Trends in Dissolved Reactive Phosphorus in Lake Erie Tributaries

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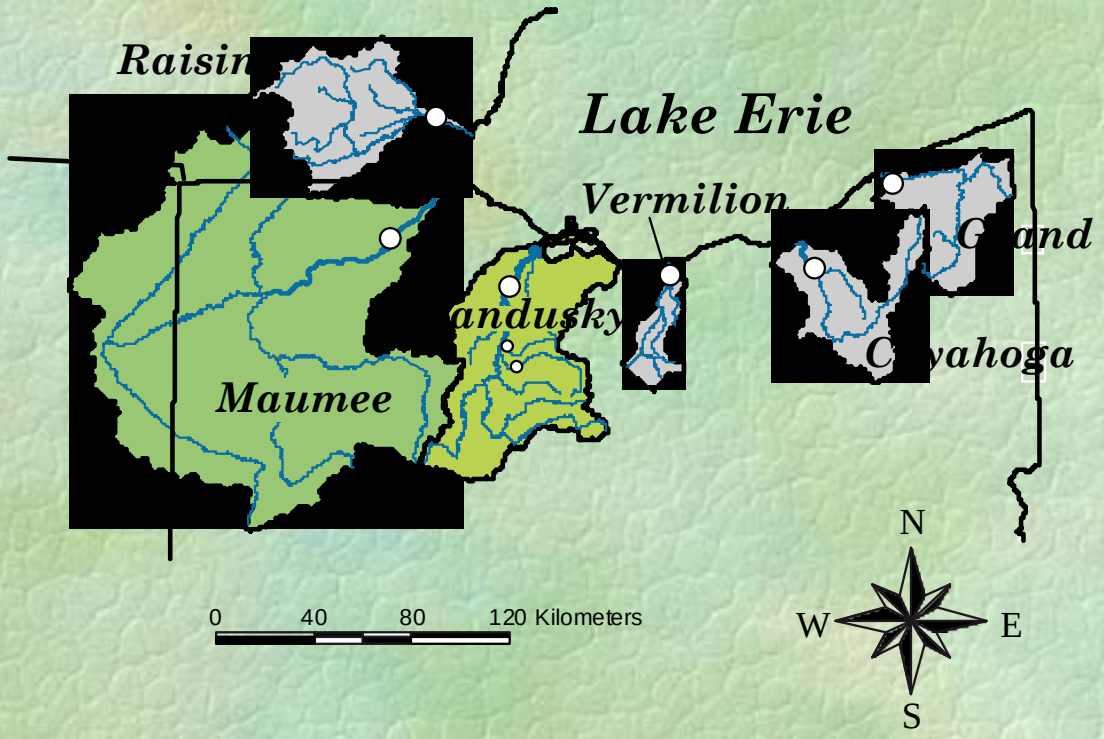
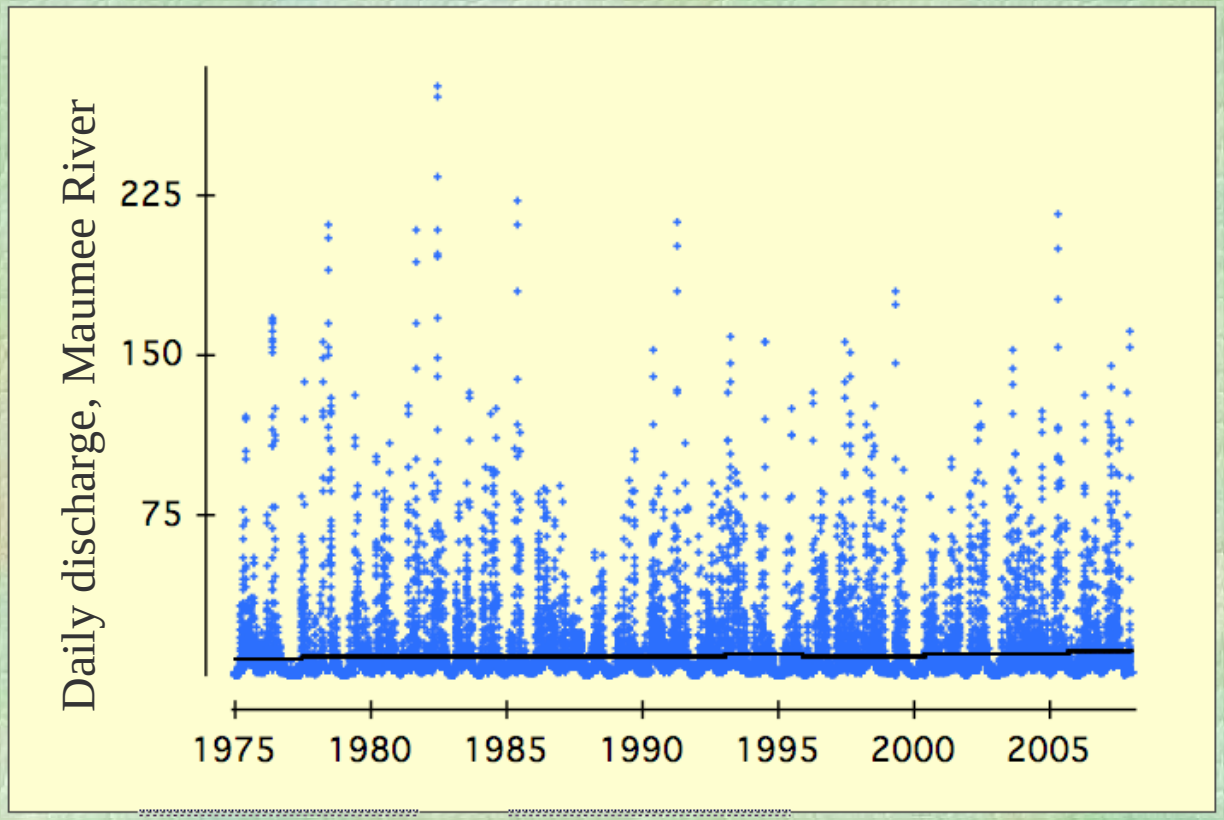
Background: NCWQR Monitoring



