

Agricultural Phosphorus and Lake Erie

perspectives from between the land and lake

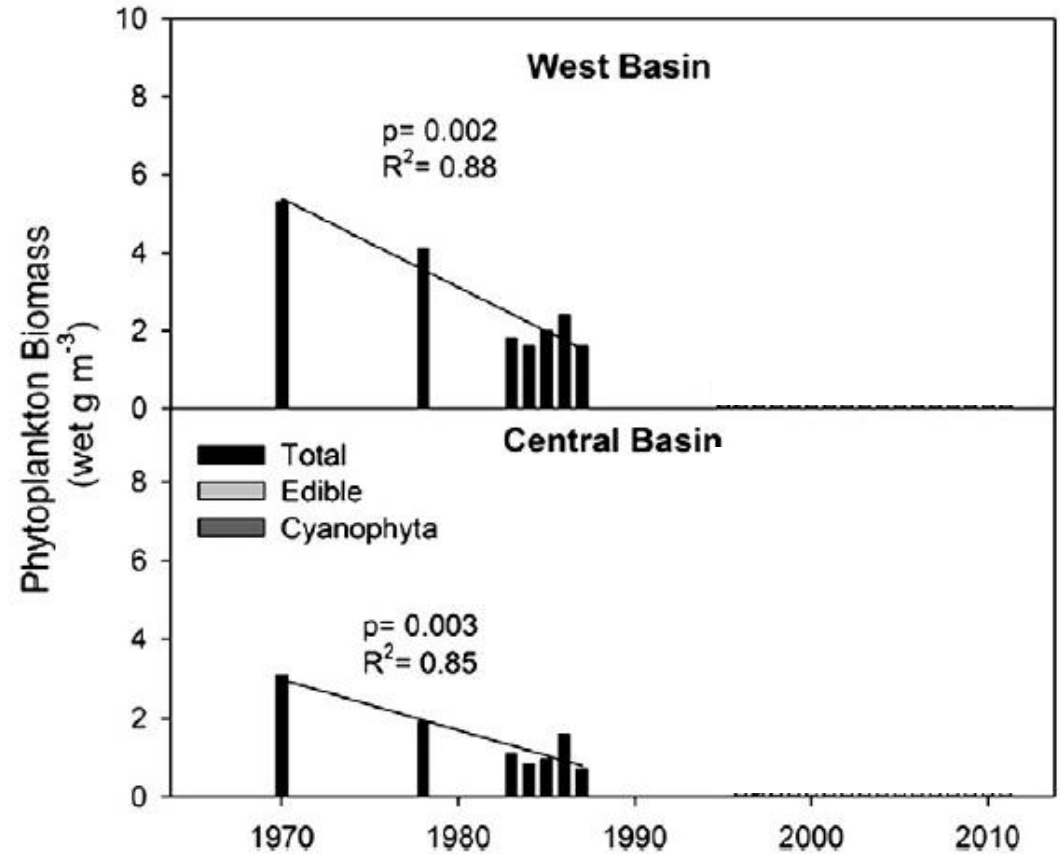
Laura Johnson



Algal blooms were prevalent in the 1960s and 1970s and the lake appeared to recover in the early 1990s



1971



2011 harmful algal bloom

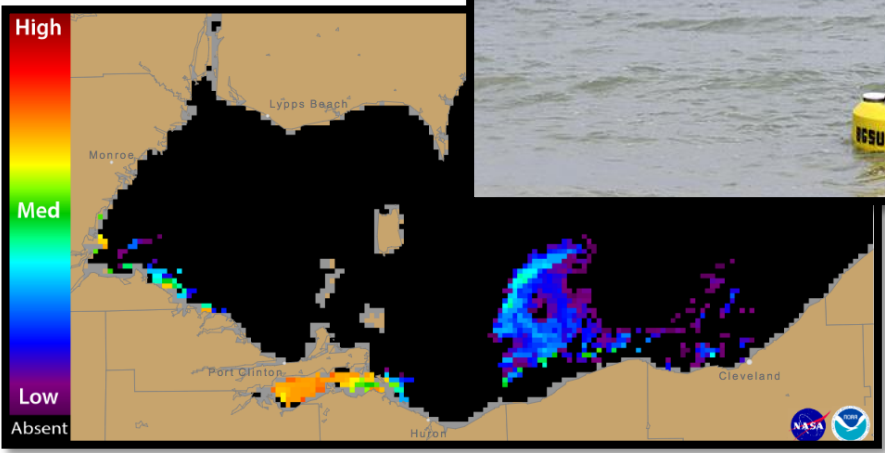
Primarily *Microcystis aeruginosa*



7 largest algal blooms since
mid-1990s have occurred
over the past 8 years

Toxins from the 2014 bloom
shut down Toledo's (pop
400,000) drinking water

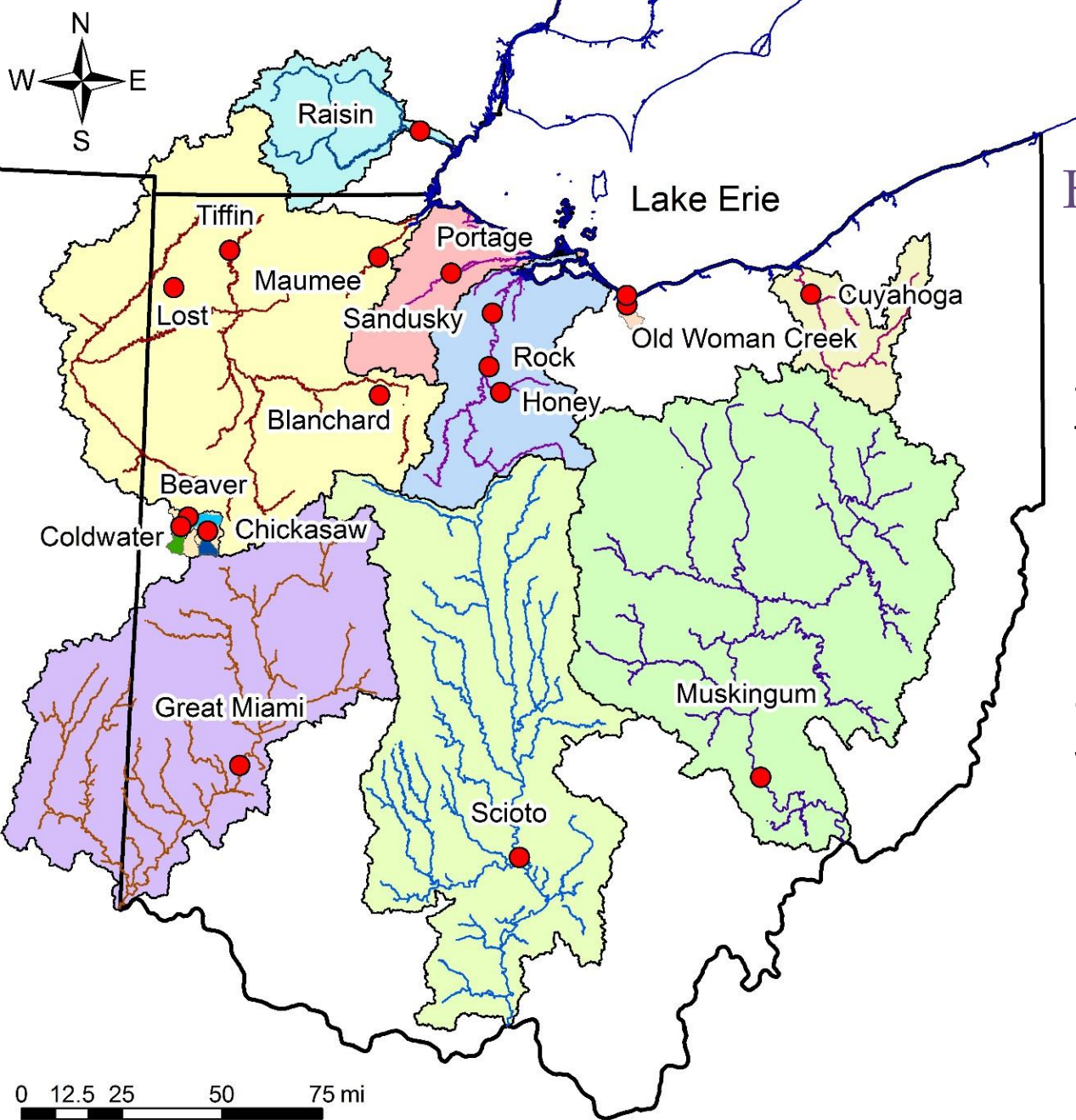
Other Great Lakes blooms



Saginaw Bay

Green Bay



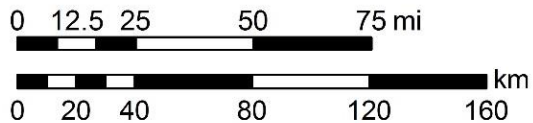


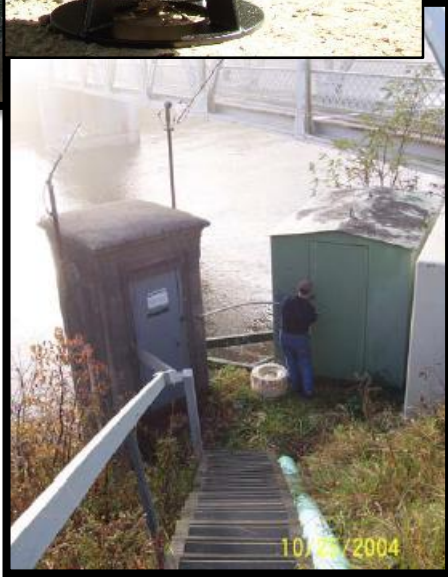
Heidelberg Tributary Loading Program

Sampling began in 1974 in the Maumee and Sandusky

Each station paired with a USGS gage

Goal is to quantify watershed loads





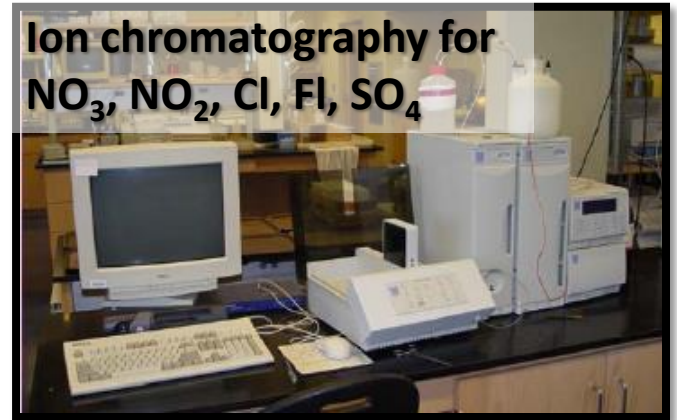
Samples
collected 3x
a day!



