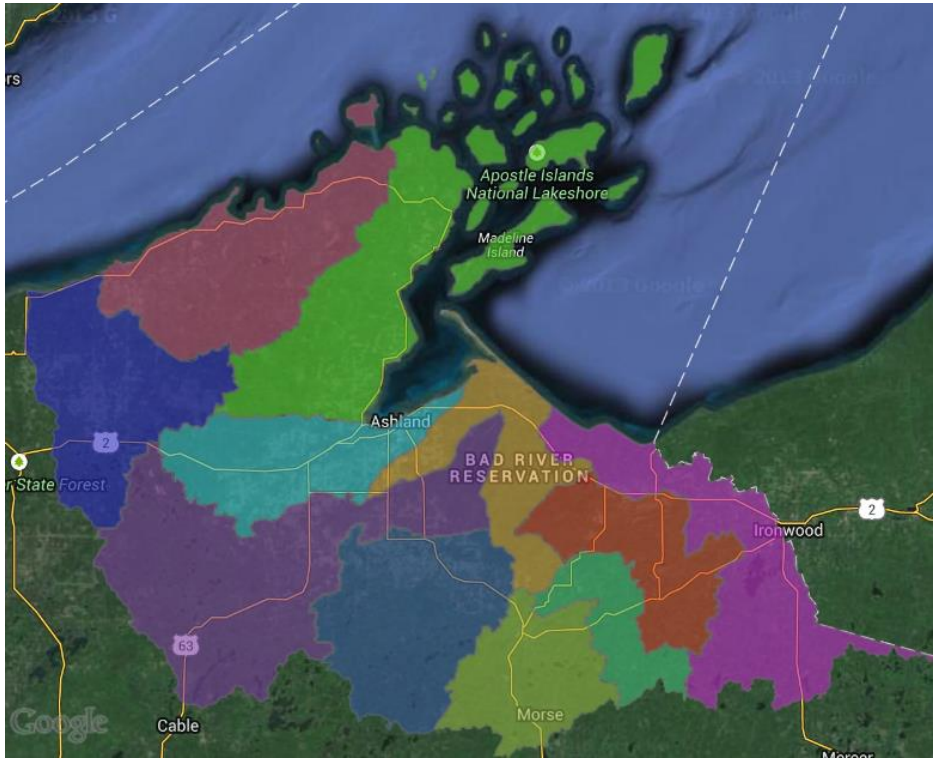
Surface Water Quality in the Chequamegon Bay Region



What We Know and What We Don't

Randy Lehr, Ph.D.

NORTHLAND COLLEGE

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Broader Context

- Global
  - Food demand
    - 50%-110% increase in production by 2050

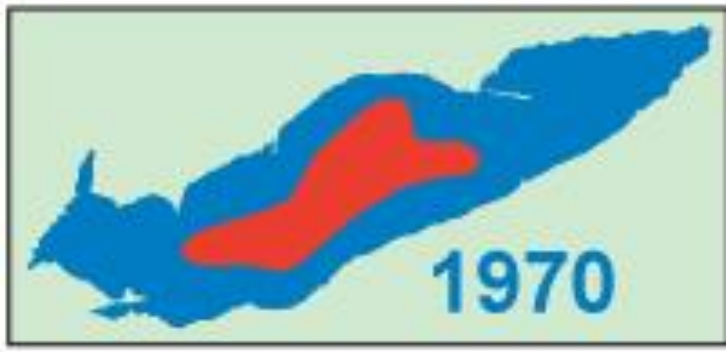
- Regional
  - Water
    - Globally scares, locally abundant
  - Growing season
    - Increasing 3-4 weeks
  - Land price
    - Among the lowest in the region
  - Transportation
    - Local land and water “hubs”

