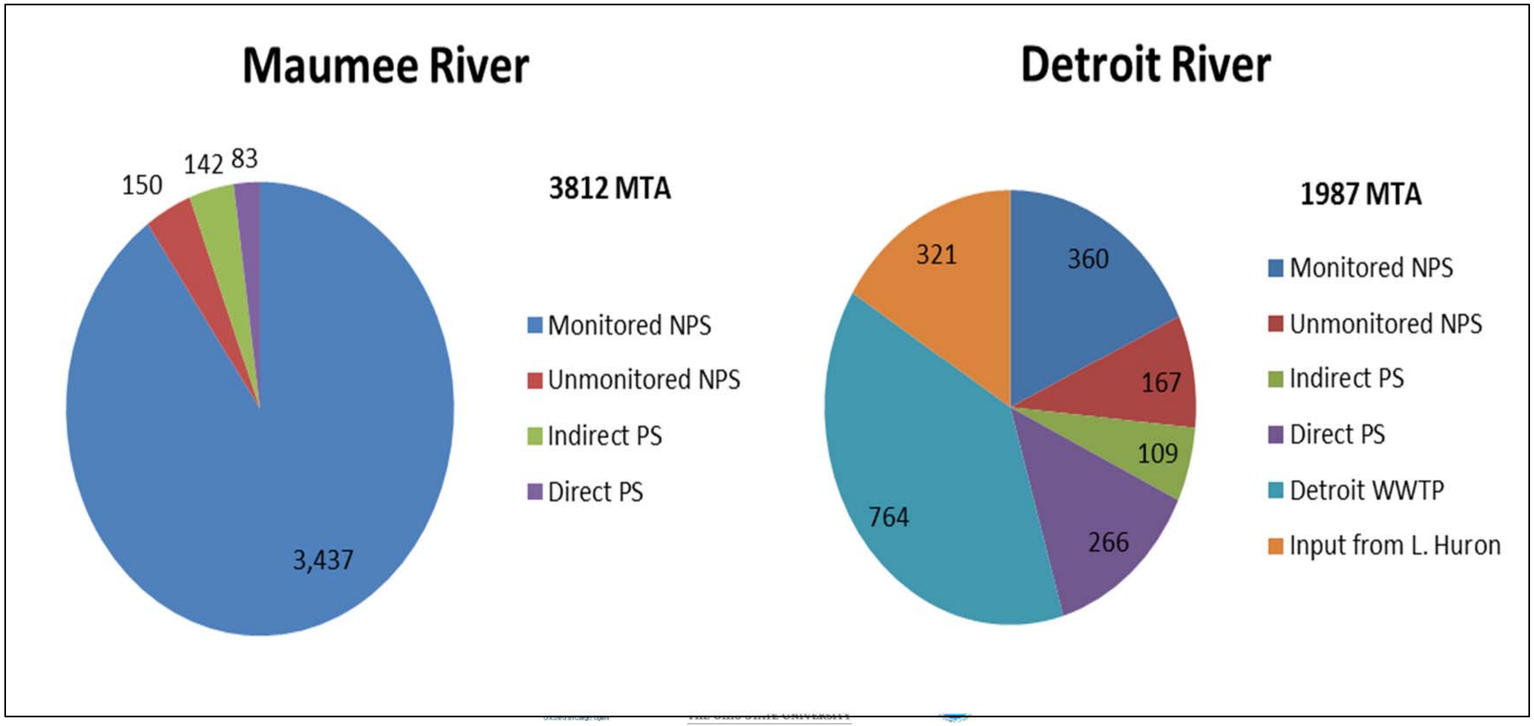



Great Lakes Tributary
Total Phosphorus Loads (MTA)
2008
Legend
Total Phosphorus: < 100 MTA
500
Total Phosphorus: > 100 MTA
100
Connecting Channel
506
61
77
575
62
239
28
195
74
98
41
210
100
29
240
269
40
43
240
120
24
32
152
86
658
90
26
69
396
34
136
637
67
124
52
201
601
107
502
3,812
2,040
1,105
57
264
49
28
32
366
22
87
61
235
137
189
58
28
42
2016
241
132
121
28
57
156
137
325
475
22
81
59
80
35
45
41
83
64
279
41
37
452
179
105
79
59
202
206
University of Wisconsin
Green Bay