Colorimetry for TP, DRP, TKN, NH₄, Si



Ion chromatography for NO₃, NO₂, Cl, F, SO₄

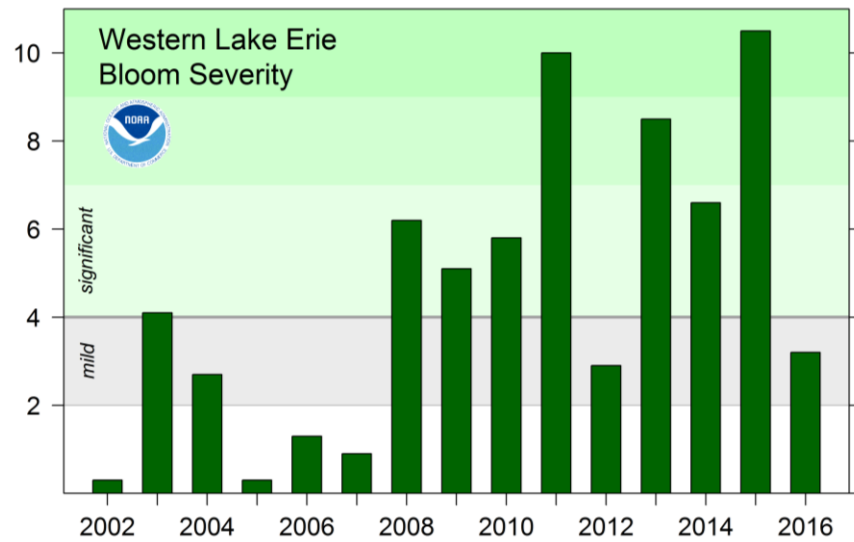


Suspended Sediments

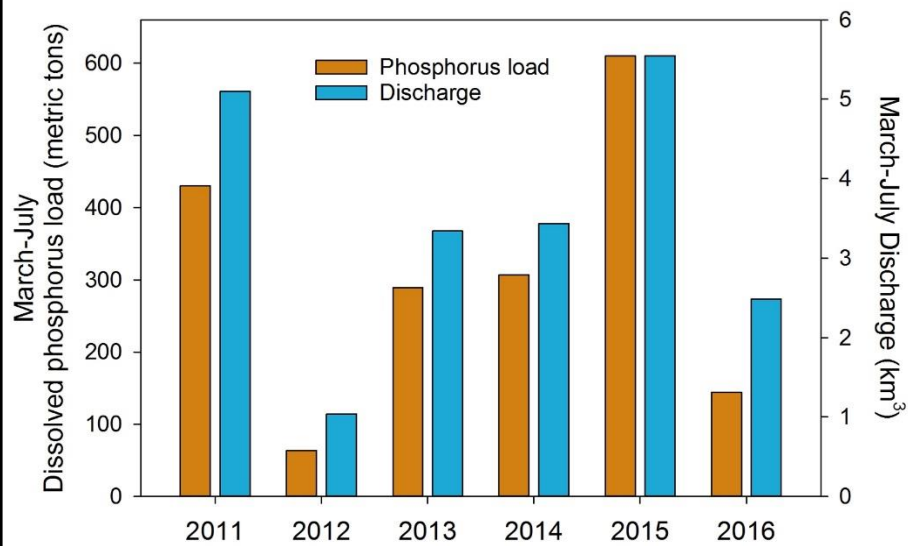


What is driving the blooms in Lake Erie?

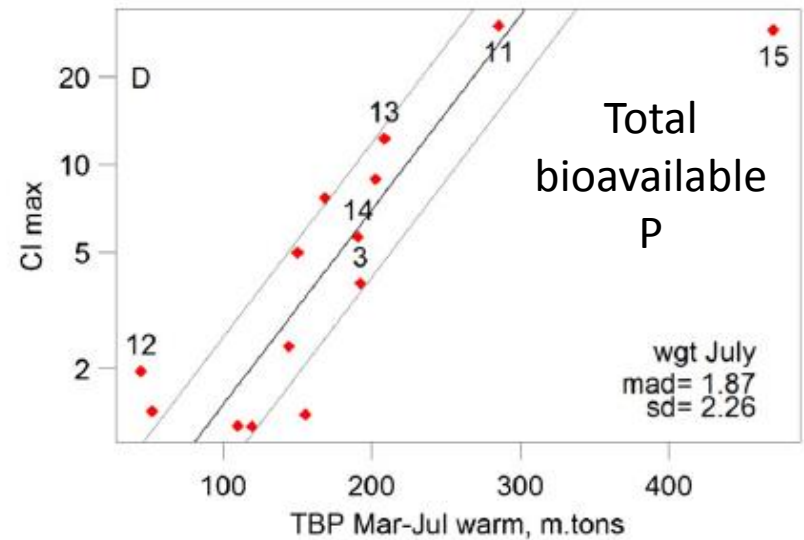
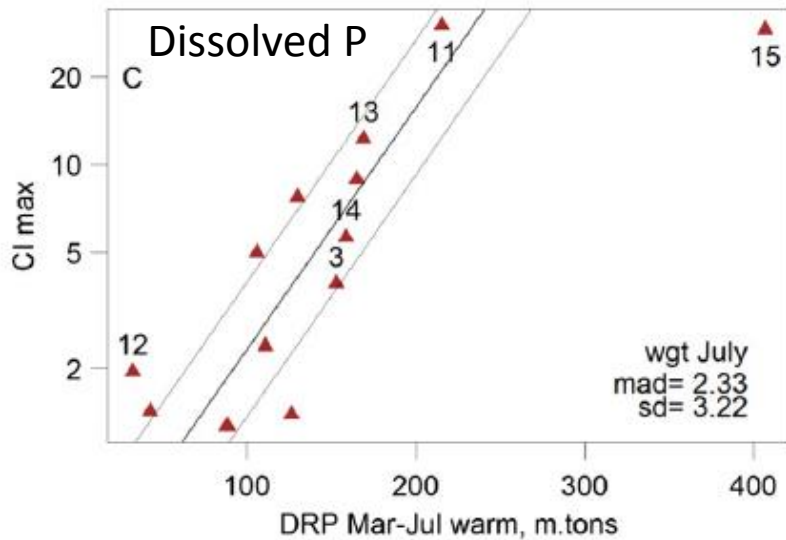
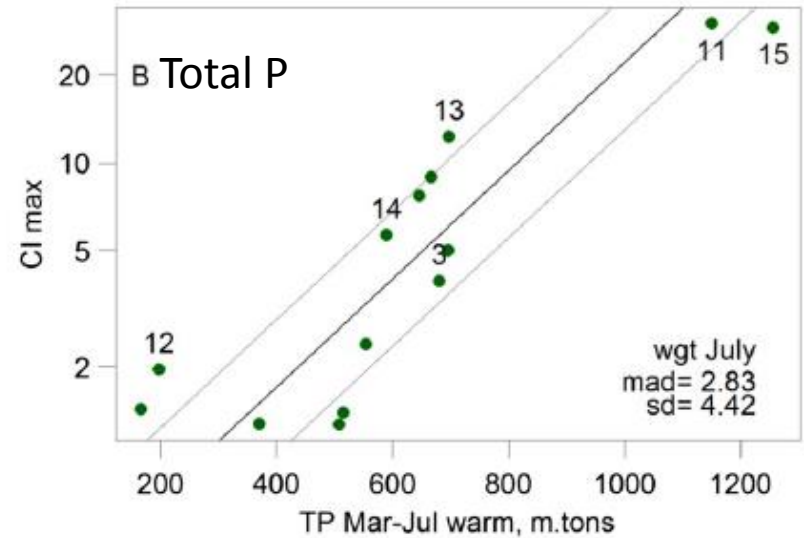
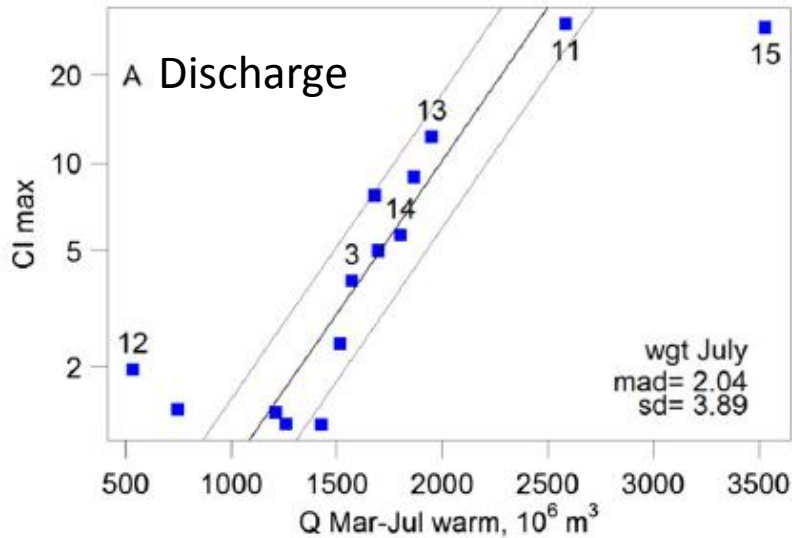
09/03/2011 (DOY=246)