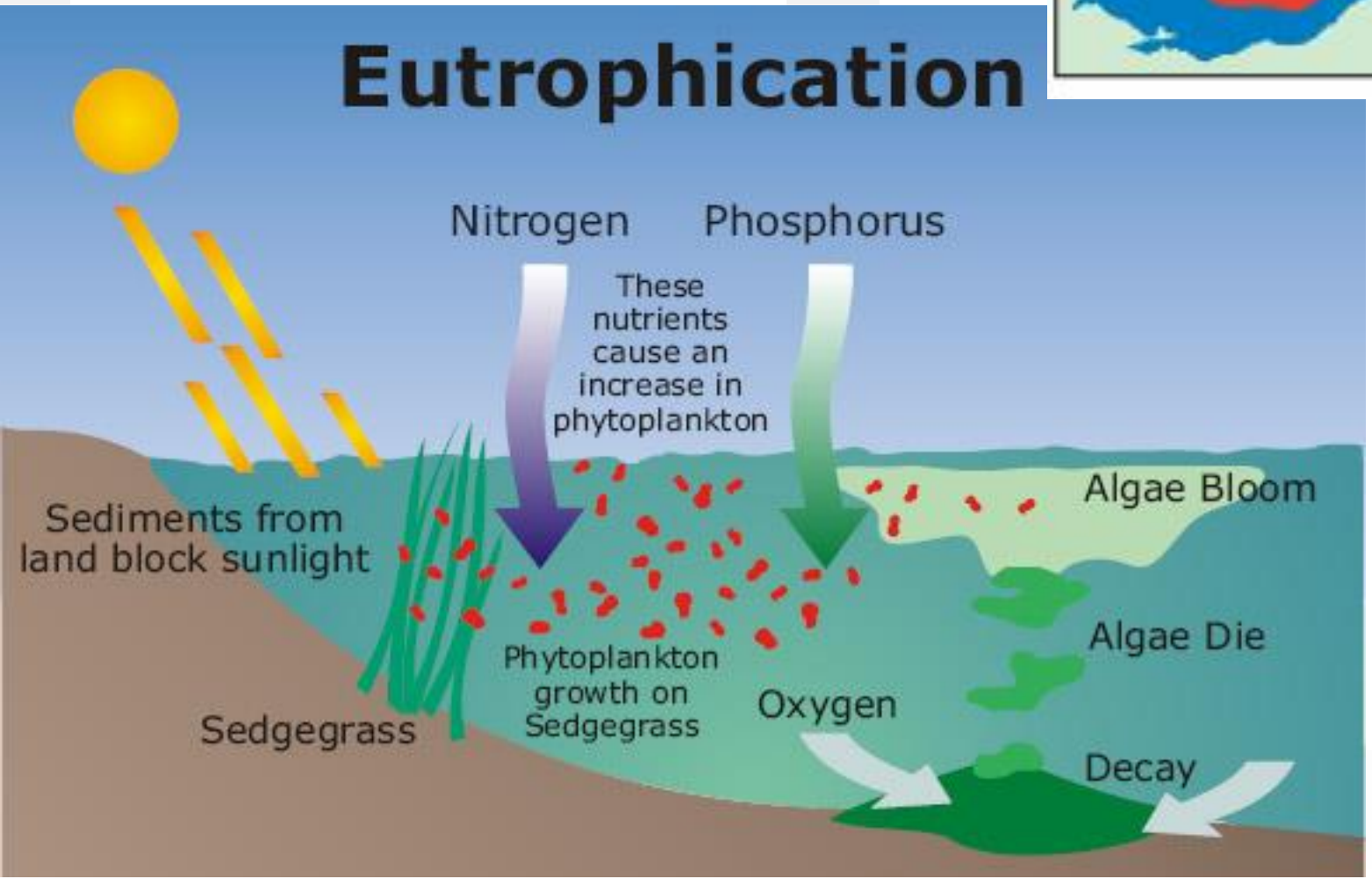
Lake Erie and Water Quality

math of the June 22, 1969 fire as the fire boat continues to break up oil
urtesy of The Cleveland Public Library Photograph Collection.)

"…even a great lake can die." (Time, 1969)

