OHIO SEA GRANT AND STONE LABORATORY

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

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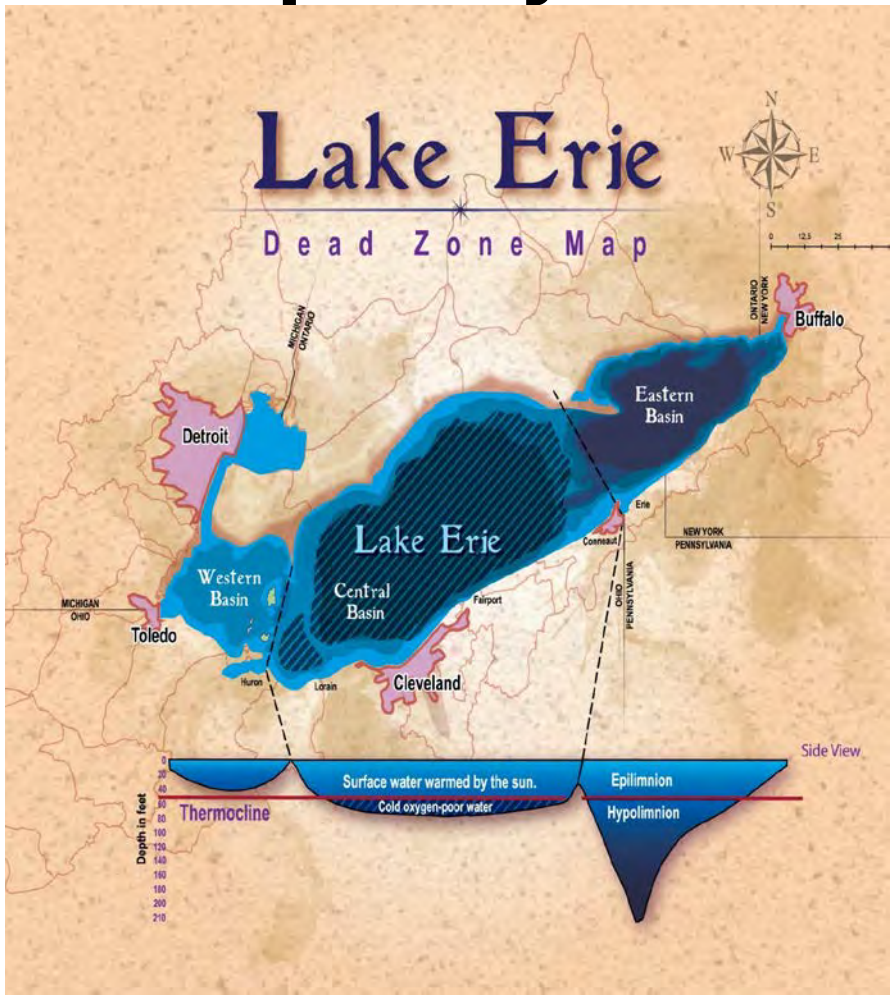
80:10:10 Rule

- 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



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Sea Grant

The Ohio State University

OSU's Island Campus

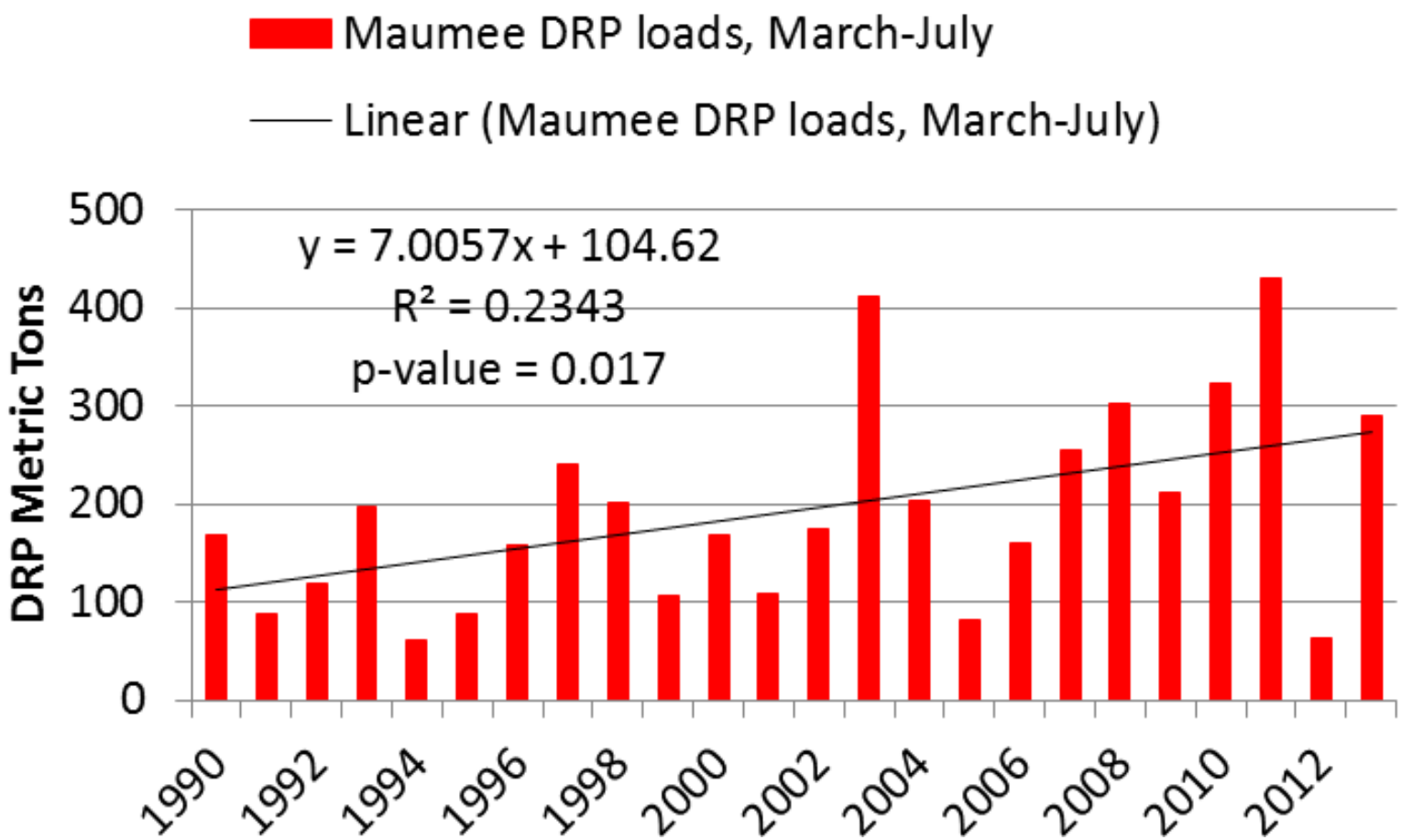
Blue-green Algae Bloom circa 1971, Lake Erie