Loading Definitions

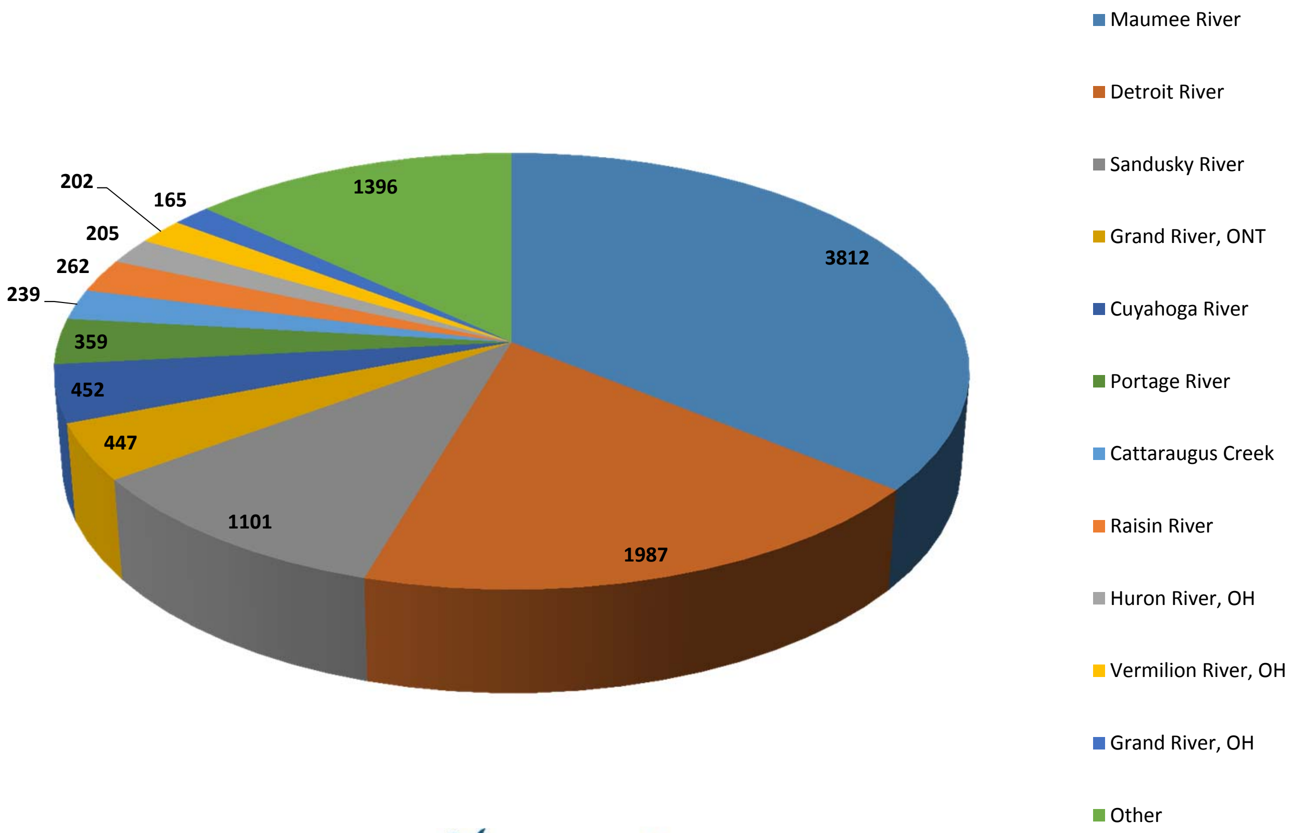
- Monitored NPS = Monitored tribs with point sources subtracted
- Unmonitored NPS = non-point source estimates for tributaries that are not monitored
- Direct Point Sources = Municipal and industrial point sources that are lakeward of the monitoring station (or discharge directly into the lake)
- Indirect Point Source = point sources upstream from the monitoring station

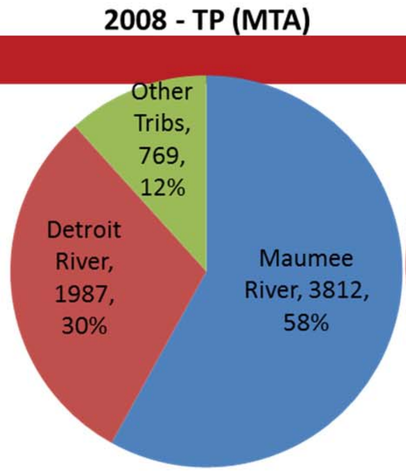
Distribution of annual TP load for the 2008 water year from the Maumee and Detroit Rivers by source category (Maccoux unpublished data).