Nutrients Impacts in Lake Erie





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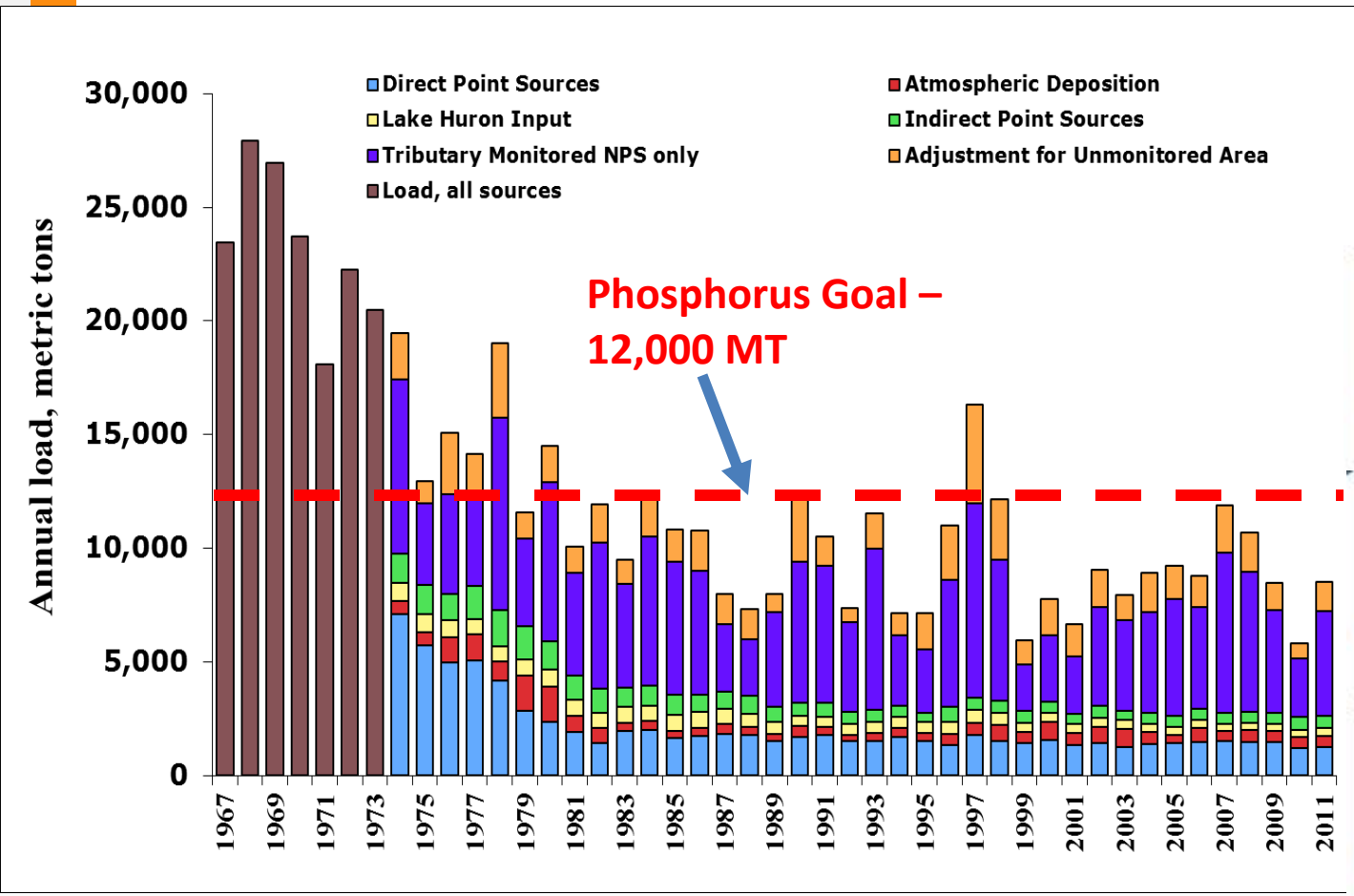
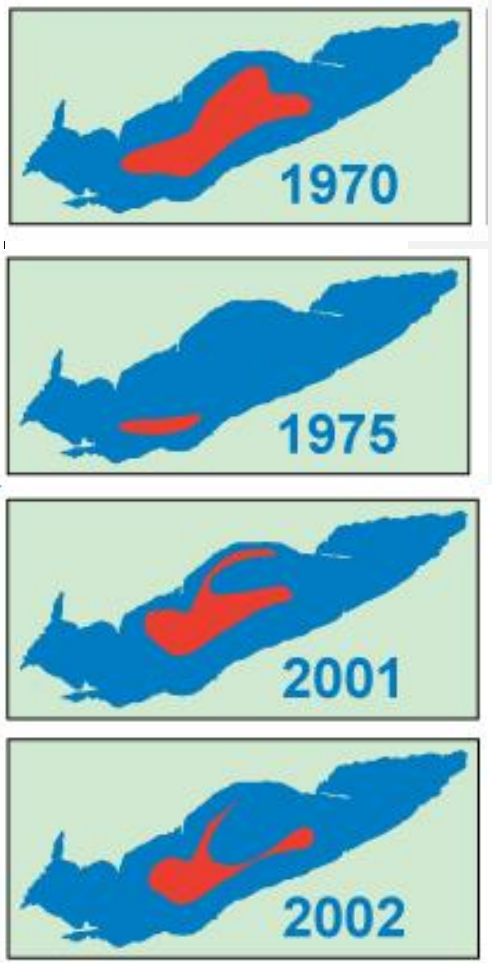
Restoring Lake Erie

- Reduce phosphorus runoff to a “background” level





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Since then….its gotten more complicated

- Toledo water quality crisis

- Green Bay Dead Zone

- Apostle Islands algal bloom 2012

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Water Quality Management Process