Photo: Forsythe and Reutter

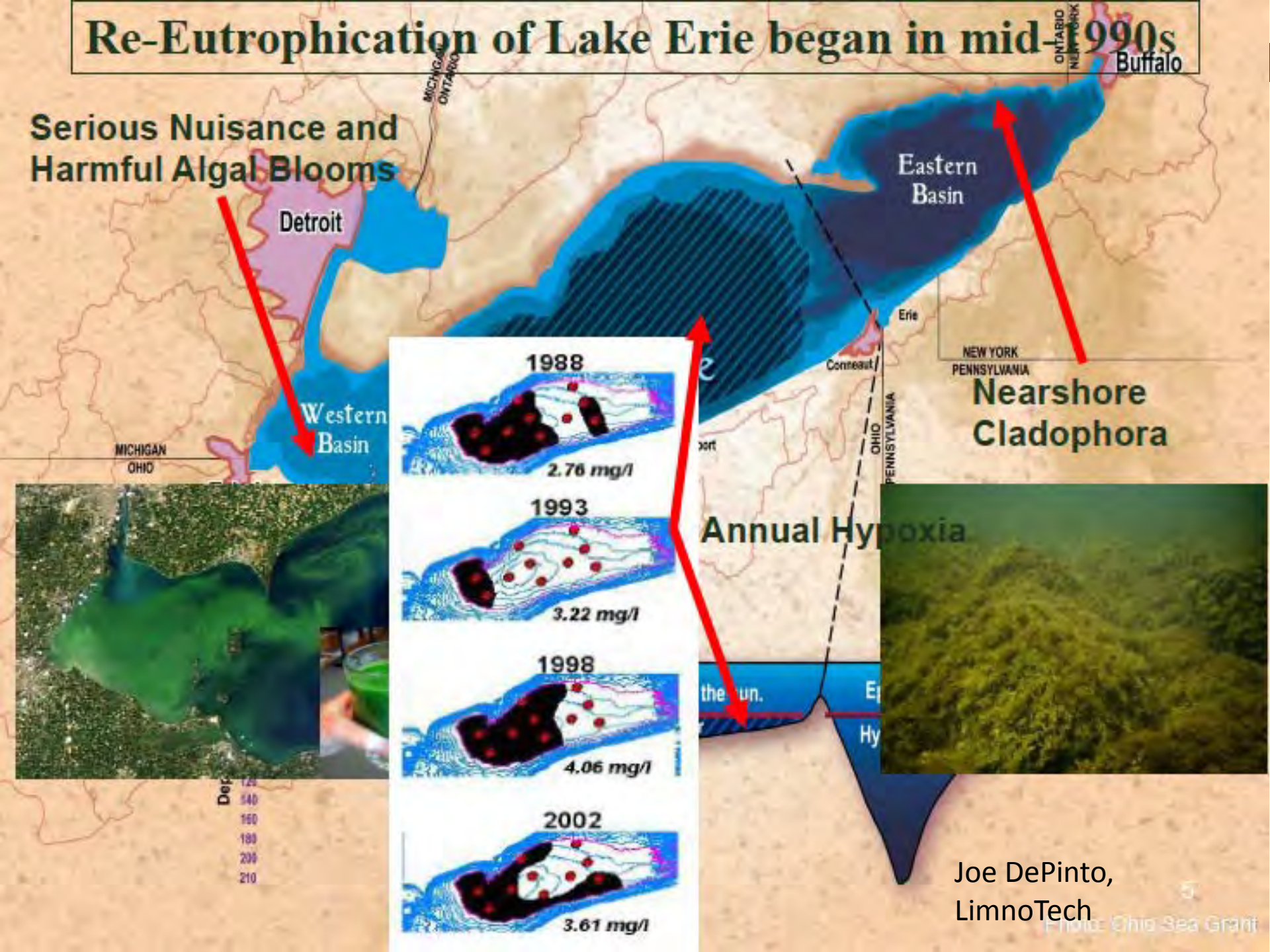
What brought about the rebirth (dead lake to Walleye Capital)?

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

144% Increase in DRP



Re-Eutrophication of Lake Erie began in mid-1990s

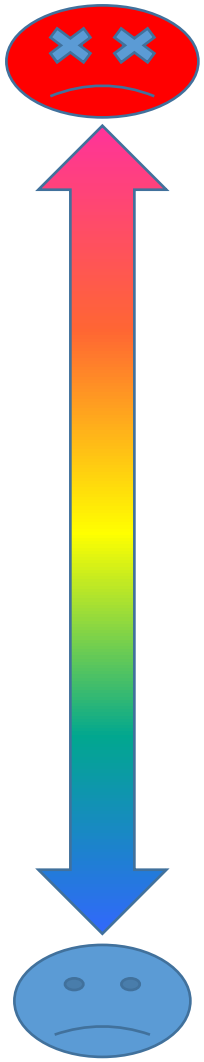


Joe DePinto, LimnoTech

Photo: Ohio Sea Grant

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

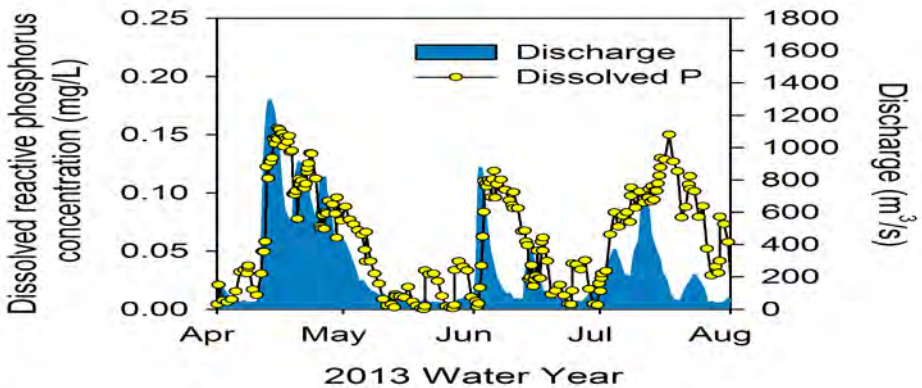
- Dioxin (0.000001 mg/kg-d
- Microcystin LR (0.000003 mg/kg-d)
- Saxitoxin (0.000005 mg/kg-d)
- PCBs (0.00002 mg/kg-d)
- Cylindrospermopsin (0.00003 mg/kg-d)
- Methylmercury (0.0001 mg/kg-d)
- Anatoxin-A (0.0005 mg/kg-d)
- DDT (0.0005 mg/kg-d)
- Selenium (0.005 mg/kg-d)
- Botulinum toxin A (0.001 mg/kg-d)
- 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)

Where did the dissolved phosphorus come from?