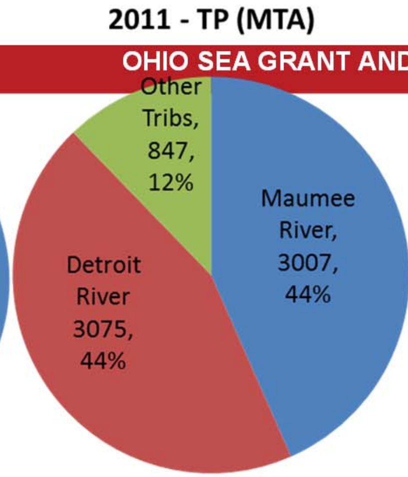


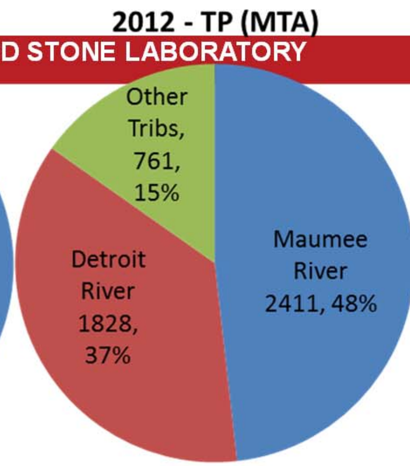
2008 Total Annual TP Load to Lake Erie = 10,722 MTA