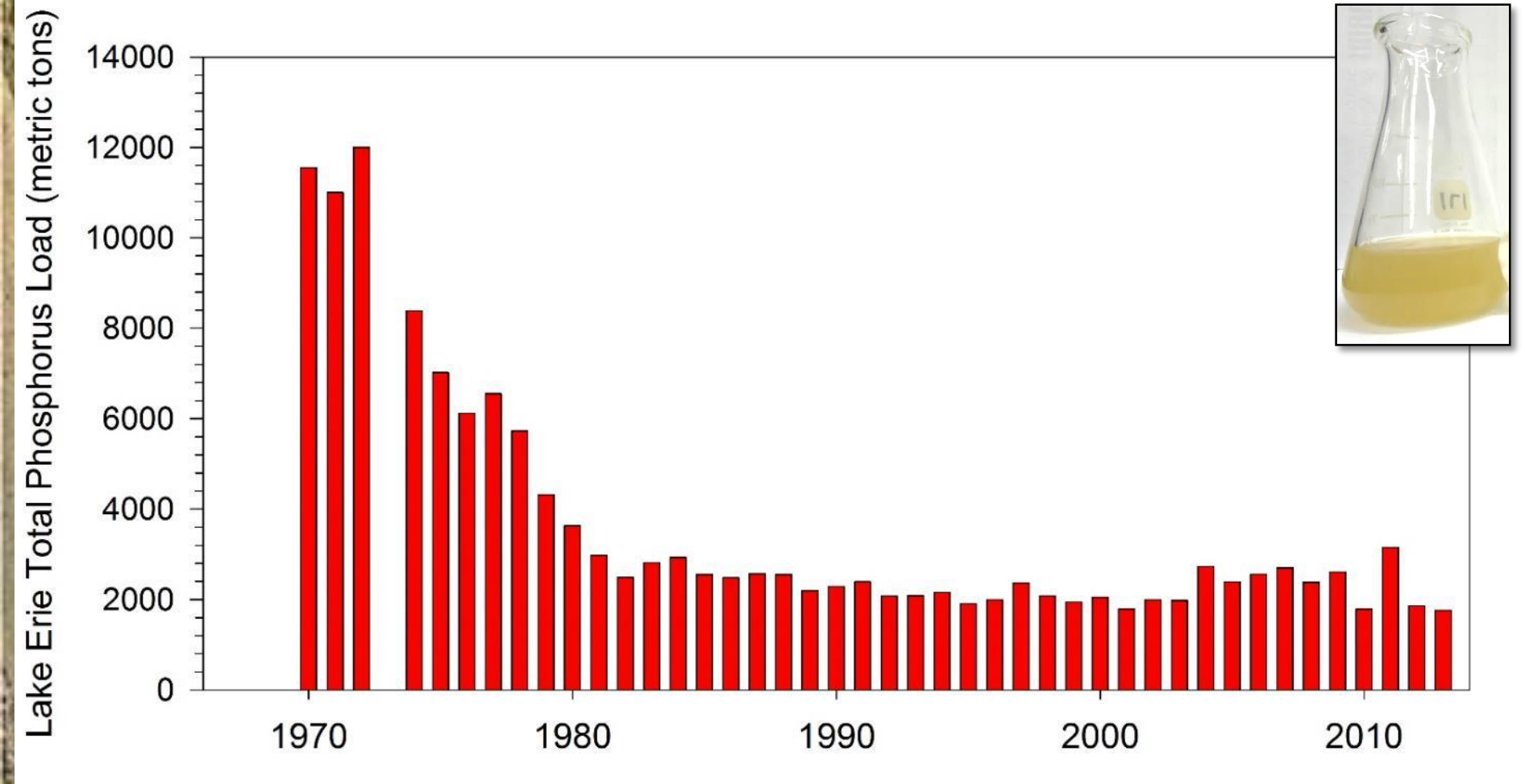
08/30/2012 (DOY=243)



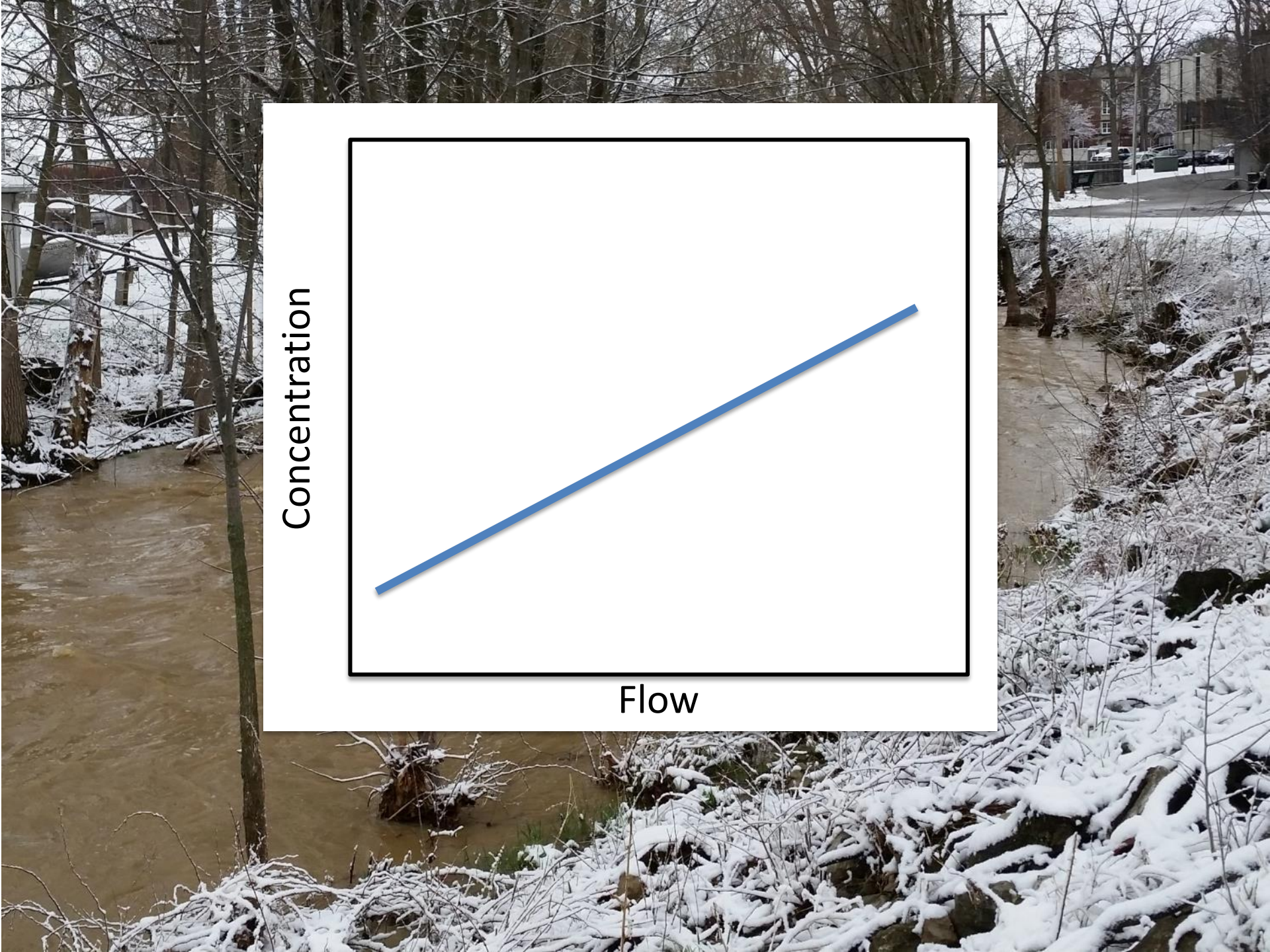
The size of the bloom is related to Maumee River phosphorus exports from March - July



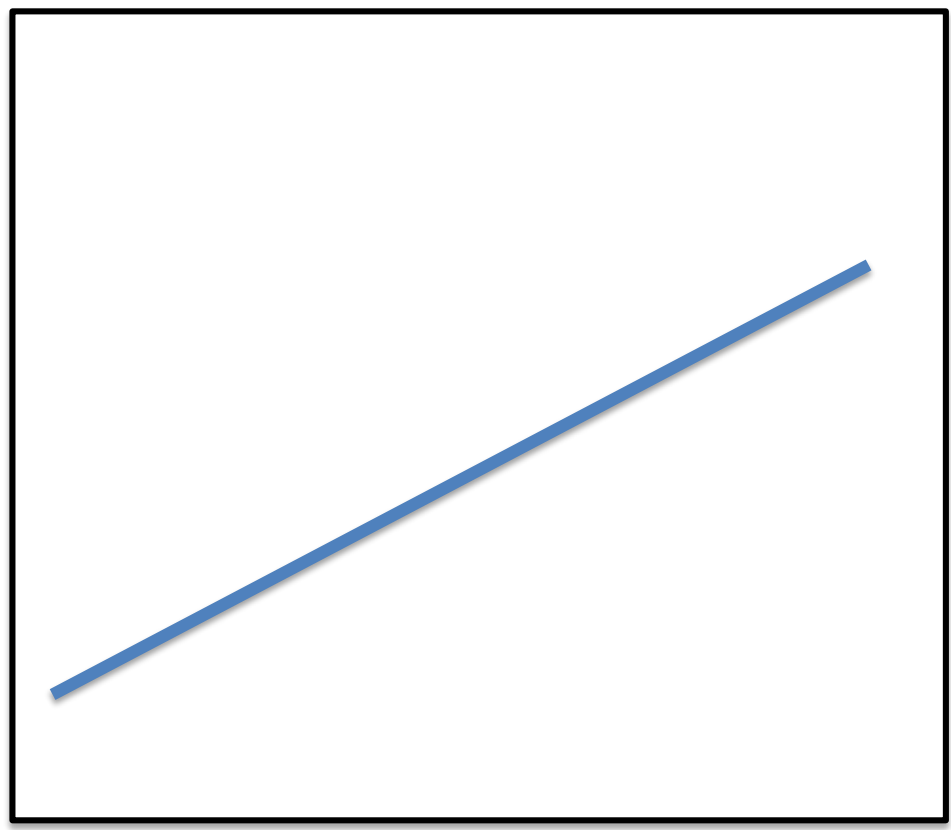
Why have blooms returned to Lake Erie?