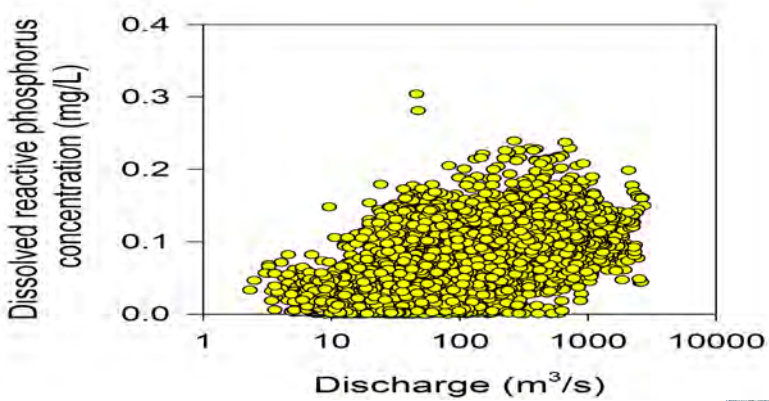
Dissolved phosphorus is highly bioavailable to algae

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

1) Concentration increases during storms

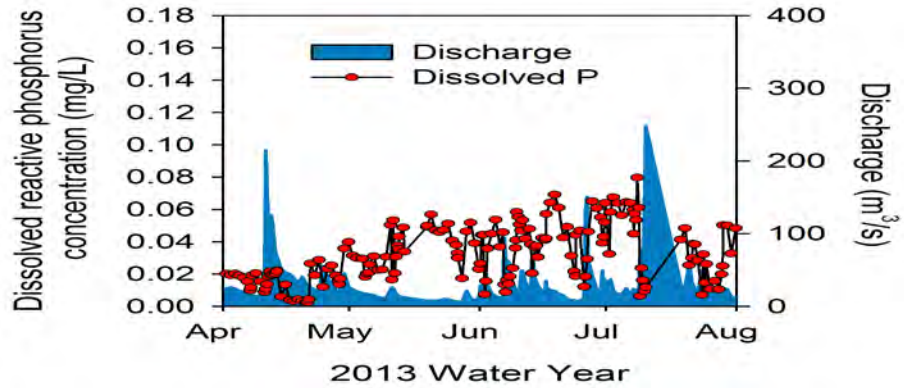


2) Concentration increases with flow

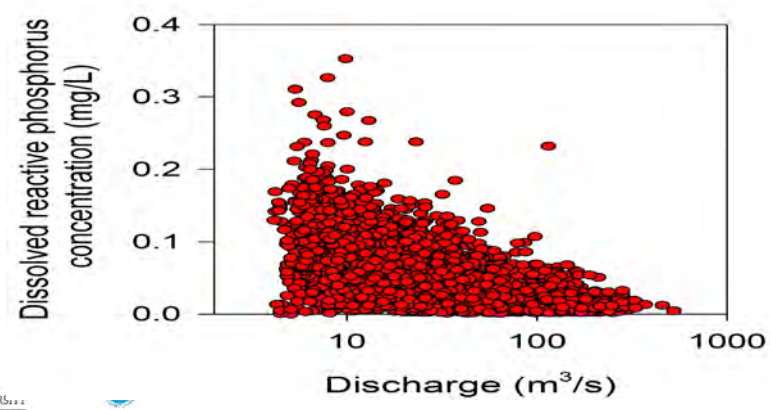


Indicators of point sources