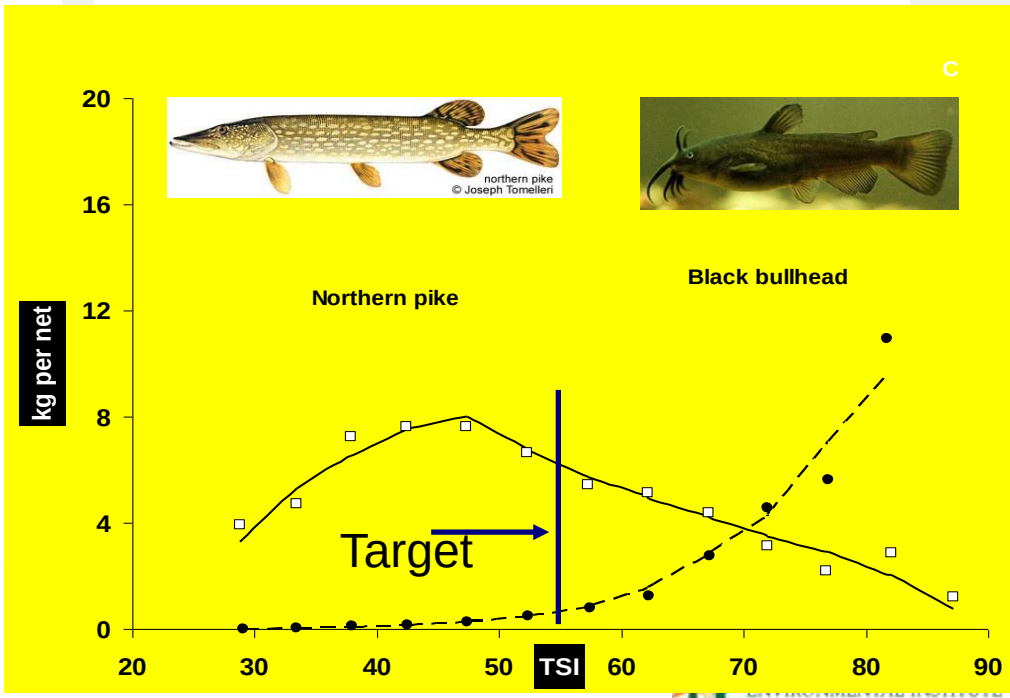
- Clean Water Act (1972)
  - Set water quality standards
  - Assess water quality conditions
  - Identify impaired waters
  - Restore impaired waters

Assessing Water Quality

- Setting Standards
  - Beneficial uses
  - Triennial review

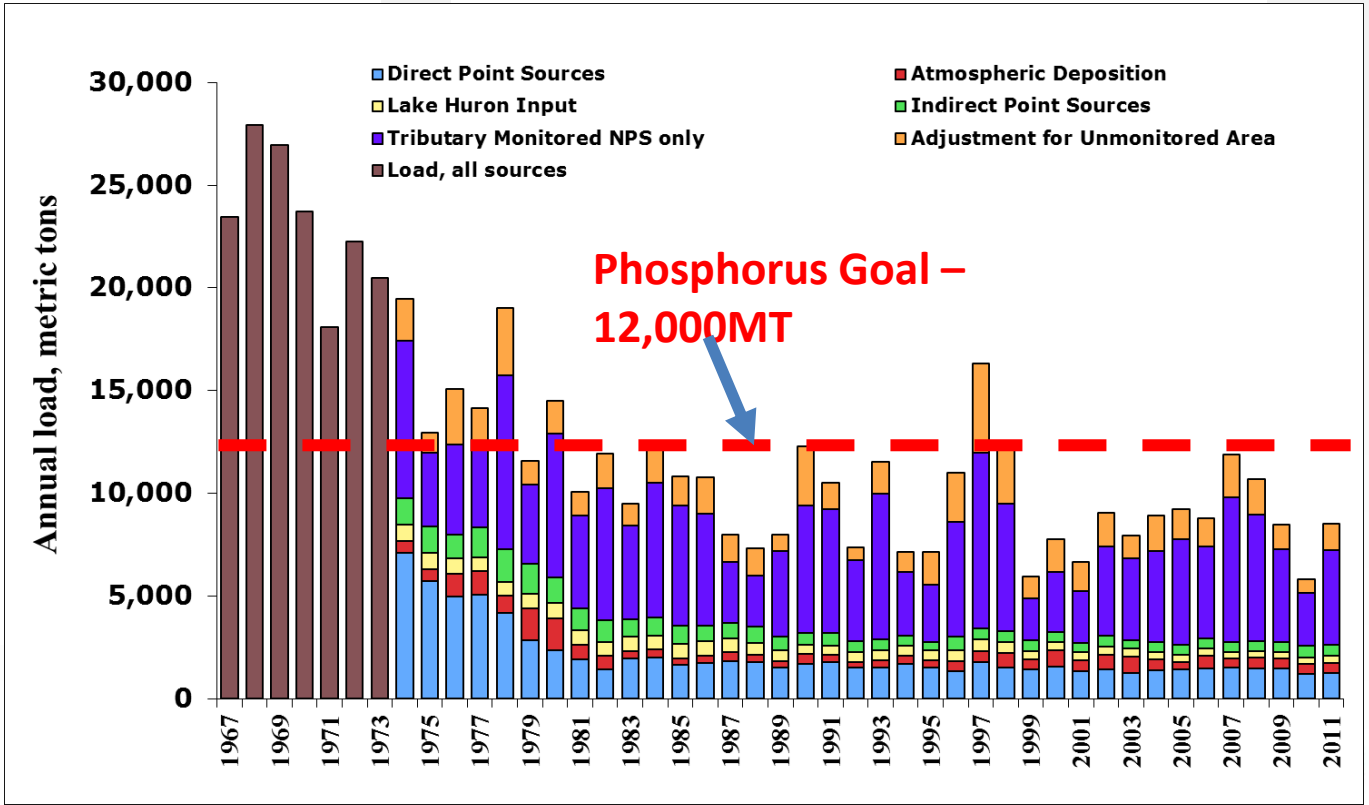
Vs.