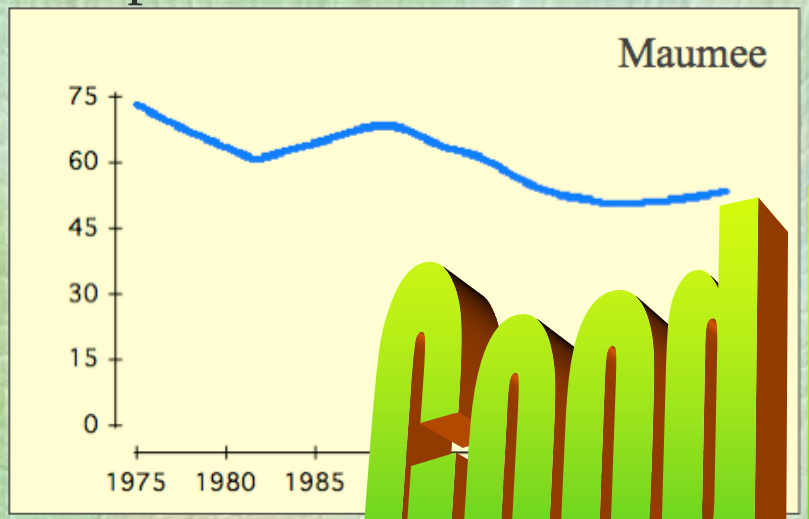
- Autosamplers at USGS stations, 3 samples per day
- Sediment, nutrients, major ions
- 1974 to present, ~15,000 samples per station

Trends are subtle things!

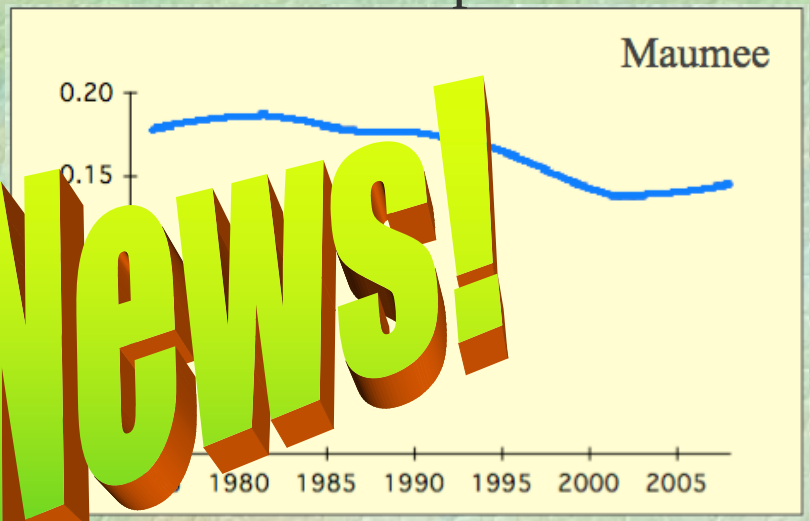


Trends in concentrations of:

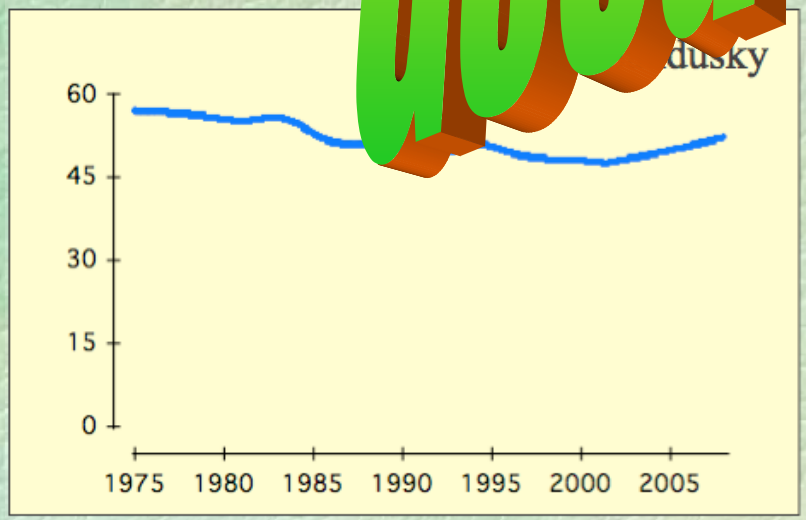
Suspended Solids

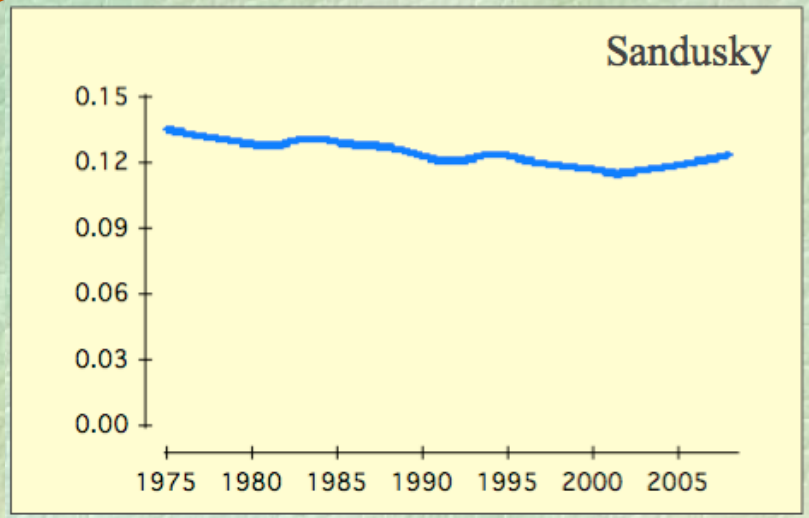


Particulate Phosphorus



Good News!

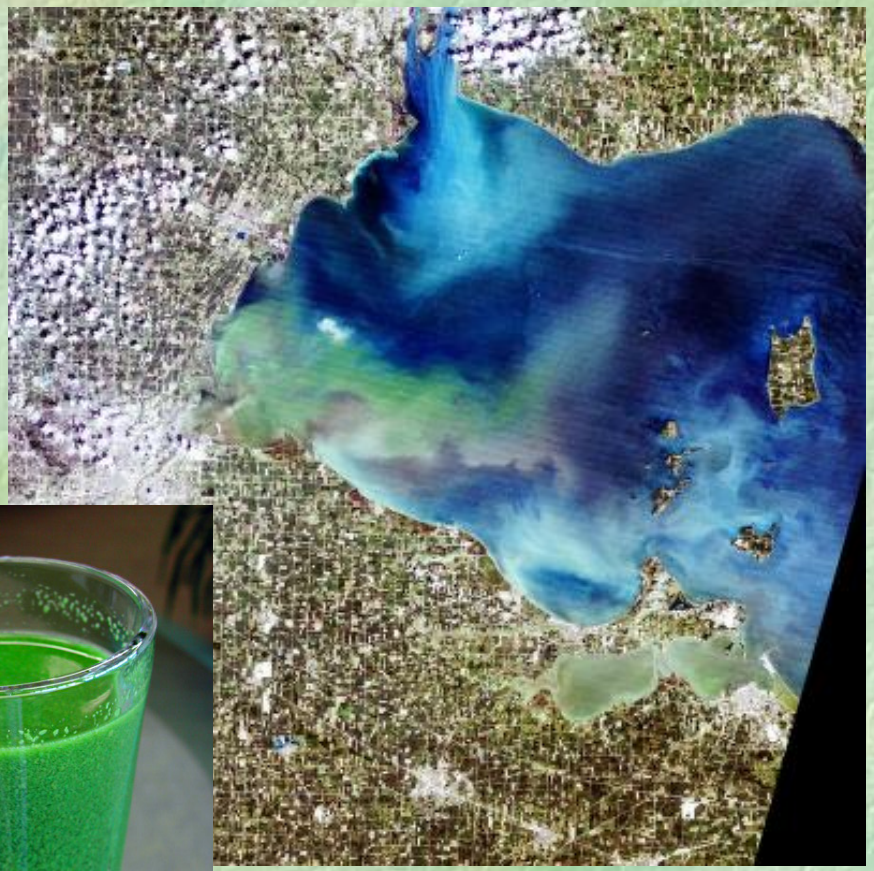




Lake Erie: re-emerging issues

Cladophora and noxious “blue-green algae” are back with a vengence!

Where are the nutrients that drive this coming from?