e.g., effluent
Example: Cuyahoga River

1) Concentration increases during low flow



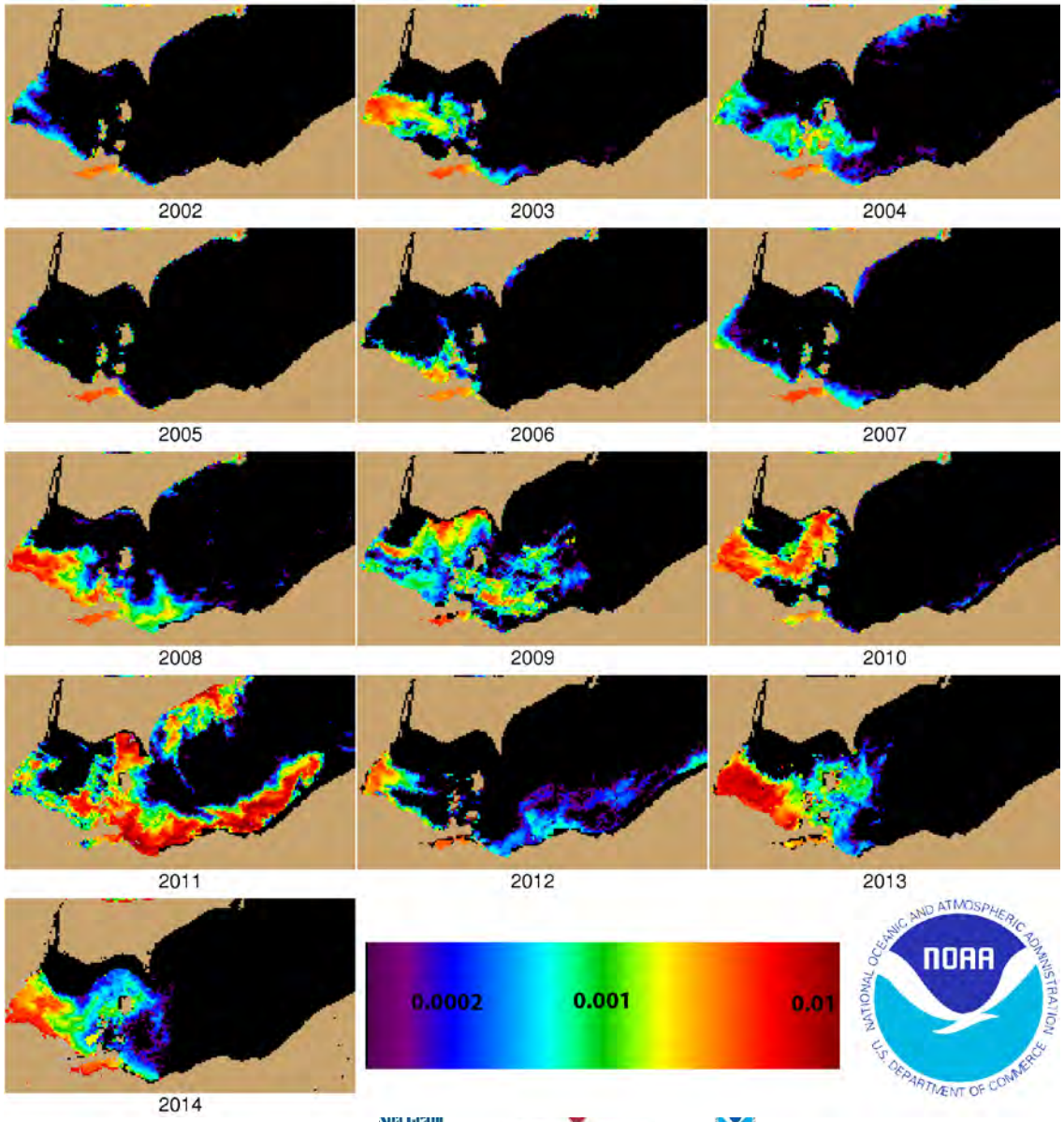
2) Concentration decreases with flow

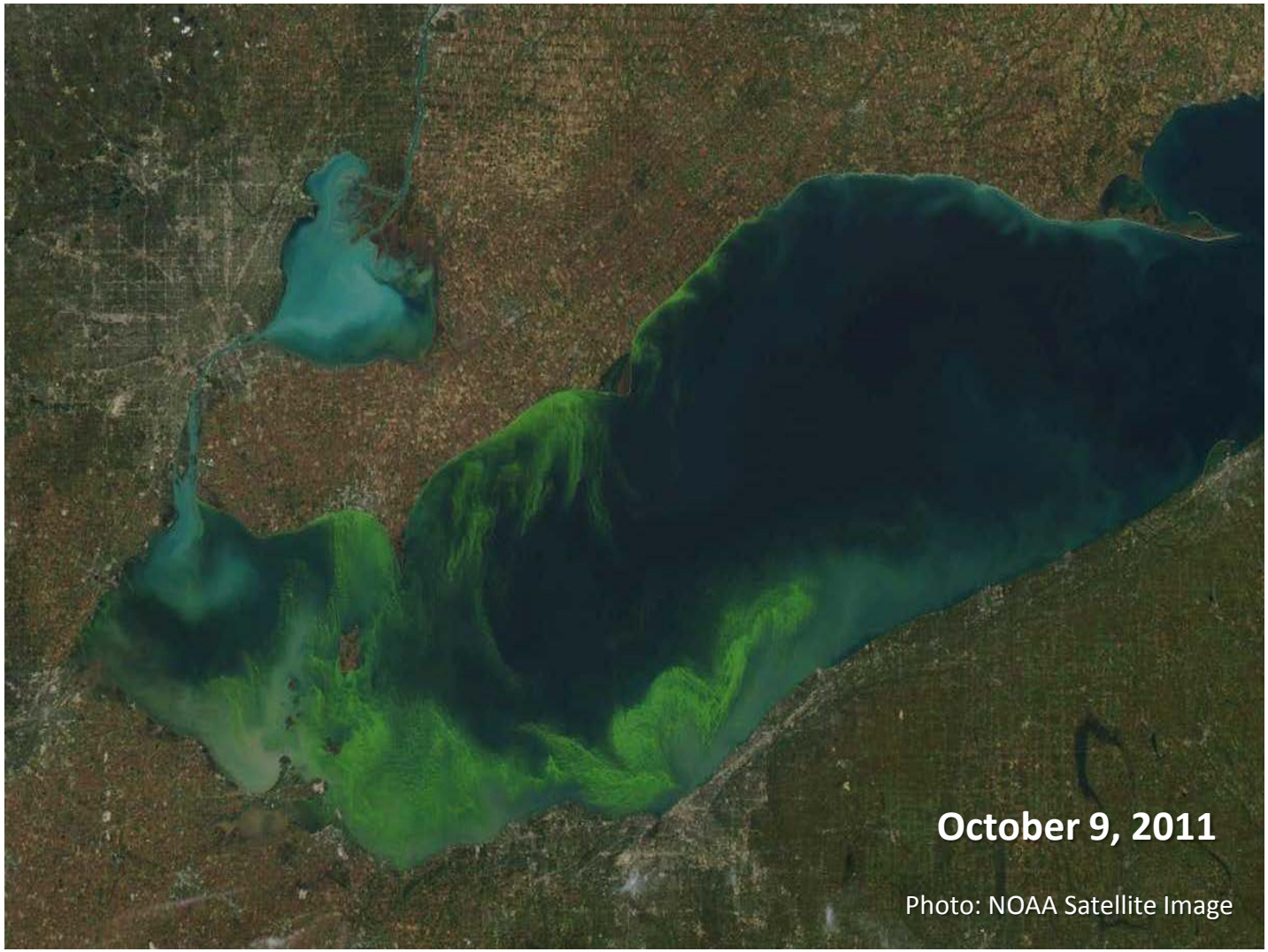


Nutrient Loading

- 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

13 Years of Satellite Bloom Data




October 9, 2011
Photo: NOAA Satellite Image