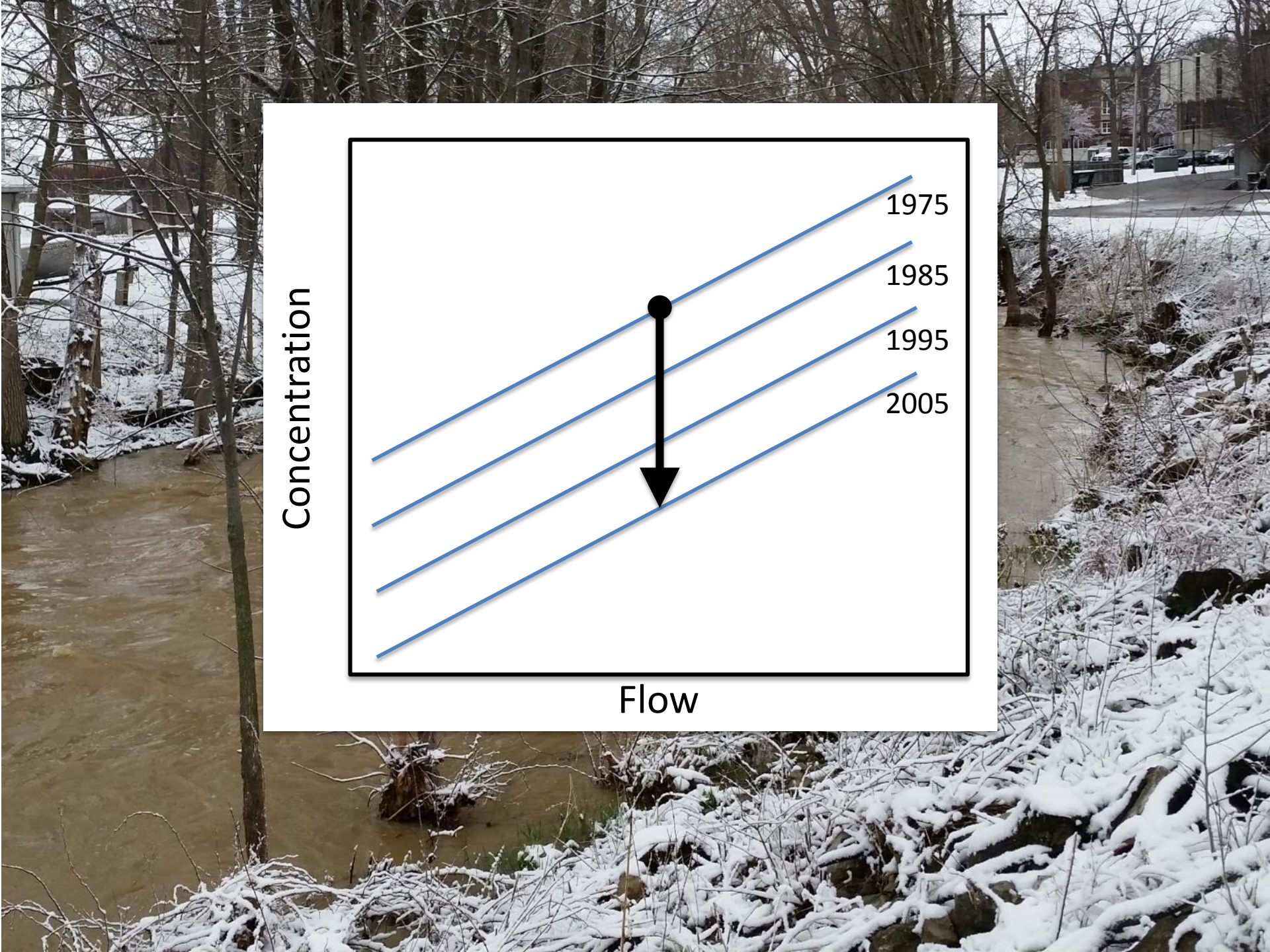




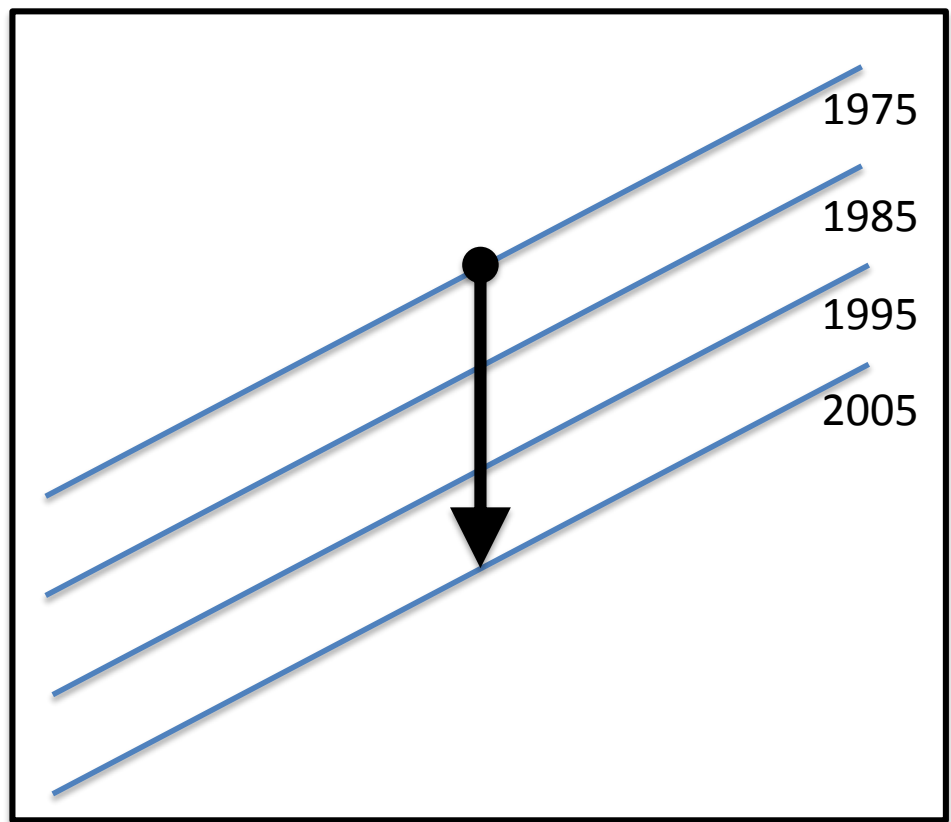
Concentration



Flow



Concentration

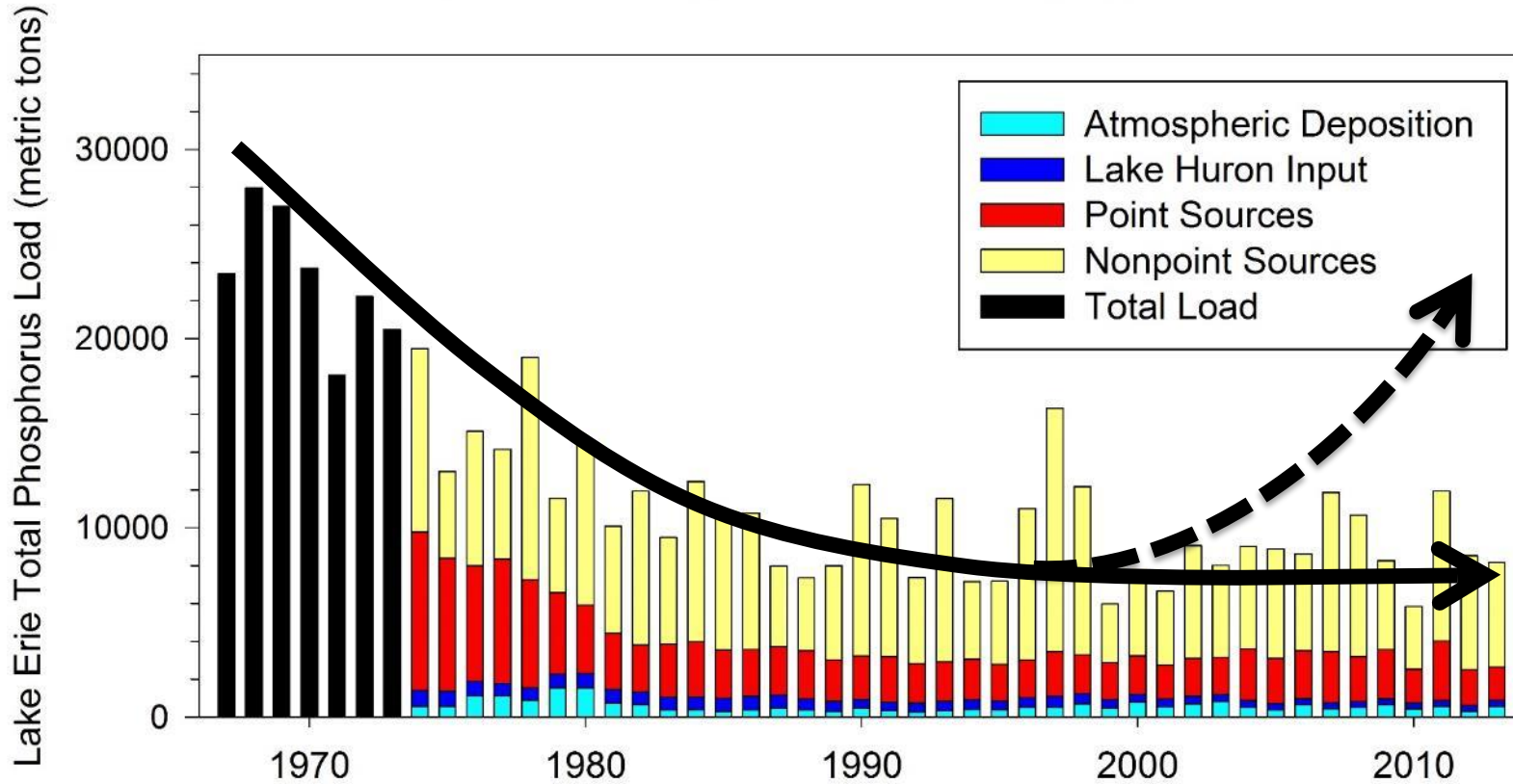


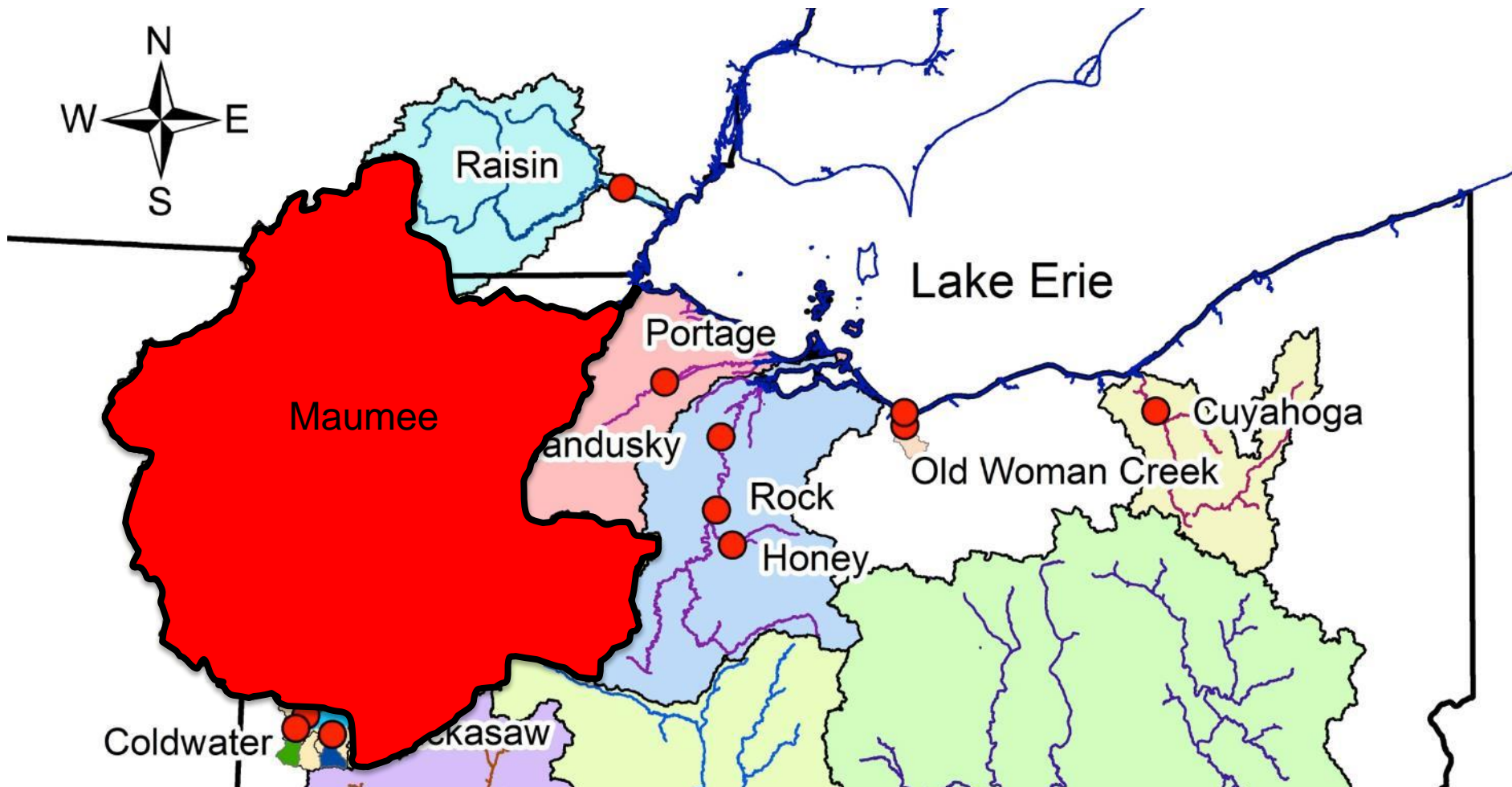
1975
1985
1995
2005

Flow

Trends in Total Phosphorus

Lake Erie Total Phosphorus Load 1967-2013
Data from Dr. David Dolan and Matthew Maccoux