Tom Bridgeman, U. Toledo

Lake Erie issues

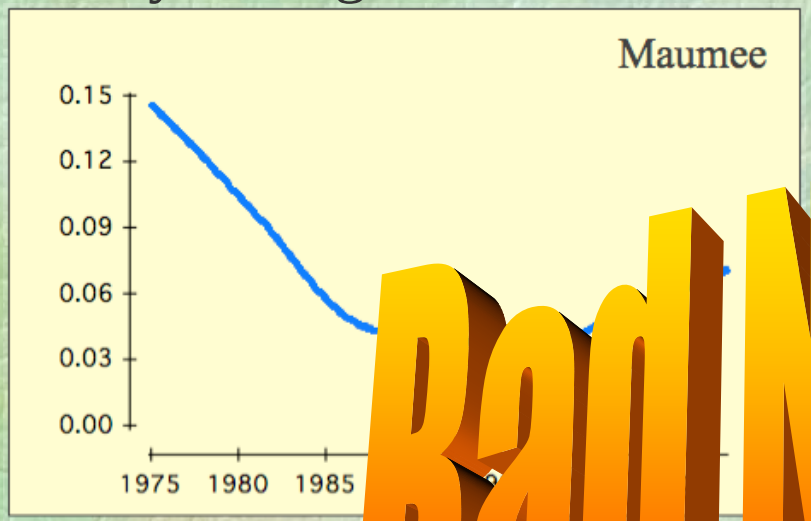
Cladophora

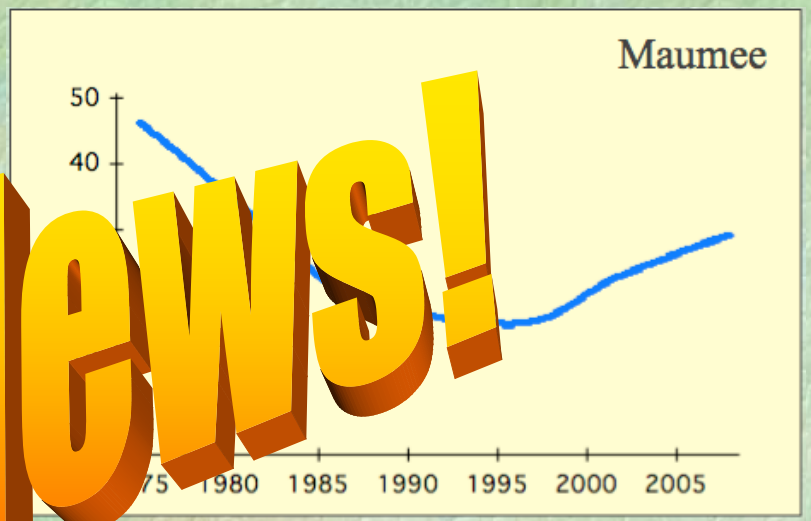
Lingbya

Trends in dissolved reactive P

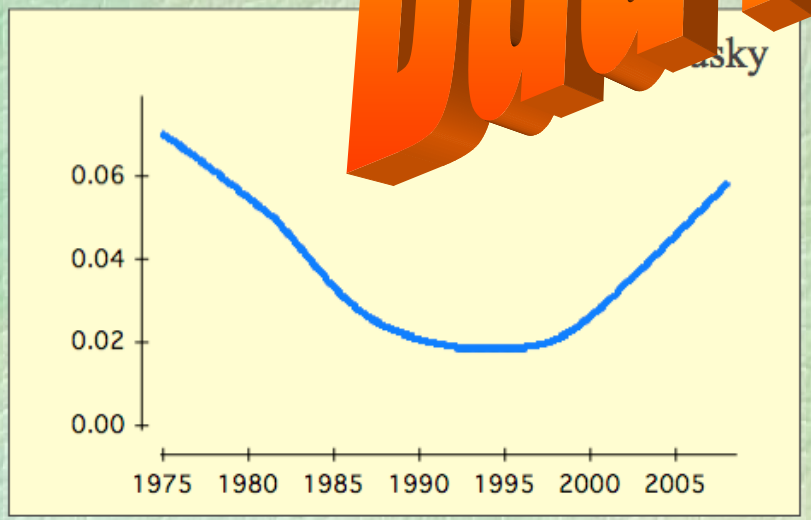
Daily average concentration

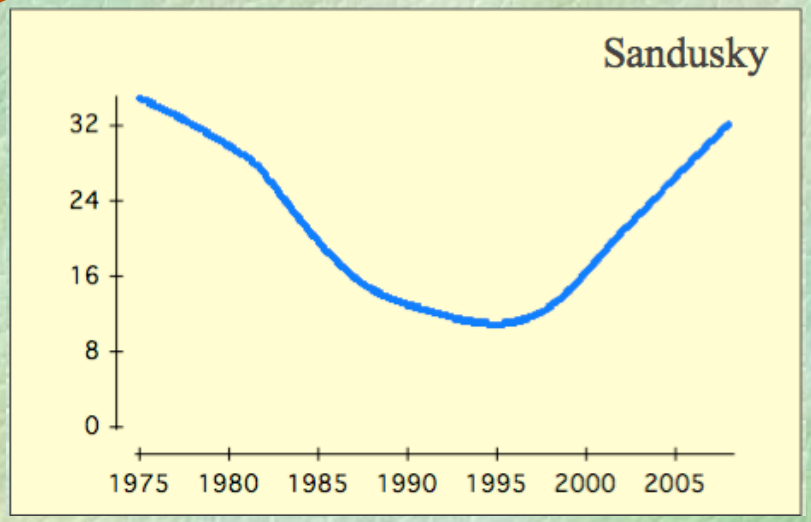
DRP as % of total P





Bad News!