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

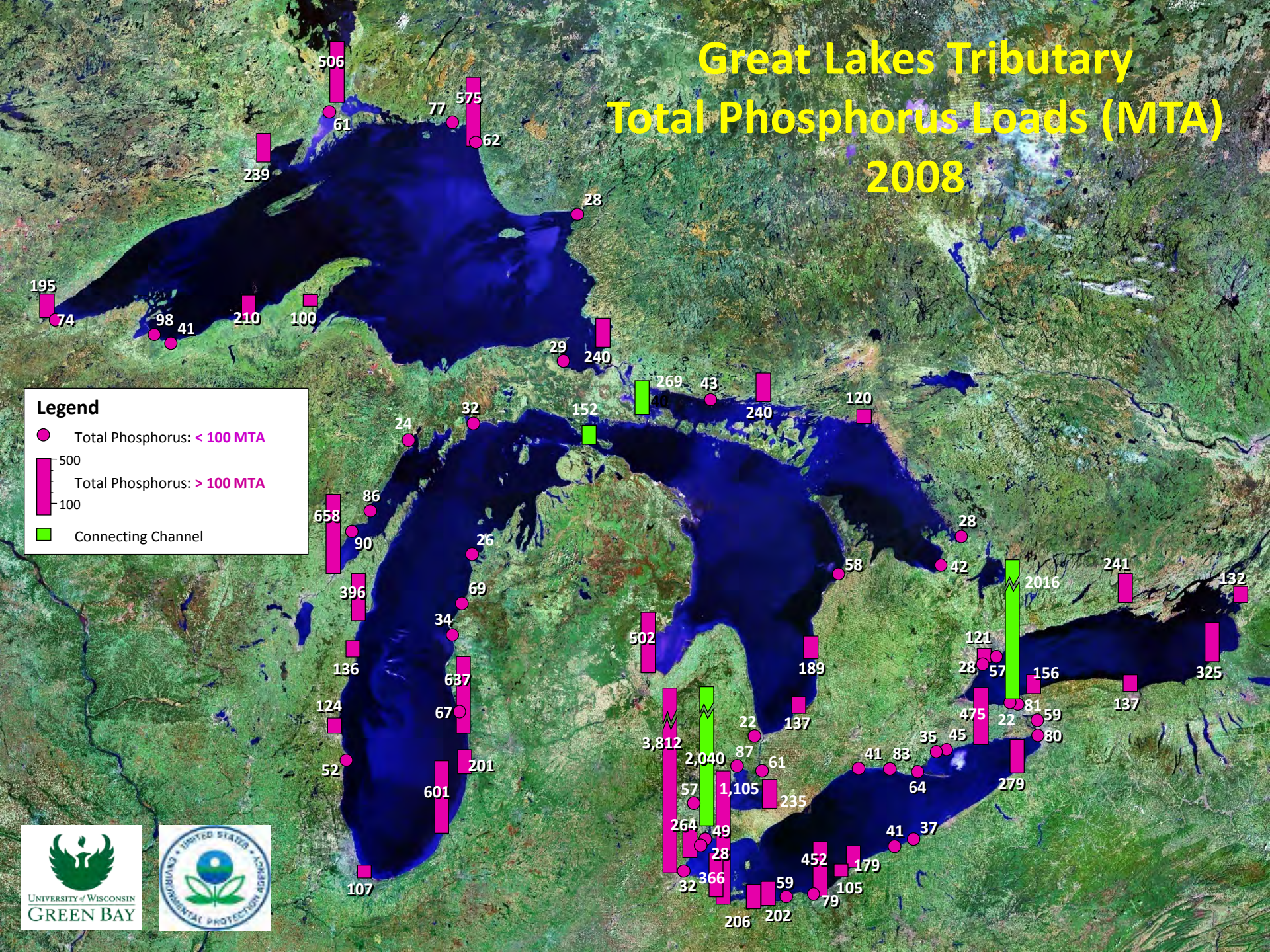
Target Loads to Solve Problem

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

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

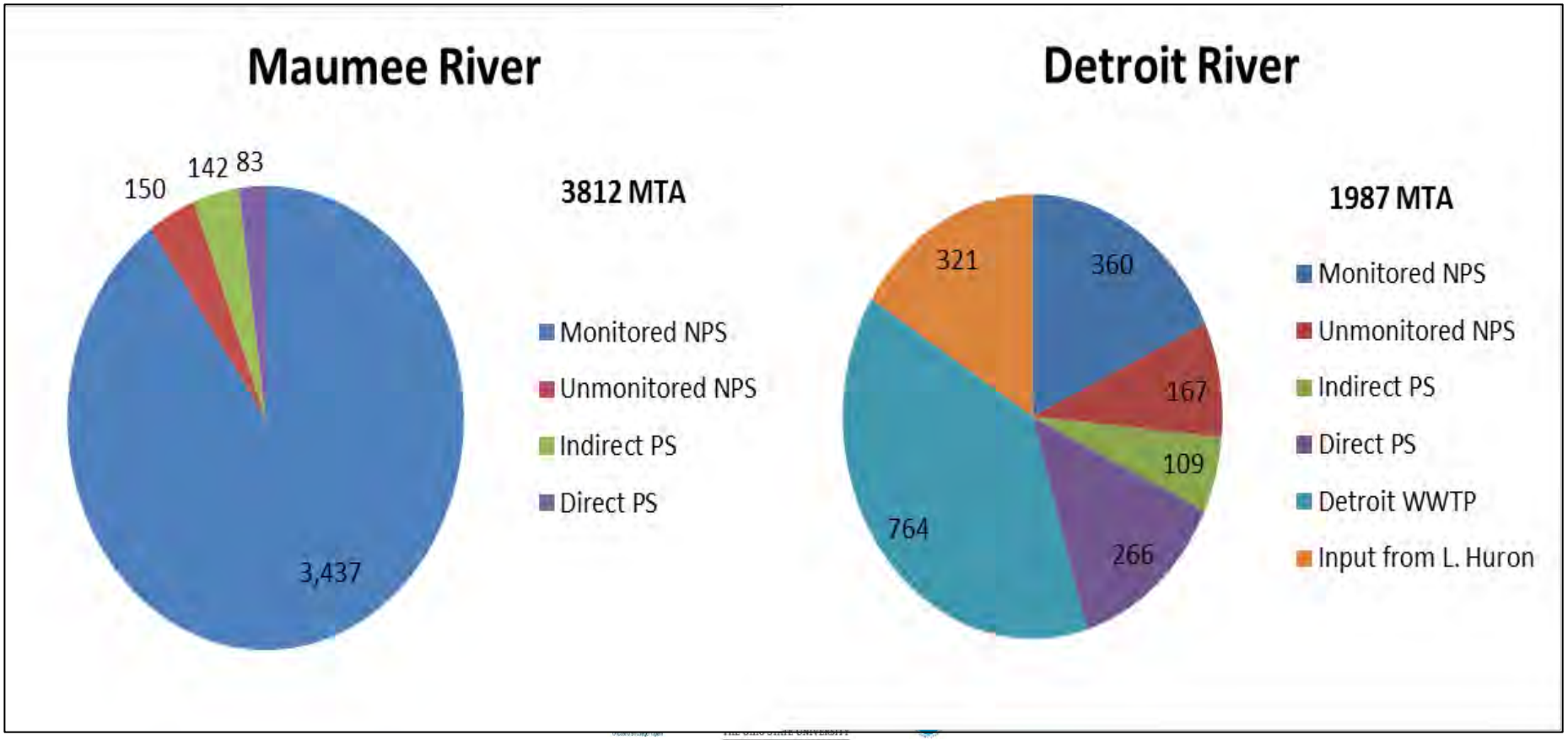
Great Lakes Tributary Total Phosphorus Loads (MTA) 2008