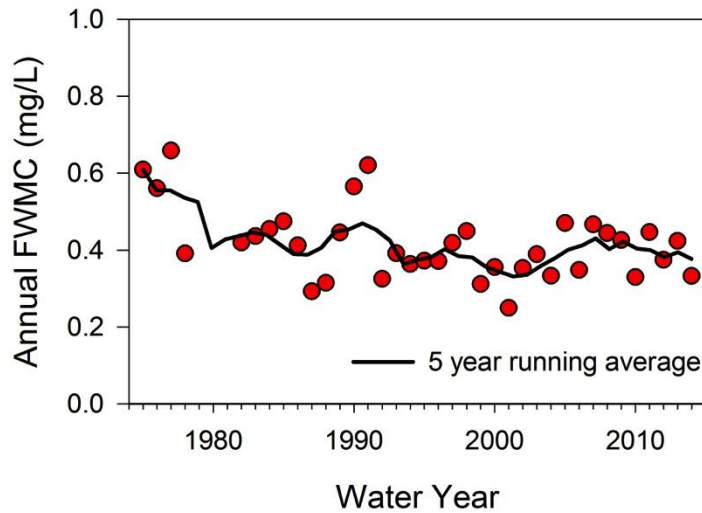




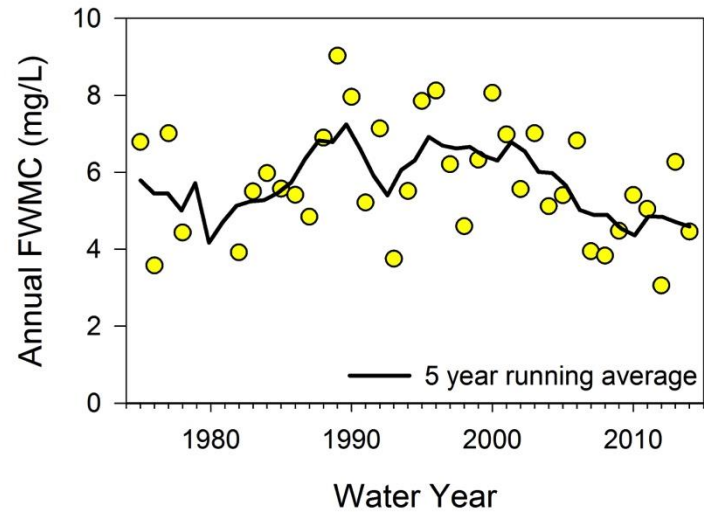
Maumee is the largest tributary to any of the Great Lakes

Maumee River trends

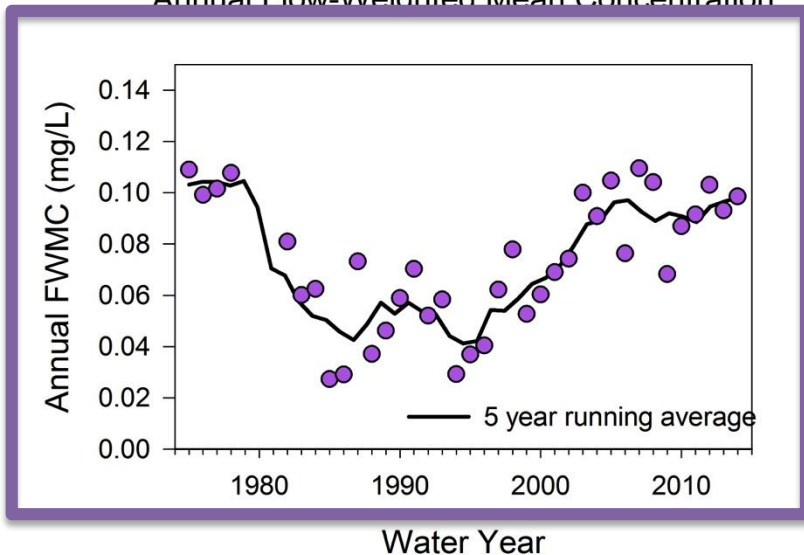
Total Phosphorus
Annual Flow-Weighted Mean Concentration



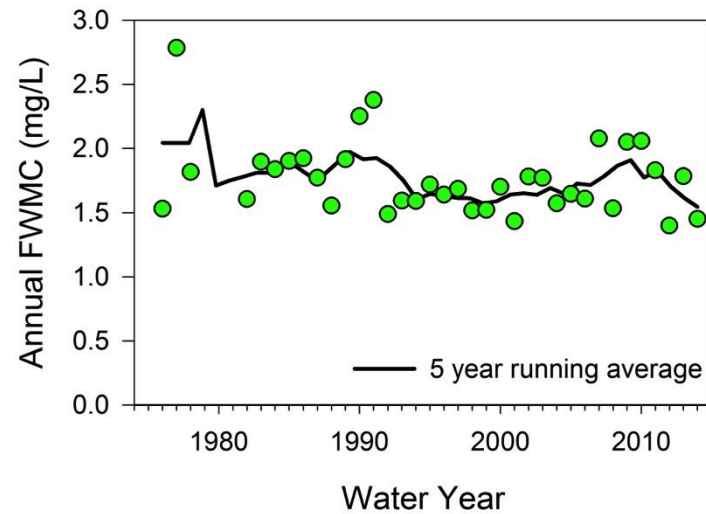
Nitrate-N
Annual Flow-Weighted Mean Concentration