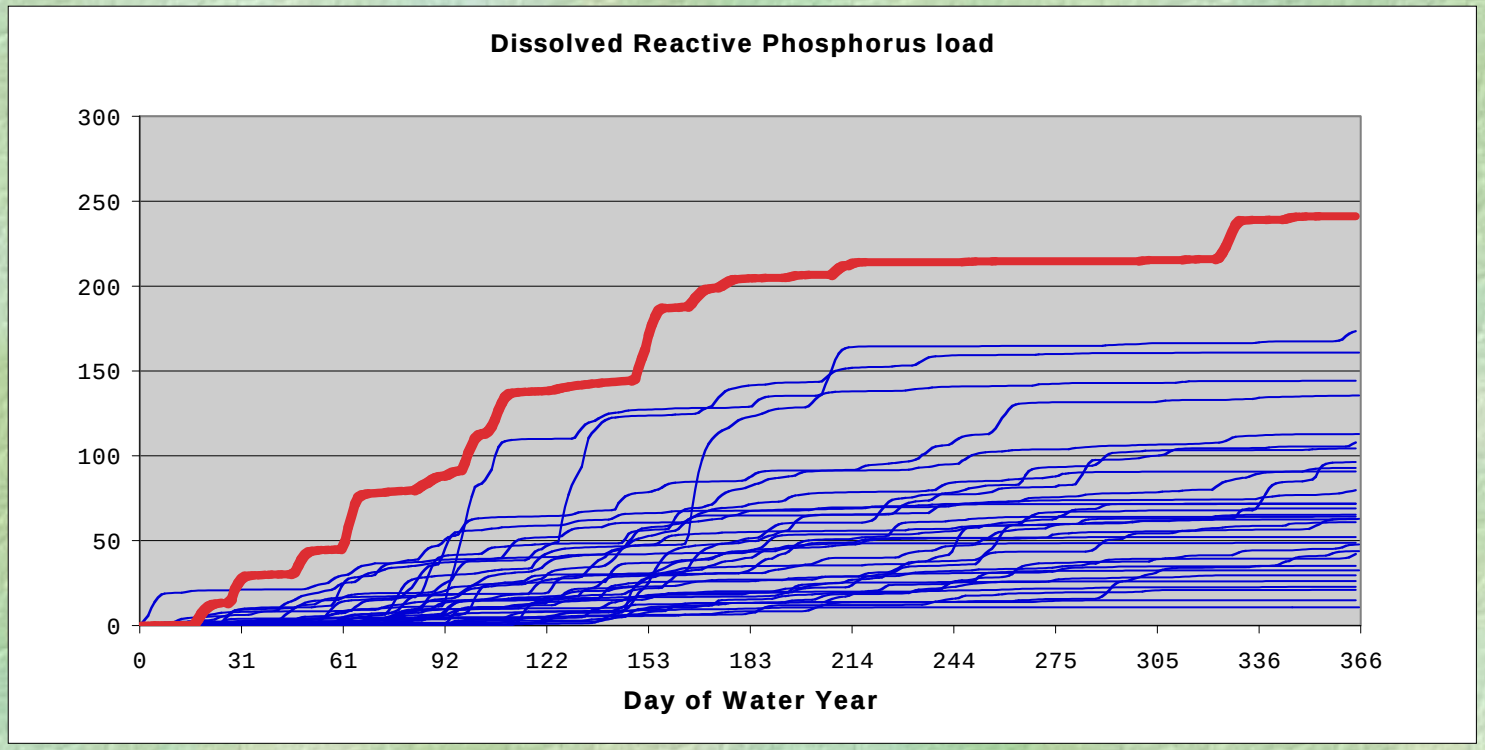
Summary of trends

Percent change per decade
in average concentrations

	Maumee	Sandusky
Flow	4.6	4.9
SS	-18	-11
PP	-14	-10
DRP*	-58, 151	-64, 273

* For DRP, percent decrease per decade prior to 1995 followed by percent increase since then.

DRP loads in 2007 (Sandusky)



- Highest in 33 years of monitoring
- >3x average, recurrence interval >1000 yrs
- A consequence of warm fall weather interacting with farming practices, reinforcing the general trend of increasing loads over the last decade

Sources and transport

- Suspended solids, particulate phosphorus, and dissolved reactive phosphorus are transported to the tributary system primarily by surface runoff following storms.
- The major source of increased DRP must be rural non-point. Point sources are responsible for only a small fraction (<10%) of the P loading in these watersheds.
- Land use is 80% row crop agriculture - corn/soy/wheat

But… an aside

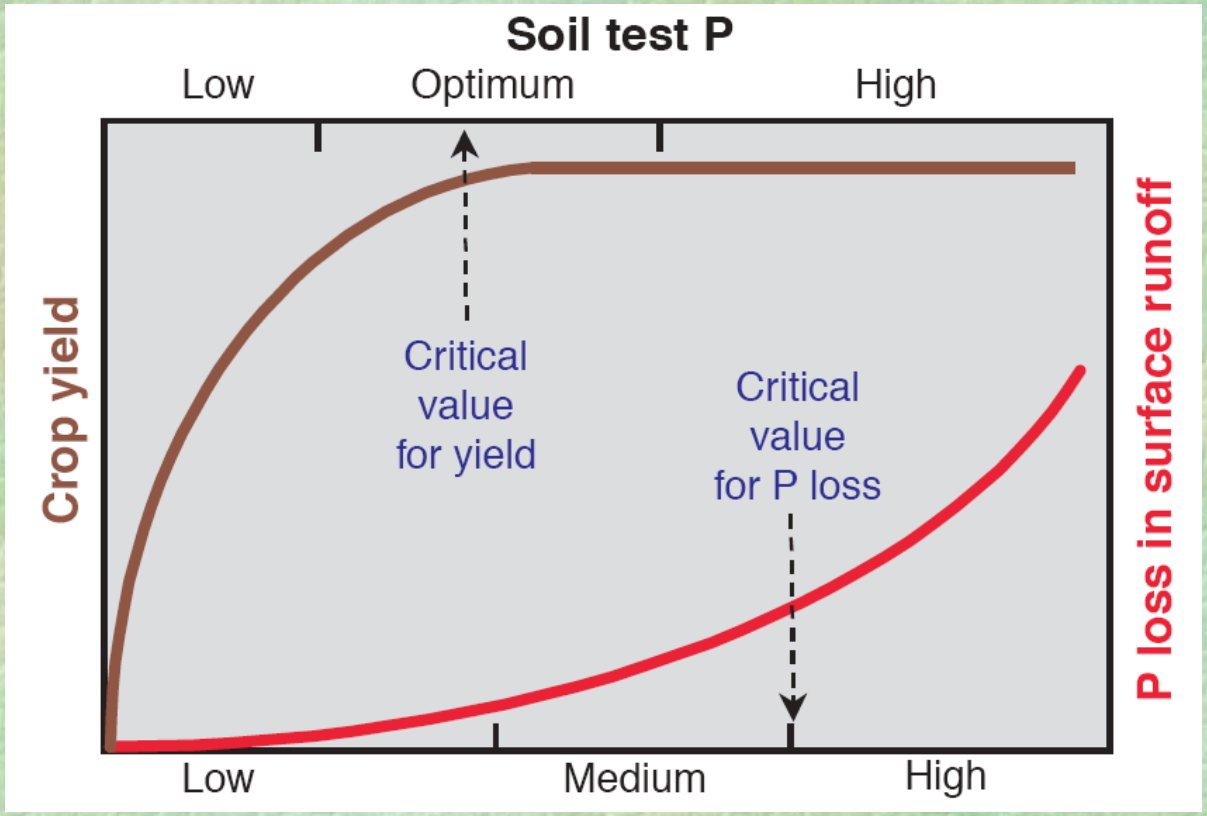
- Upward trends in DRP also seen in Cuyahoga and Grand watersheds
- These are more urban/forested watersheds
- Concentrations are highest under low flow
- Point sources or “pseudo point sources”, e.g. septic systems
- These tribs have a smaller impact on Lake Erie than Maumee and Sandusky