- Condition Assessment
  - WisCALM
    - How many samples?
    - Over what timeframe?
    - How "different" from standard?



Managing Water Quality

- Protect
  - Antidegradation
    - ORWs and ERWs
  - National Pollutant Discharge Elimination System (NPDES)
- Restore
  - Total Maximum Daily Load (TMDL)



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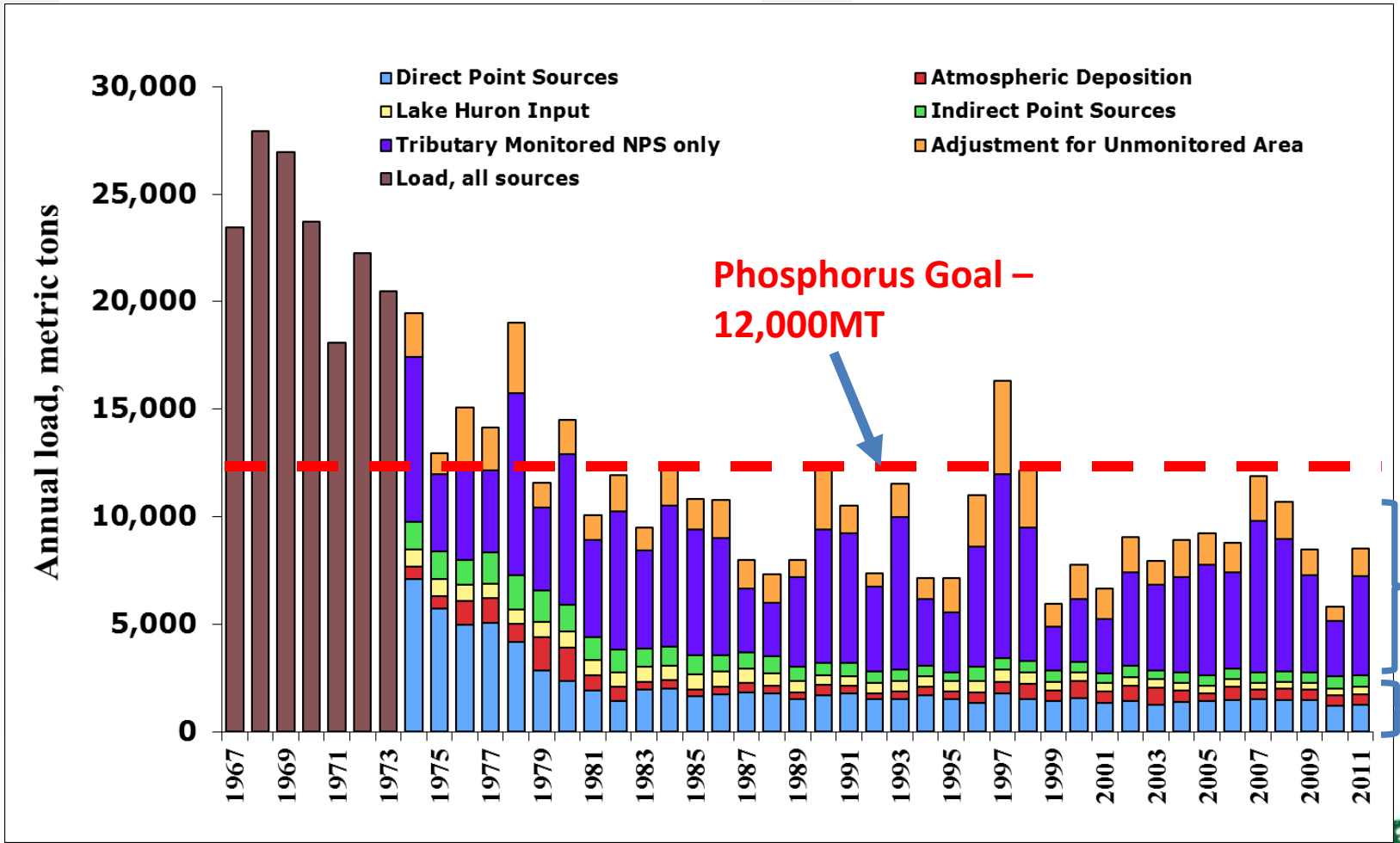
Limits to the Clean Water Act