Loading Definitions

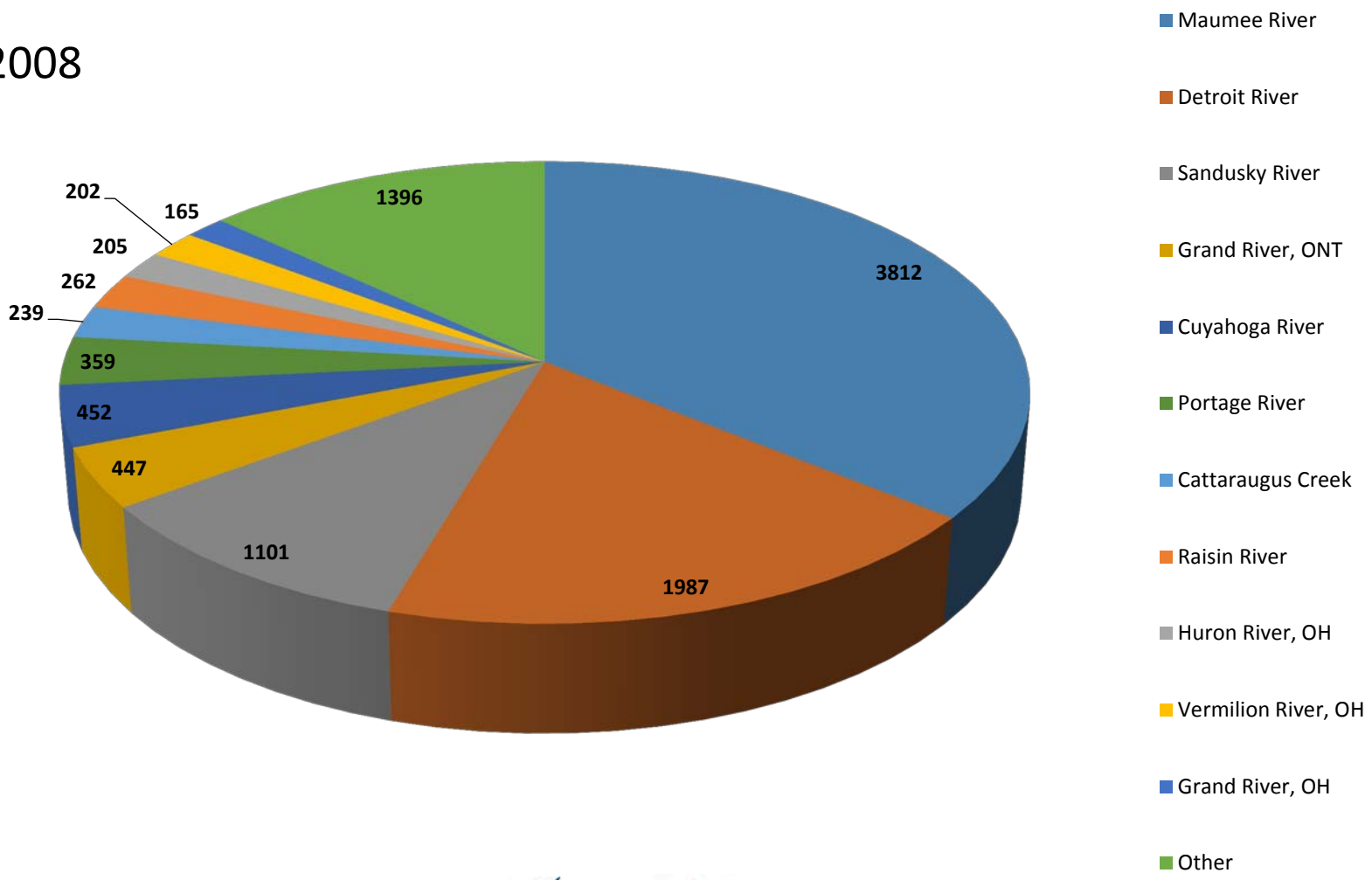
- Monitored NPS = Monitored tribs with point sources subtracted
- Unmonitored NPS = non-point source estimates for tributaries that are not monitored
- Direct Point Sources = Municipal and industrial point sources that are lakeward of the monitoring station (or dump directly into the lake)
- Indirect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