Possible causes for increased DRP: urban

- Aging wastewater treatment infrastructure
- More and/or failing septic systems
- Additions of DRP to drinking water
- Increased use of dishwashers with P-containing detergent
- Urban lawn care
- We believe these are minor contributors to the overall problems affecting Lake Erie

Possible causes for increased DRP: rural

- Increased soil P levels



http://www.ars.usda.gov/is/np/Phos&Eutro2/agphoseutro2ed.pdf

Possible causes for increased DRP: rural

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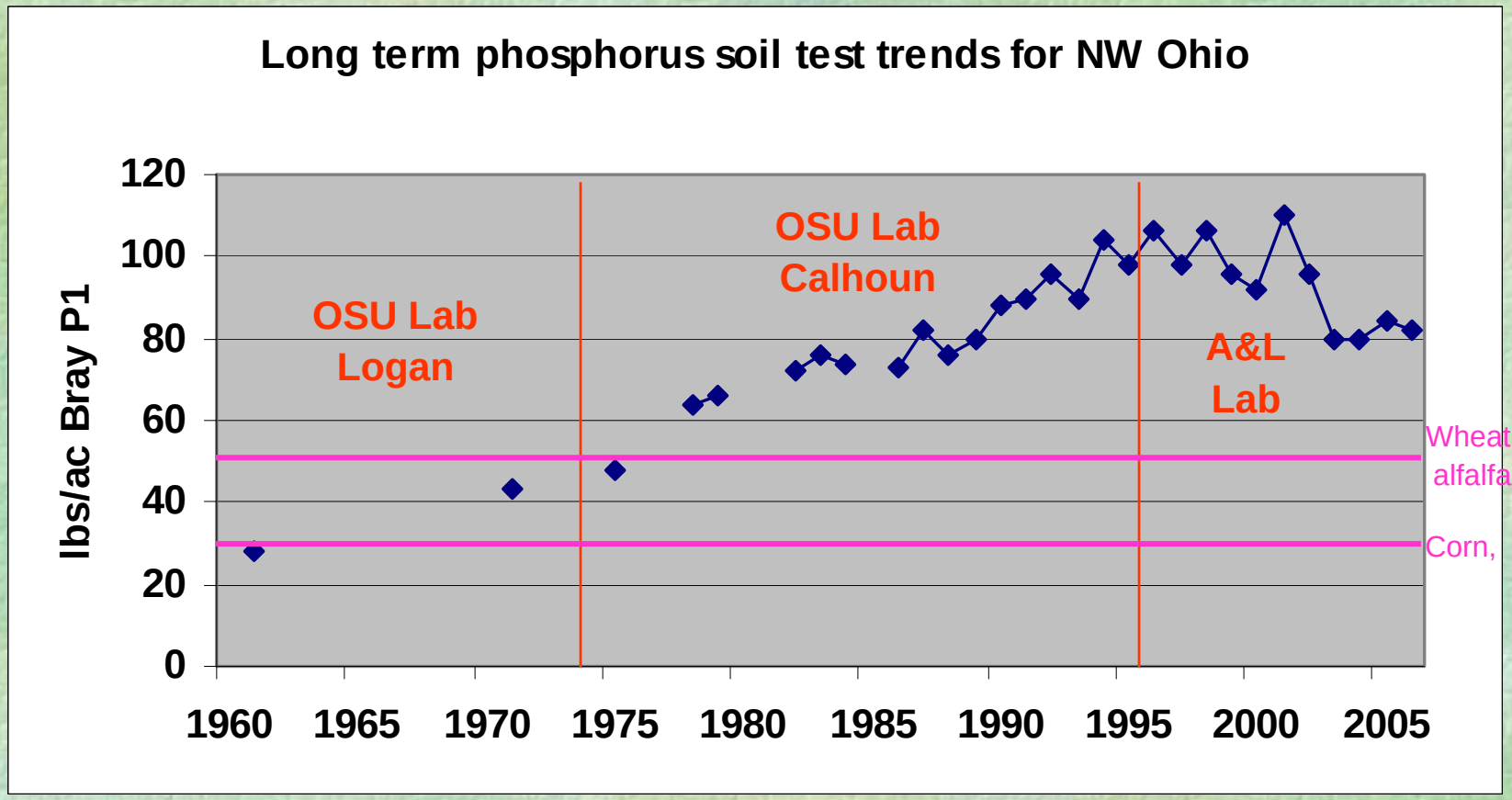
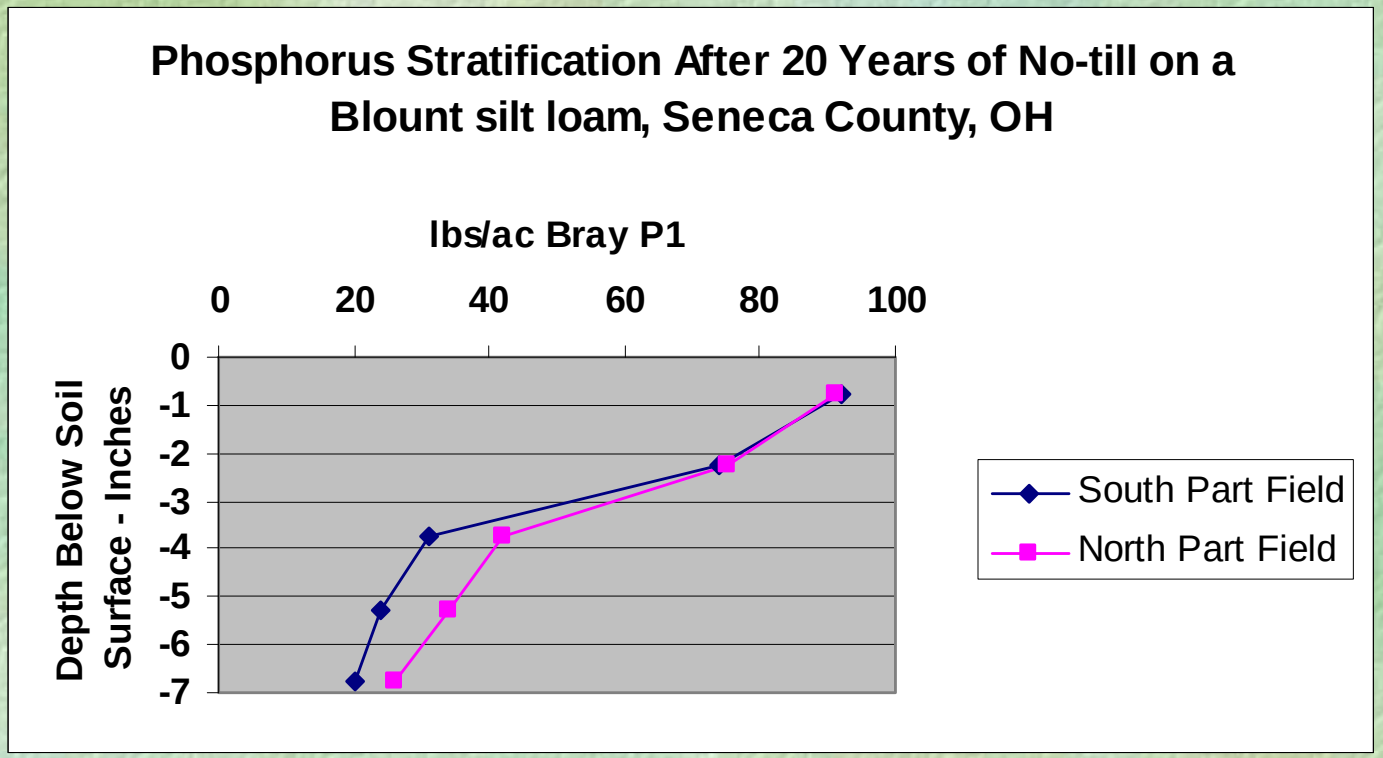


