Long-term and Seasonal Trends in Phosphorus Loading to Lake Erie: Links to Harmful Algal Blooms with Insights from 2011 and 2012

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Tom Bridgeman
Algal blooms in Lake Erie have been increasing.

**2011 harmful algal bloom**

Primarily *Microcystis aeruginosa*

Data from Tom Bridgeman, UT-LEC
see Bridgeman et al. 2013 JGLR

4 largest algal blooms since mid-1990s have occurred over the past 6 years

*May 2013 issue of National Geographic*
Algal blooms were prevalent in the 1970s and the lake appeared to recover in the mid-1990s.

• Phytoplankton biomass
• Kane et al. 2014, JGLR
Trends in Total Phosphorus

Components of Lake Erie Total Phosphorus Load Estimation
- Unmonitored nonpoint sources
- Tributary monitored nonpoint sources
- Indirect point sources
- Direct point sources
- Atmospheric Deposition
- Lake Huron
- Total load estimates

Lake Erie, Total Phosphorus Target Load
Why are algal blooms increasing?

• Long-term trends in phosphorus and discharge
• 2011/2012 phosphorus loading and discharge
Heidelberg Tributary Loading Program

- 16 stations paired with USGS gages
- Monitoring began in 1975
- Longest, most detailed program of its kind in US
  - Over 142,000 water samples analyzed
- Focus today on Sandusky, Maumee, and Cuyahoga
• Samples collected 3x a day
• Analyzed for all major nutrients and suspended sediments

Colorimetry for TP, DRP, TKN, NH₄, Si

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

Suspended Sediments
Long-term discharge and phosphorus trends
Annual discharge

- Upward trend for all rivers over the period of record
Annual discharge

• 5 year running mean show a marked increase since 2000
Annual total particulate P
77% of TP is particulate

TPP FWMC has decreased when analyzed via ANCOVA to correct for discharge, *(Richards et al. 2009 JSWC)*

\[ r^2 = 0.02 \quad P = 0.37 \]

\[ r^2 = 0.02 \quad P = 0.40 \]

\[ r^2 = 0.04 \quad P = 0.29 \]
Annual dissolved reactive P loads and FWMCs have been increasing in agricultural watersheds since the mid-1990s.
Annual dissolved reactive P unit area loads are increasing in subwatersheds of the Sandusky as well as other agricultural rivers.

- River Raisin is less flashy than other agricultural watersheds
  - only 50% agriculture
  - drains sandier soils
2011 vs. 2012
2011 vs 2012

09/03/2011 (DOY=246)

Big Contrast!

08/30/2012 (DOY=243)
Annual loads were very similar between 2011 and 2012.
Maumee River in spring March-June

- Spring loading appears to better describe algal blooms
- Lake Erie is responsive to reduced phosphorus in a short timeframe
Relationship between **Maumee** spring loads and cyanobacterial index

*Stumpf et al. 2012, PLoS ONE*

- Strongly related to spring discharge
- Less related to DRP loads
Maumee River in spring

March-June

Data from Tom Bridgeman, UT-LEC
How is 2014?

Cumulative loadings

Maumee Discharge

Maumee Dissolved P

- HAB forecast for 2014 planned for July 10th
Summary

• Although TP loads to Lake Erie reached the target in 1981, algal blooms have returned and have been increasing over the past decade.

• Over this time, dissolved reactive P has increased drastically from agricultural rivers.

• It appears spring loading (March-June) best predicts the extent of algal blooms in the western basin.

• Our inability to accurately predict the magnitude of 2013 indicates we still have more to learn!
For more information visit:
http://www.heidelberg.edu/NCWQR
Or contact me at ljohnso1@heidelberg.edu

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Why is dissolved P increasing?

Farm soil
Why is dissolved P increasing?

- Climate change
- Surface application of P fertilizers
- Application on frozen ground or shortly before precipitation
- P stratification
- Tile drain intensity
- Tile delivery from macropores
Weekly bulletin produced throughout season

Google “Lake Erie HAB bulletin”