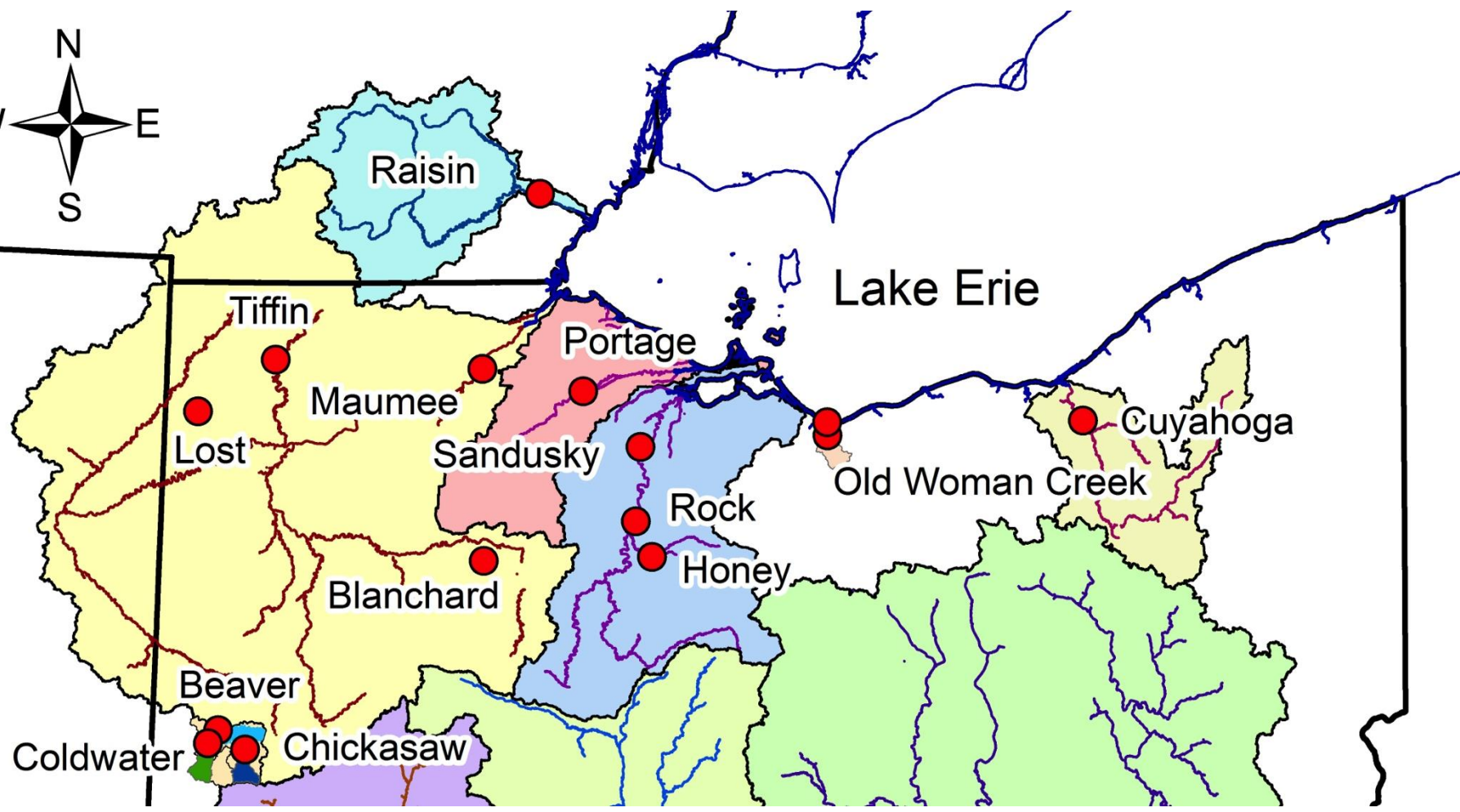


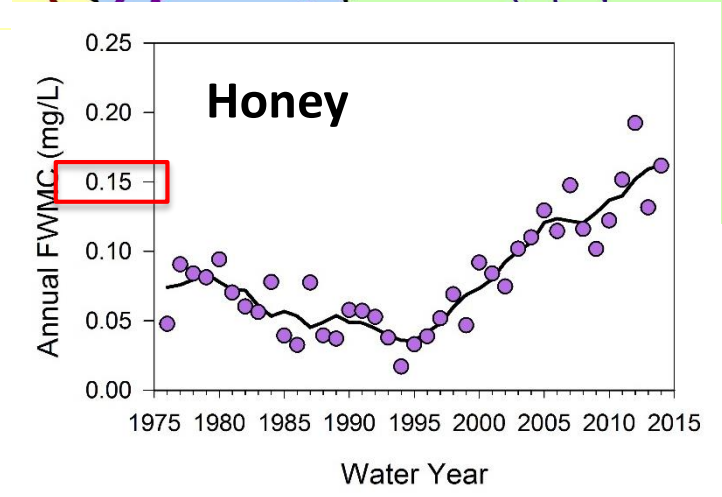
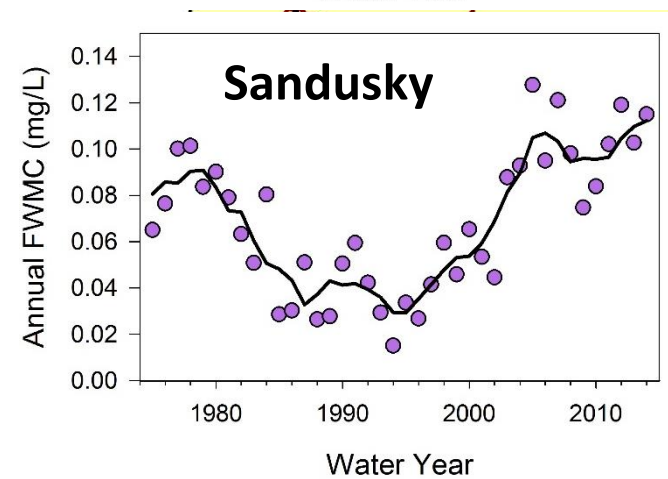
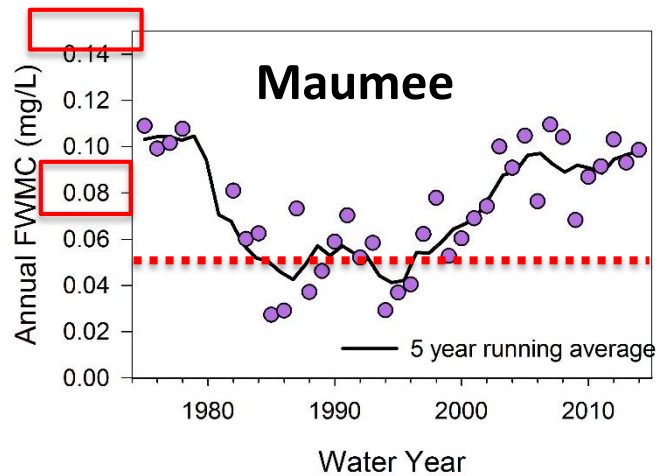
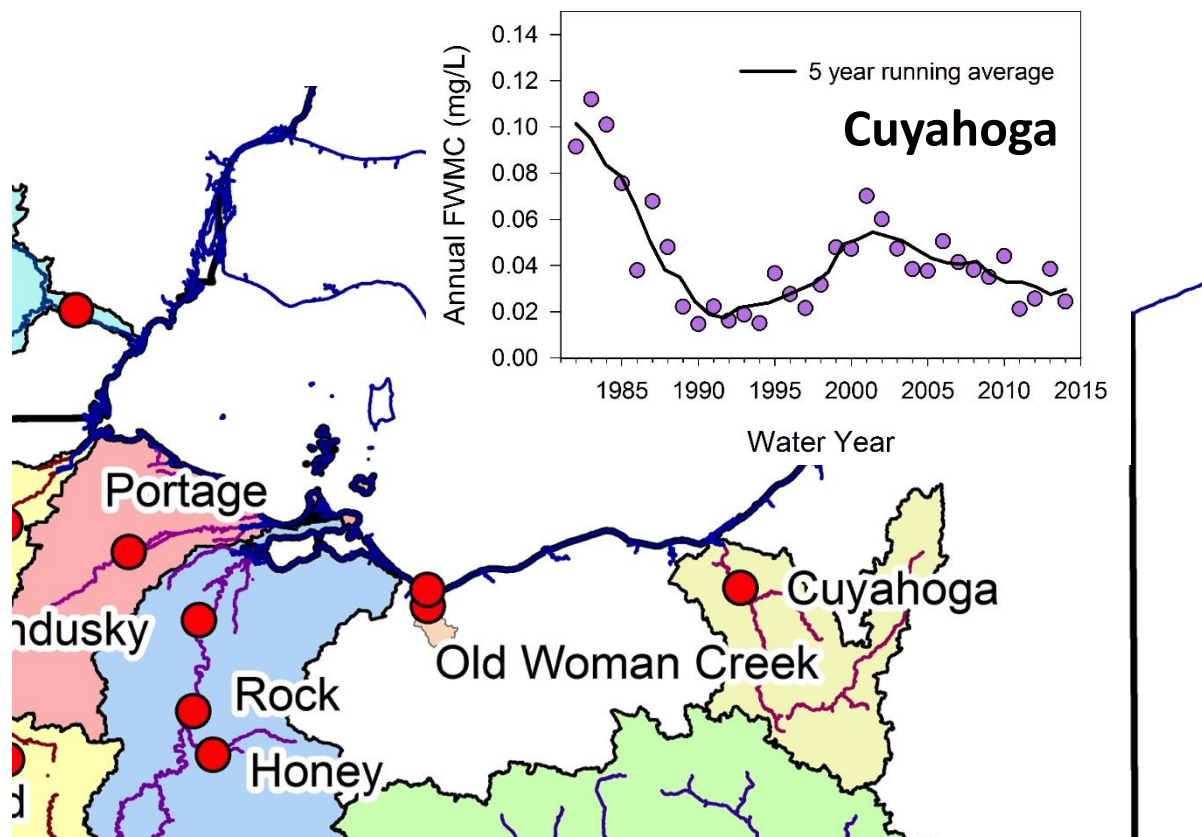
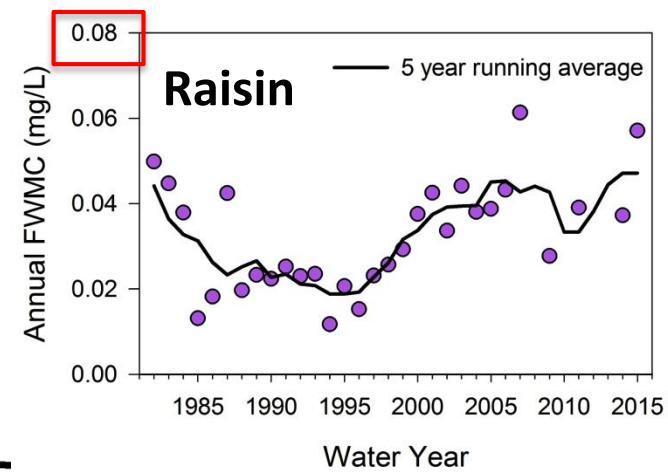
Dissolved Reactive Phosphorus
Annual Flow-Weighted Mean Concentration



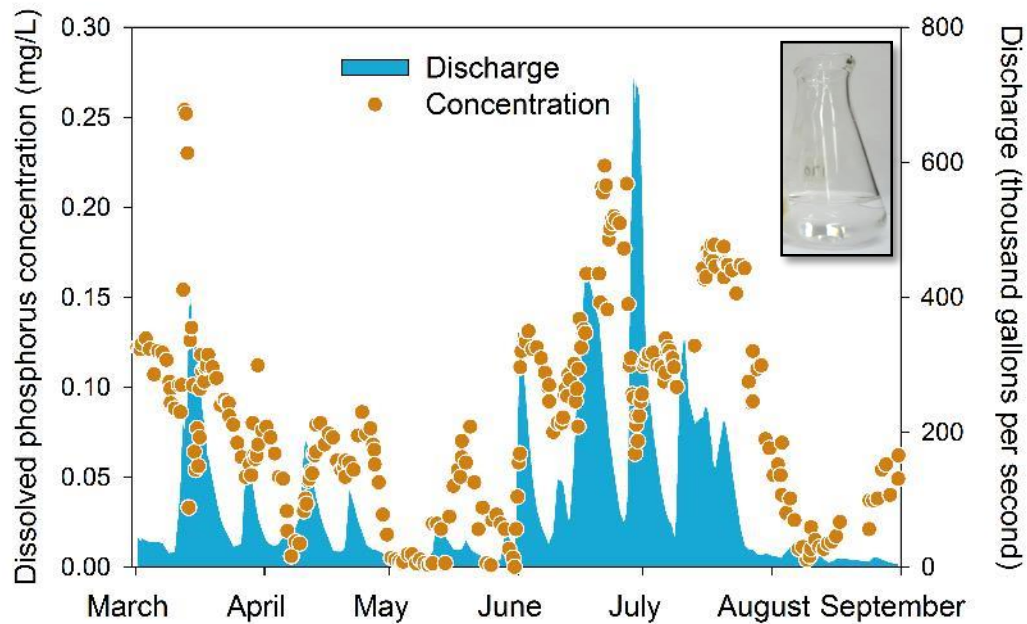
Total Kjeldahl Nitrogen
Annual Flow-Weighted Mean Concentration