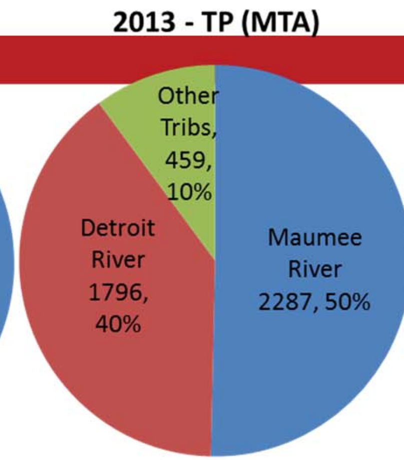
2008

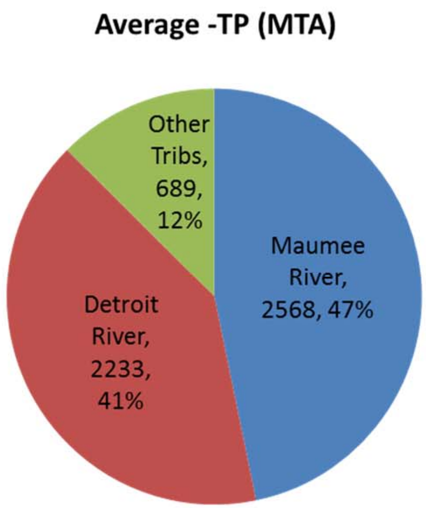


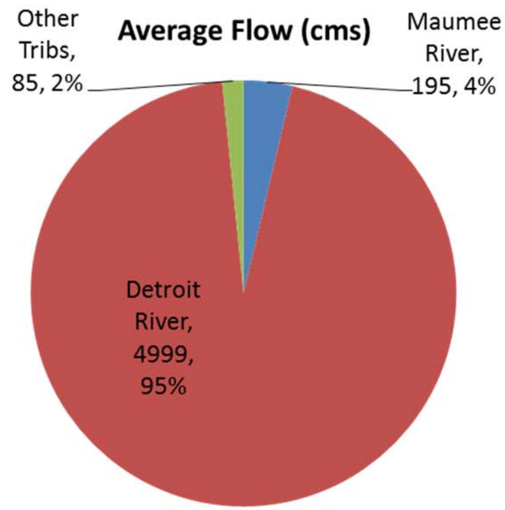


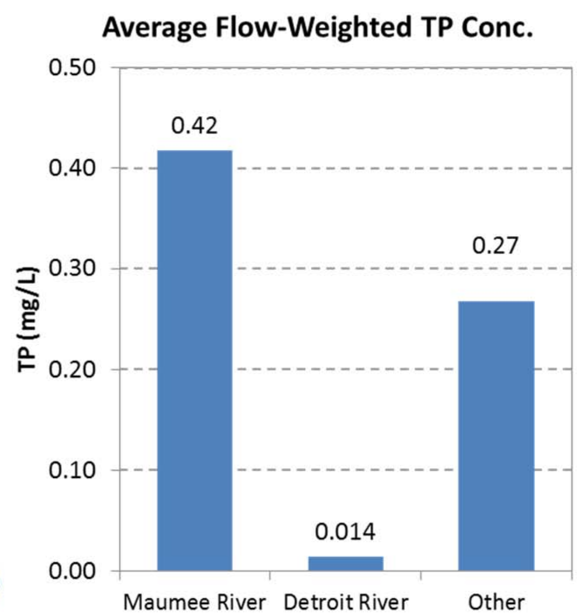












Flows into Western Basin

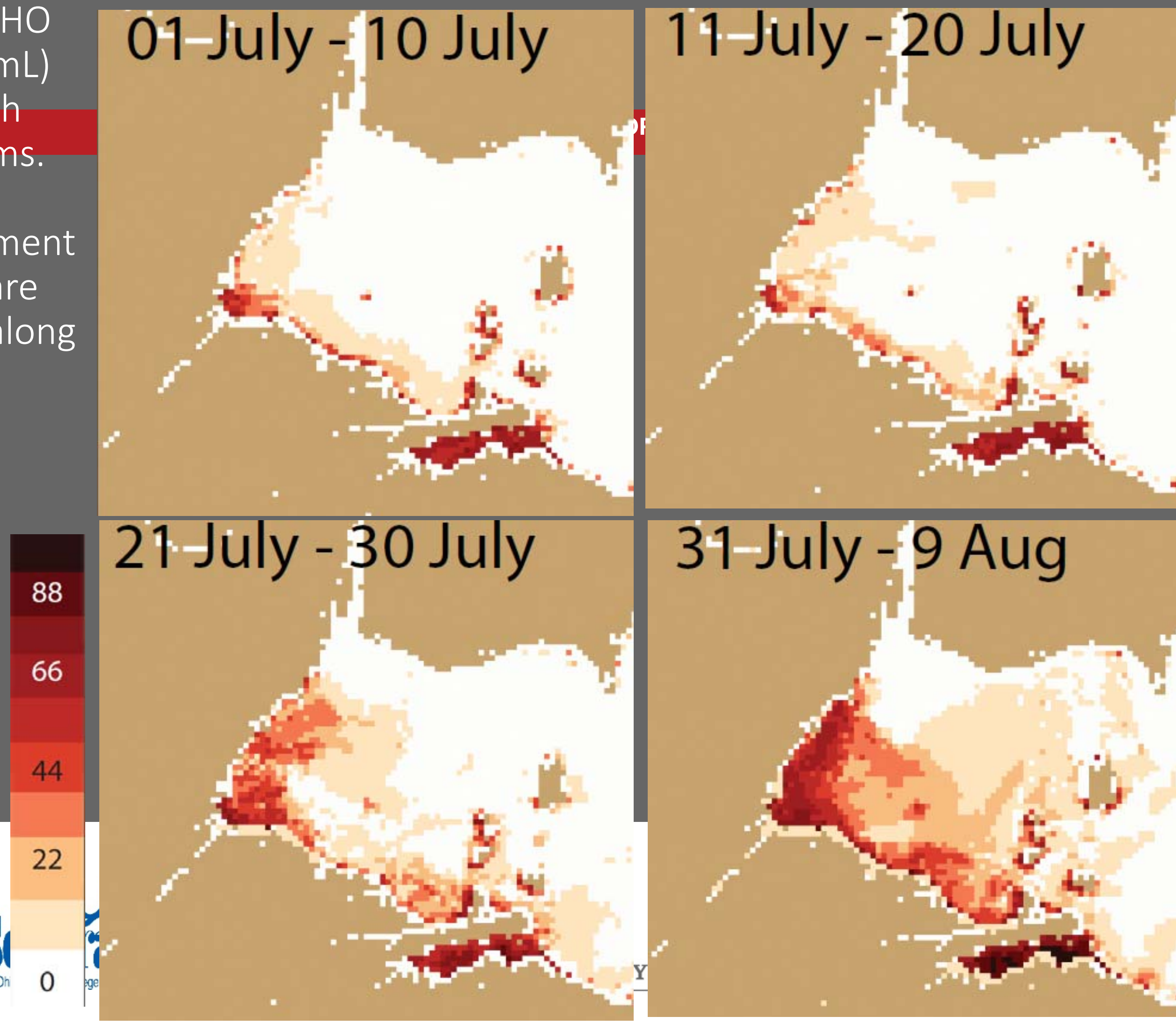
Sea Grant
The Ohio State University

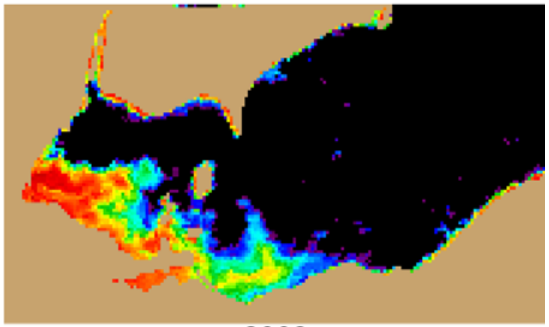
Frequency of WHO risk (>10^5 cells/mL) during years with significant blooms.