Possible causes for increased DRP: rural

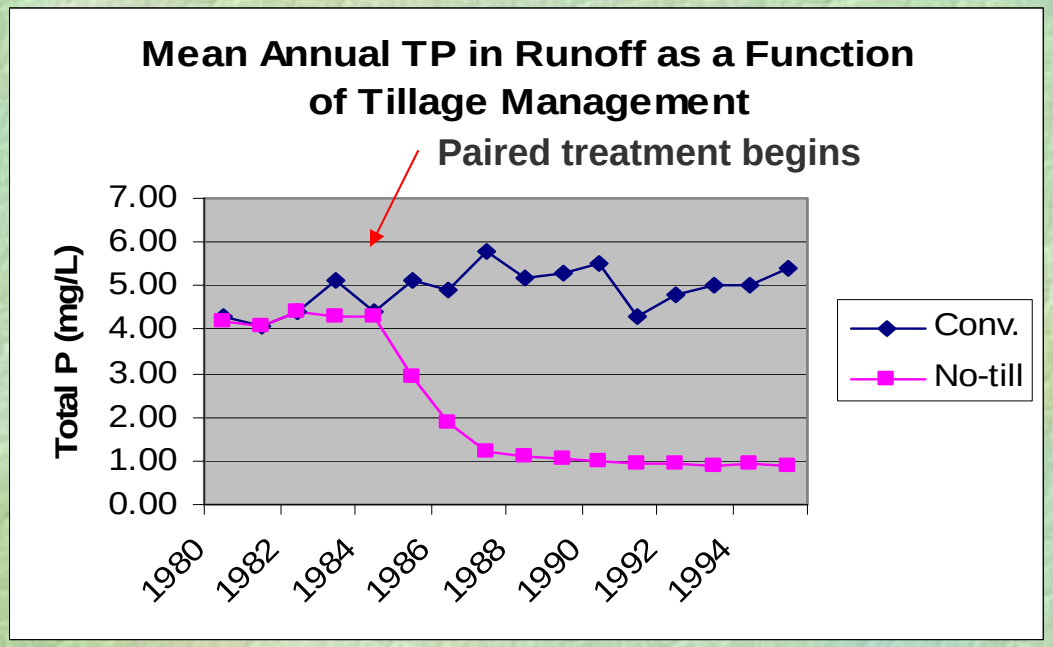
- Concentration of soil P near surface where it can interact with rainfall and dissolve