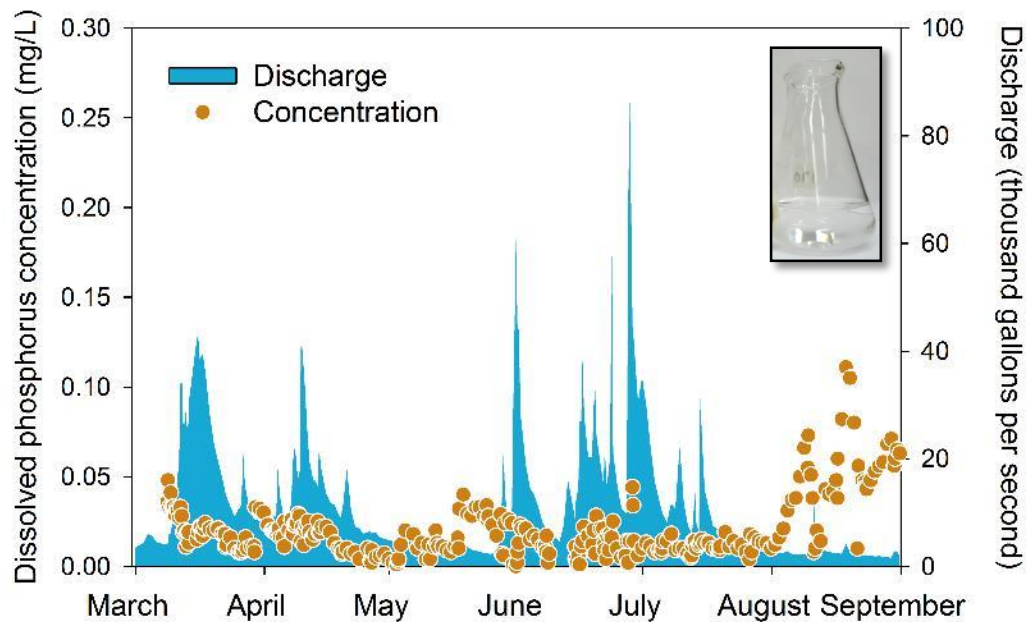




Maumee River



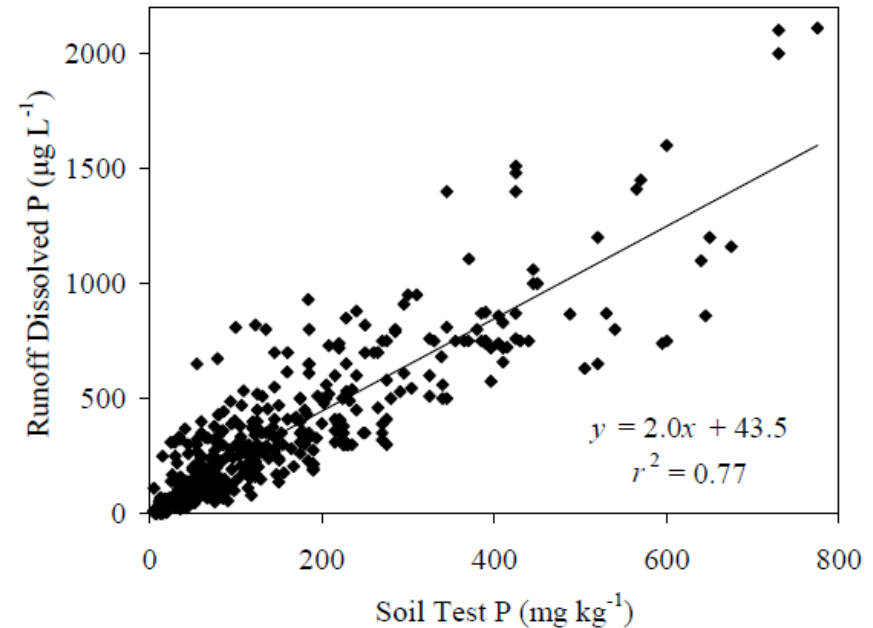
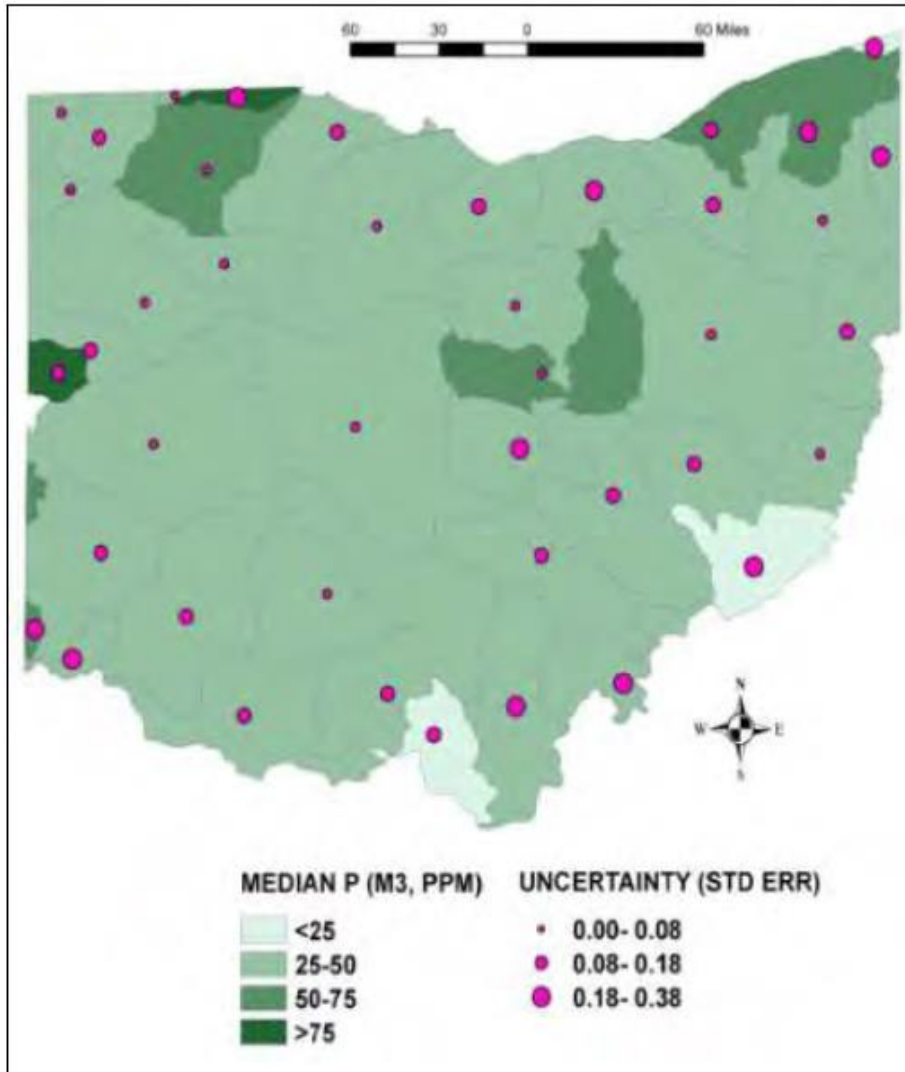
Cuyahoga River



2015

Why is dissolved P increasing?

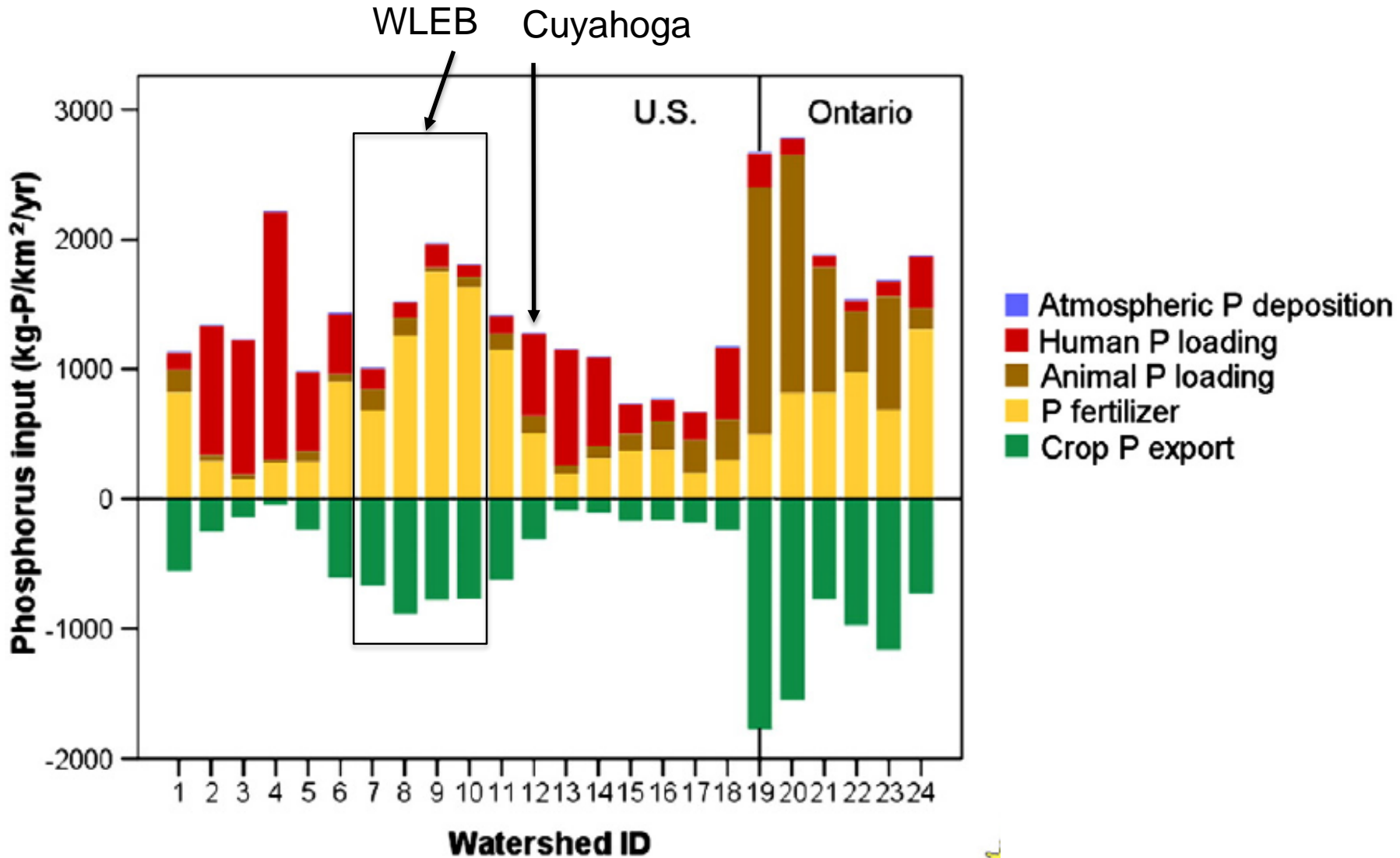
Is soil P high indicating over application of fertilizer or manure?