- Focused on “point sources” of pollution
- Water quality vs. performance based



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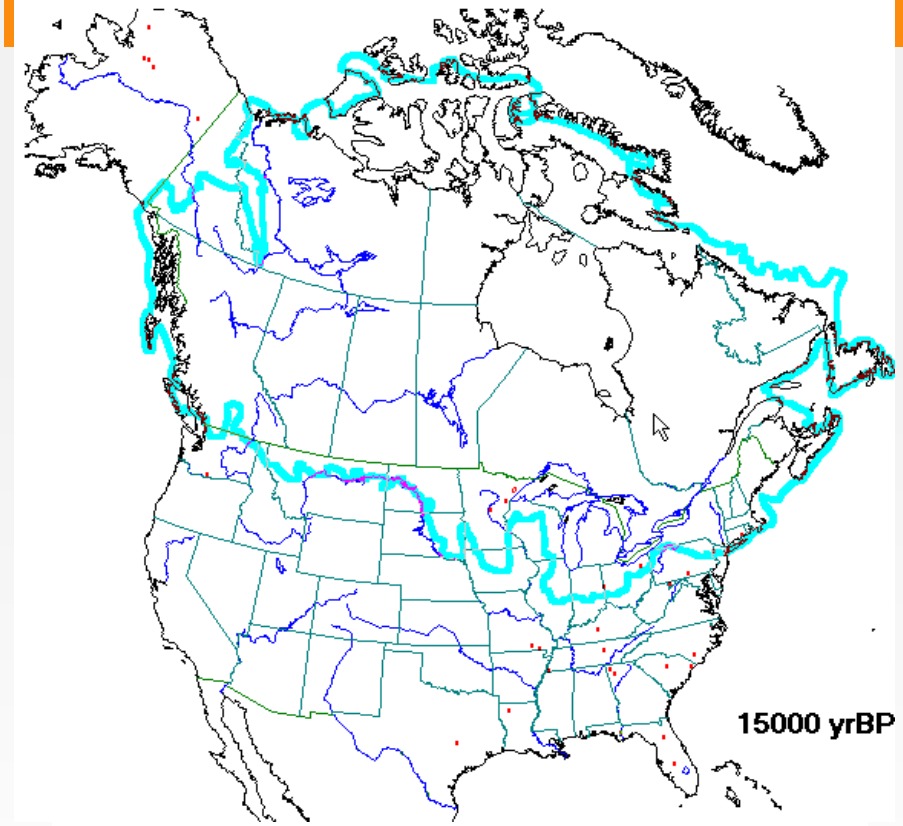