During development period blooms are most common along the coast

(Wynne & Stumpf submitted)

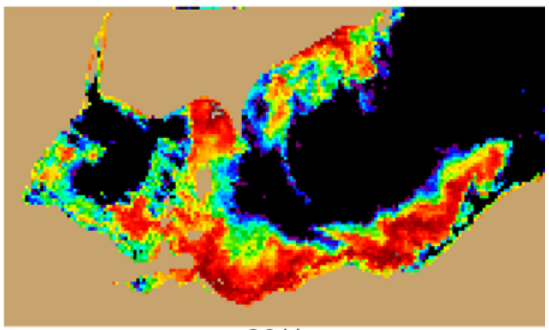
Blooms start At the Mouths Of Tributaries





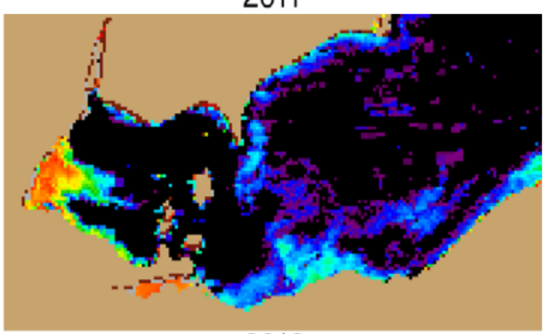
2008

- 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

Immediate Needs

- Arm water treatment plants with tools, technology, and training to remove toxins
  - Assures that plants produce safe drinking water
- Reduce load of P into Lake Erie by 40%
  - Eliminates HABs and toxins
  - Target bioavailable P
    - PP is 25-50% bioavailable
    - DRP is 100% bioavailable
    - 1 pound of DRP = 2-4 pounds of PP

Ohio Sea Grant, Nutrients, and HABs

- HABs and Nutrient Related projects funded since 1990: 62 projects received $3,559,642 and provided $2,247,412 in match
- Participation on calls with OEPA, USEPA, and City of Toledo
- Took our toxin analysis supplies to Toledo
- Saturday early morning, Congressman Latta and Senator Portman called me directly to try to better understand the situation and help them formulate their remarks as they headed to Toledo. They both have my cell phone number.
- My phone never stopped ringing that entire week. Good Morning America was in my living room filming and interviewing me at 10:30 PM Sunday night, 3 August.
- In 2012 and 2013 we were covered/quoted over 400 times each year, and over 500 times in 2014. For me personally, it was 120+ in 2012, 180+ in 2013, and ~230 articles so far in 2014 in 130+ venues, and for me personally since 1 August, 150+ articles in approx 90 venues.
- I am the US Chair for all of the Great Lakes leading the effort to develop the phosphorus reductions needed to solve the problem.
- Dr. Justin Chaffin, at Stone Lab, analyzed water samples from 7 Lake Erie Communities for them for algal toxins this past summer. He also did emergency analyses for OEPA. We also annually host workshops jointly with OEPA for water treatment plant operators to teach them to identify harmful forms of algae and remove the toxins
- Currently coordinating 18 projects ($4 million and 9 universities) for Ohio Board of Regents and 5 projects $1 million for OSU College of FAES' Field to Faucet initiative

BOR and F2F Focus Areas

BOR

1) Lake Erie HABs and Lake Water Quality

2) Producing Safe Drinking Water (including test assets and capabilities)

3) Land Use Practices, Sources of Enrichment, Water Quality and Engineered Systems

4) Human Health and Toxicity

5) Economics and Policy

Field to Faucet

1) **Censors for Cyanotoxins**
2) **System to remove N&P from manure**
3) **Nutrient management mobile ap**
4) **Geospacial Data Warehouse**
5) **UAVs for HABs and water collections**

Stone Lab: Reducing Our Environmental Footprint

- Solar thermal on Dining Hall
- Solar panels on new pavilion and Lab roof
- Low-flow toilets
- Low-flow shower heads and faucets
- Compact fluorescent light bulbs
- Attic insulation
- 4-cycle outboard motors
- Improved sewage treatment
- Terraces to reduce runoff

Sustainable Energy Production

Sea Grant

THE OHIO STATE UNIVERSITY

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