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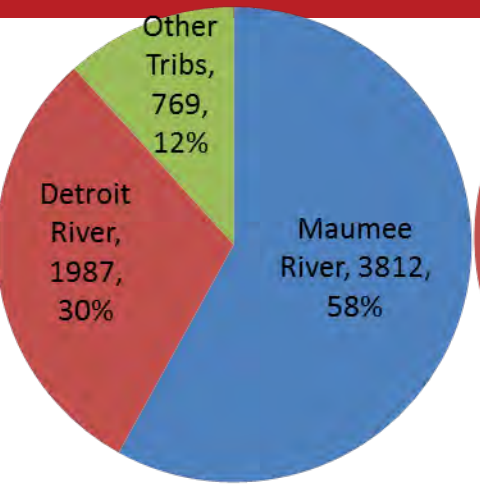
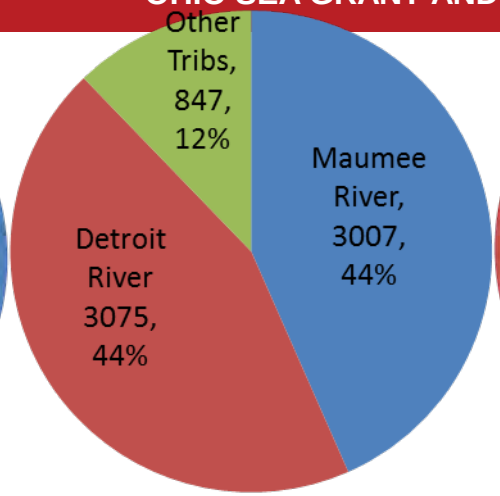
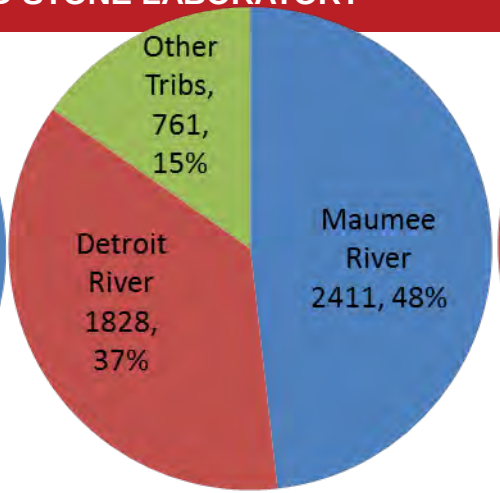
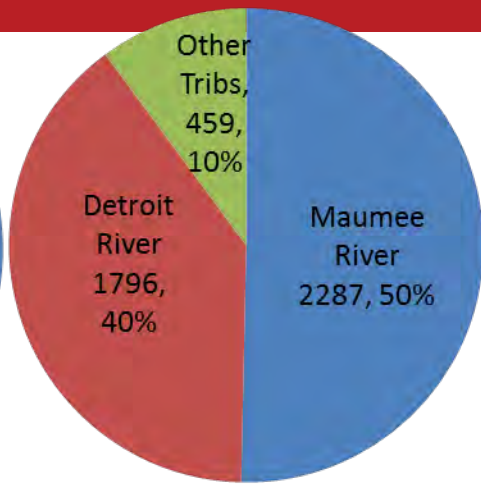
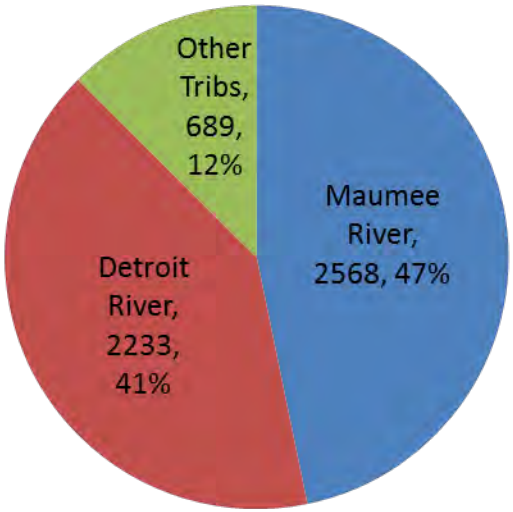
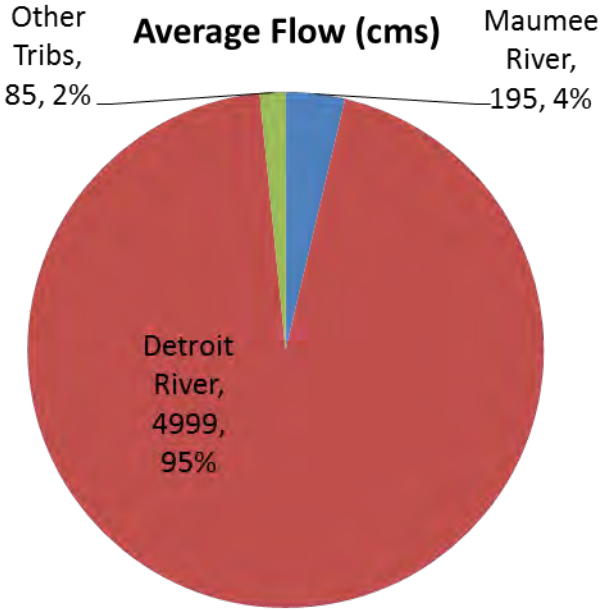