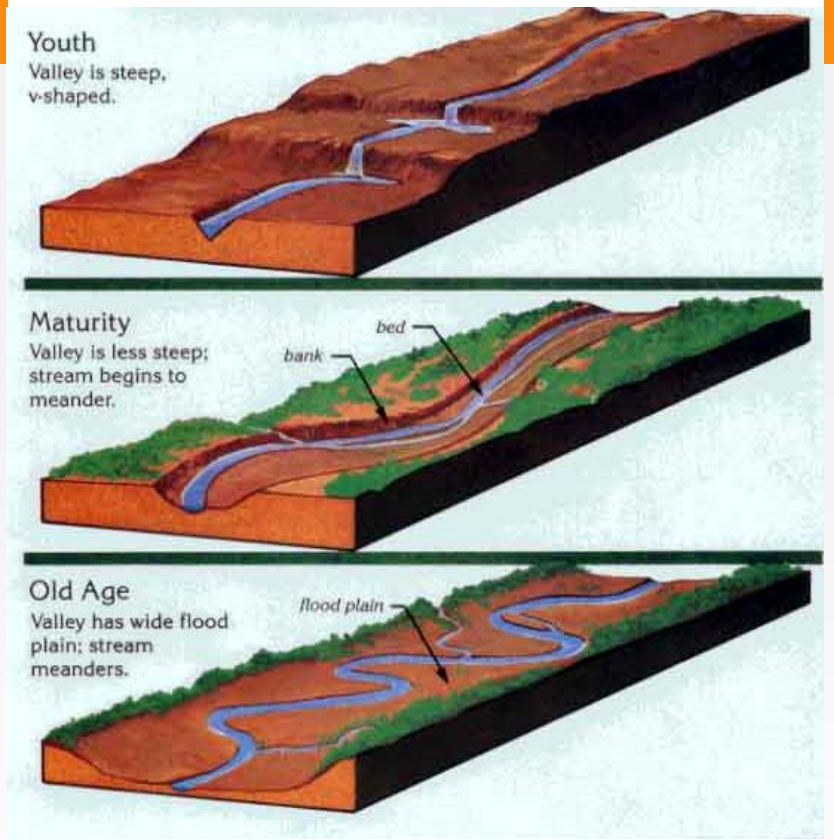
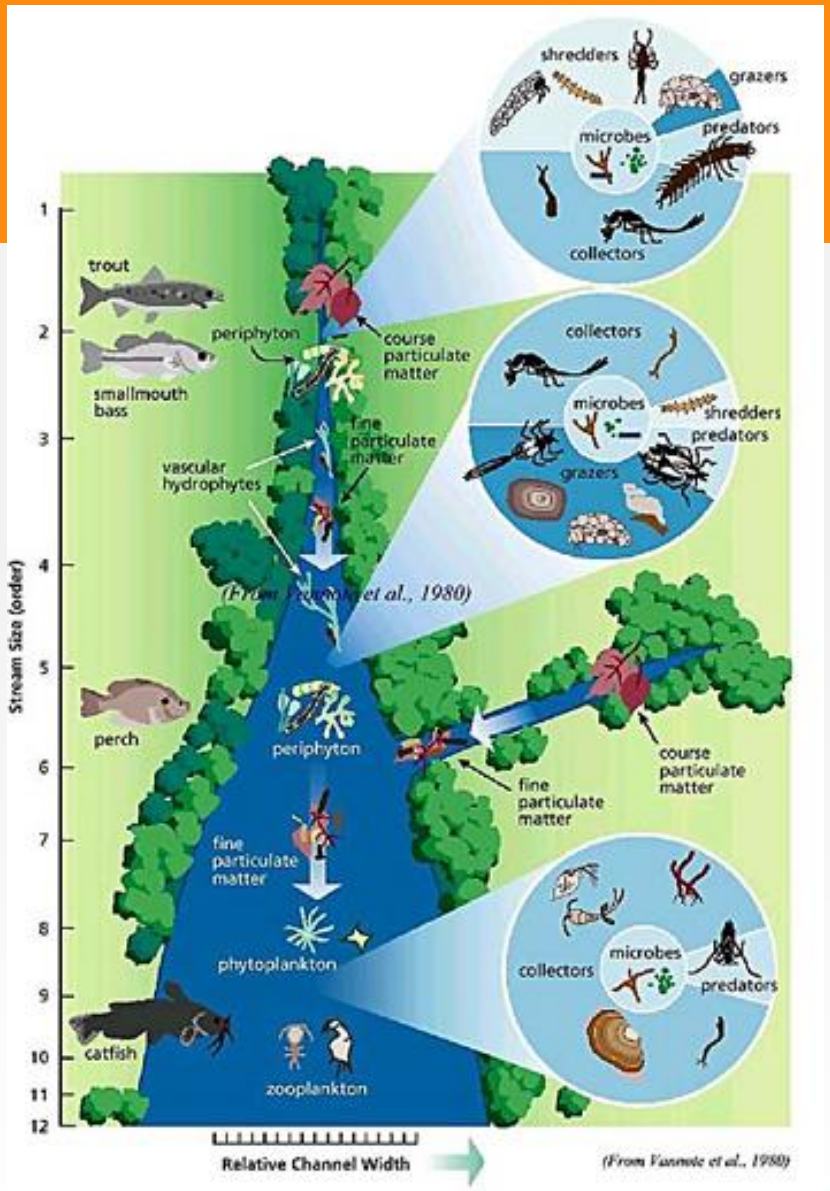
Formation and Evolution of Aquatic Ecosystems