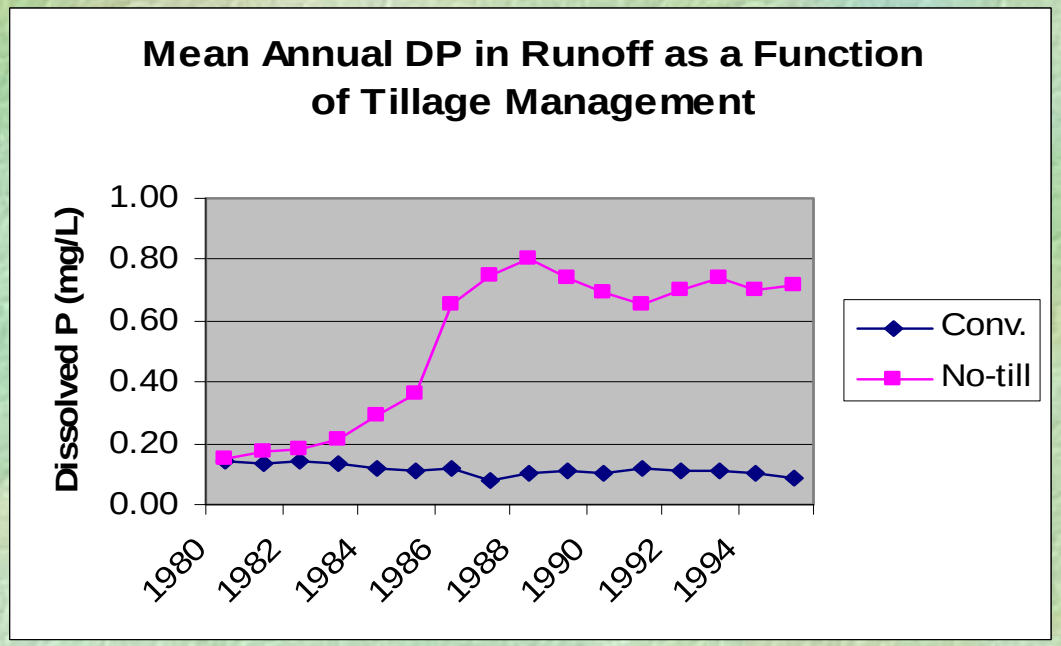
Standard 8 inch soil test:

South Field	48 lbs/ac
North Field	54 lbs/ac

Bill McKibben, CCA
Logan Labs



Reducing tillage can decrease TP in runoff …



…but it can increase DP in runoff.

Sims and Kleinman. 2006. *Phosphorus*

Possible causes for increased DRP: rural

- Interviews with fertilizer dealers: how do your customers apply P and K?
  - Fall application
  - On the surface without incorporation
  - Before corn for both corn and soybean needs
  - This is necessary or convenient because of increased conservation tillage
- Fall and winter application of manure also a concern, especially on frozen ground

Where are we headed?

- Causes for concern:
  - Ethanol means more corn, the heaviest user of fertilizer
  - High crop prices mean conversion of CRP to crops, especially corn
  - More CAFOs
- Causes for hope:
  - Fertilizer and fuel costs up, creating incentives to be efficient
  - Many fields already have more than optimal P levels. A teachable situation?

Possible approaches to solutions

- More extensive soil testing
- Stratified soil testing
- P Index as fertility guide
- Spring fertilization
- Incorporation of manure and chemical fertilizer
- Occasional inversion of the soil

The Bottom Line….

- Value of nutrients that went down the Maumee River in WY2007, based on 2008 fertilizer prices:
  - Phosphorus: $9,100,000
  - Nitrogen: $57,500,000
  - Total: $66,600,000
  - $16.43/acre

Overall Conclusions

- Suspended solids and particulate phosphorus loads have declined over the last 30 years, mostly as a consequence of conservation tillage
- Dissolved reactive phosphorus declined sharply initially, but has increased equally sharply in the last 10 years
- Because DRP is highly bioavailable, these increases are a cause for concern for the ecological health of Lake Erie
- BMP toolbox may need modification to deal with dissolved P rather than total P

Key Questions

- What do we look for that indicates the connection between land-use and transported materials?
  - Temporal patterns of concentration in relation to storm runoff
- What are key variables of concern? (stressor variables; response variables)
  - SS, TP, DRP; algae, DO, hypoxia
- Which variables could be used as land-based state indicators?
  - % agricultural land use, TP content of soils, tillage practices
- What would you say are acceptable ranges of these variables?
  - Soil P: <2x level for optimal crop production, <80 lb/acre Bray 1 P
- What databases are available? Measurement technology?
  - WQ: NCWQR. Land: NASS. Tech: precision nutrient management
- What are the research needs/land-based measurements?
  - Soil fertility, stratification. Uncensored animal numbers. Linked models.
- What is the role of watershed loading models in synthesizing information and data and in predicting the watershed response to source control actions?
  - Important potential, not yet realized. Critical for exploring alternative scenarios. The only way to sort out zebra mussels vs. tributary loading? See EcoFore 2006 project.


The End
Rock Creek 6/25/06