From Vadas et al. 2005

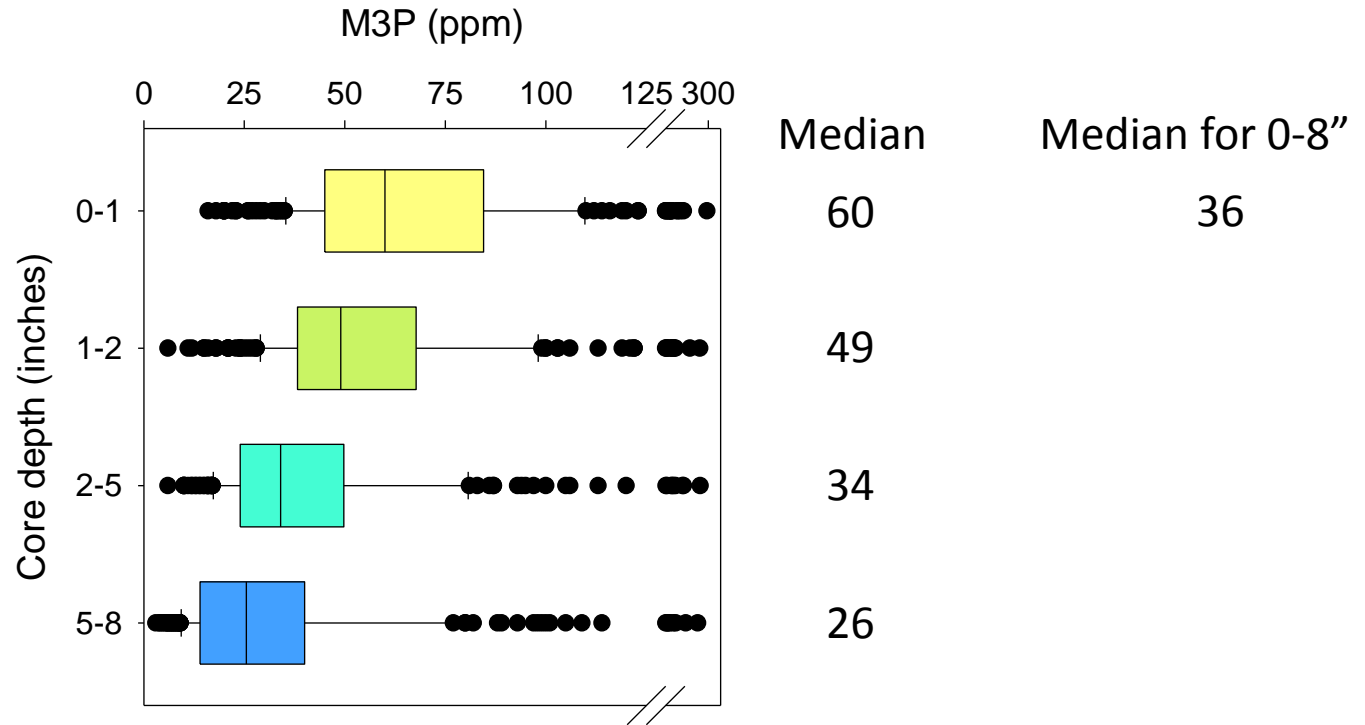
Phosphorus input budget

Scavia et al. 2014





Soil test P at varying depths across the Sandusky River watershed



- Top 1" is 40% higher than 0-8"
- If we reduced the top 2" to the mean of the 8" core, we'd reduce the risk for runoff by 28%

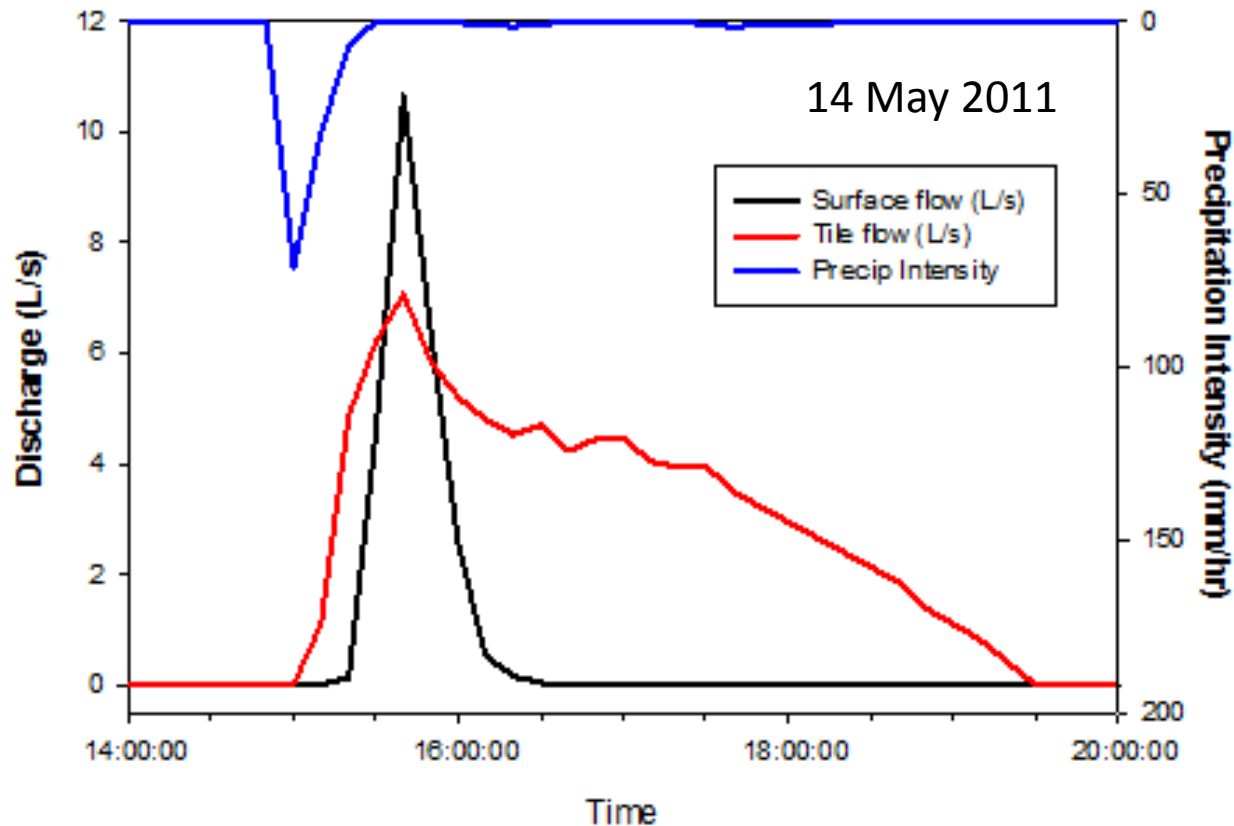


Evidence of macropore tile drain flow

Data from Doug Smith, USDA-ARS

St. Joseph River watershed

- Tile drain flow peaked with surface flow at in a May 2011 storm

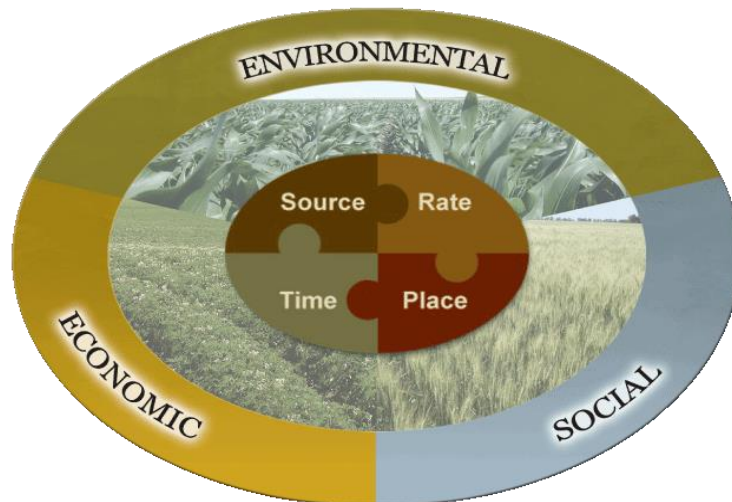


To reduce dissolved P loss, we need to control P stratification and improve nutrient management

- >80% of dissolved P load from tile drainage
- Losses are only ~1% of inputs
- Soil phosphorus is at recommended levels
- **Soil phosphorus must be in the wrong place and recommended STP may be too high!**

Follow the 4Rs

- Right rate- get close to a soil test of 15ppm
- Right place- get it off the surface
 - moldboard plow if surface STP high
- Right time- not before rain or on frozen ground
- Right source- less soluble the better!



Conclusions

- The return of blooms to Lake Erie corresponds to an almost 2-fold increase in dissolved phosphorus concentrations from agricultural watersheds
- Dissolved P in Lake Erie watersheds comes from current agricultural practices → commercial P fertilizer application, rotational no-till
 - To reduce current loads efforts should be focused on reducing P stratification and nutrient management
 - To prevent legacy P problems, efforts should be focused on better management and application of manure

Heidelberg Tributary Loading Program – Current Sponsors



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