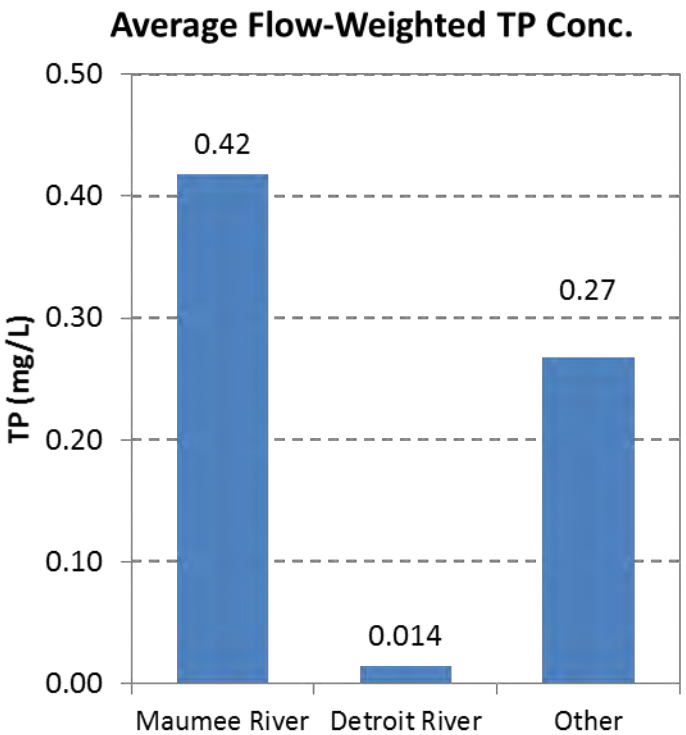












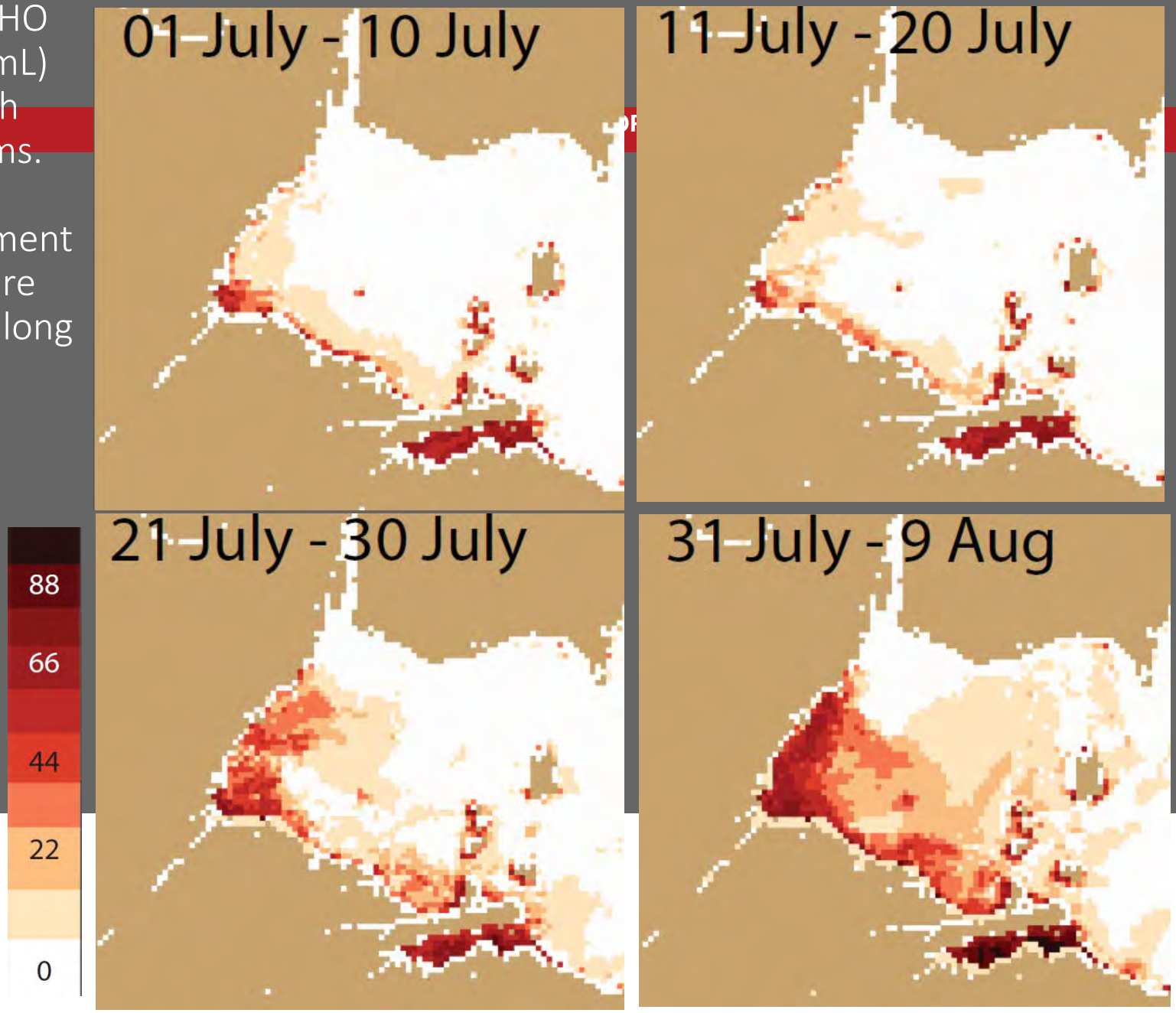
Flows into Western Basin

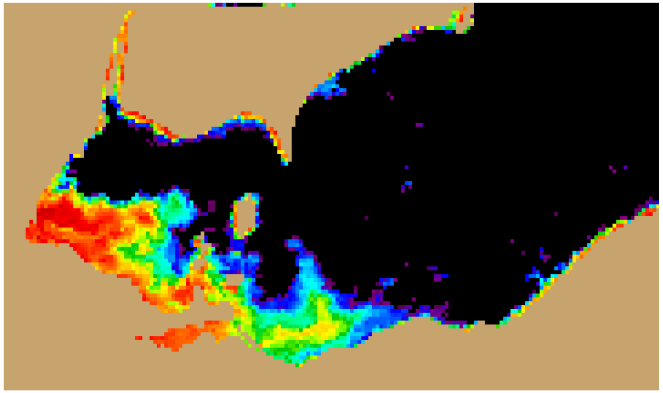
Frequency of WHO risk (>10^5 cells/mL) during years with significant blooms.

During development period blooms are most common along the coast

(Wynne & Stumpf submitted)

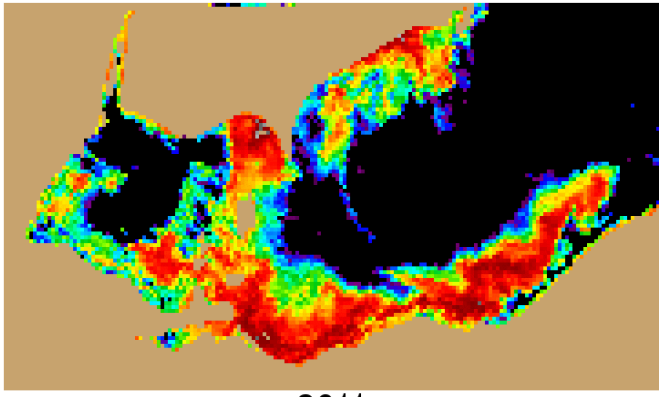
Blooms start At the Mouths Of Tributaries





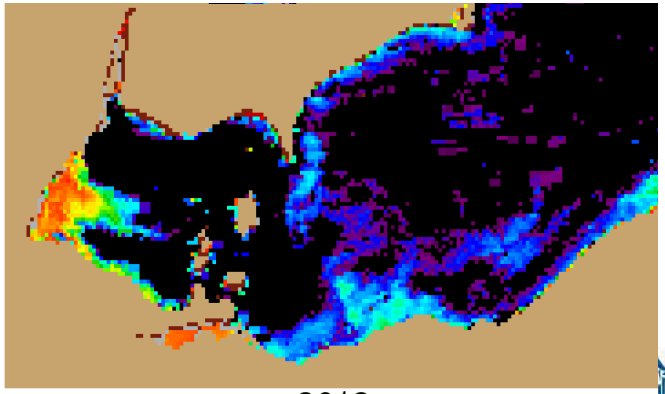
2008

- 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

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