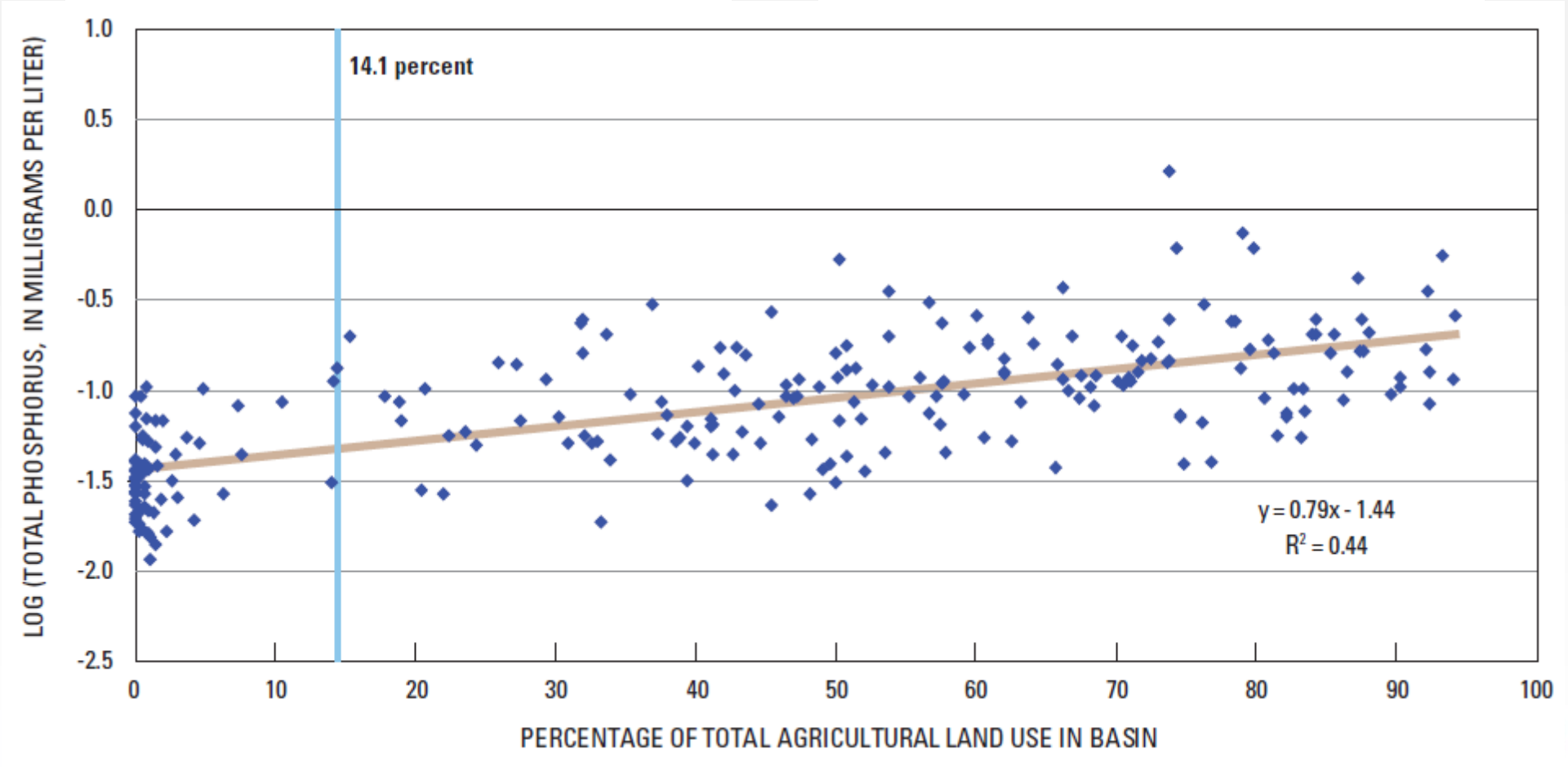
Formation of Water Quality Conditions

- Product of watershed conditions
- Responsive to long-term “averages”
- Annually variable
- **Soil nutrient “deficiencies” do not exist**



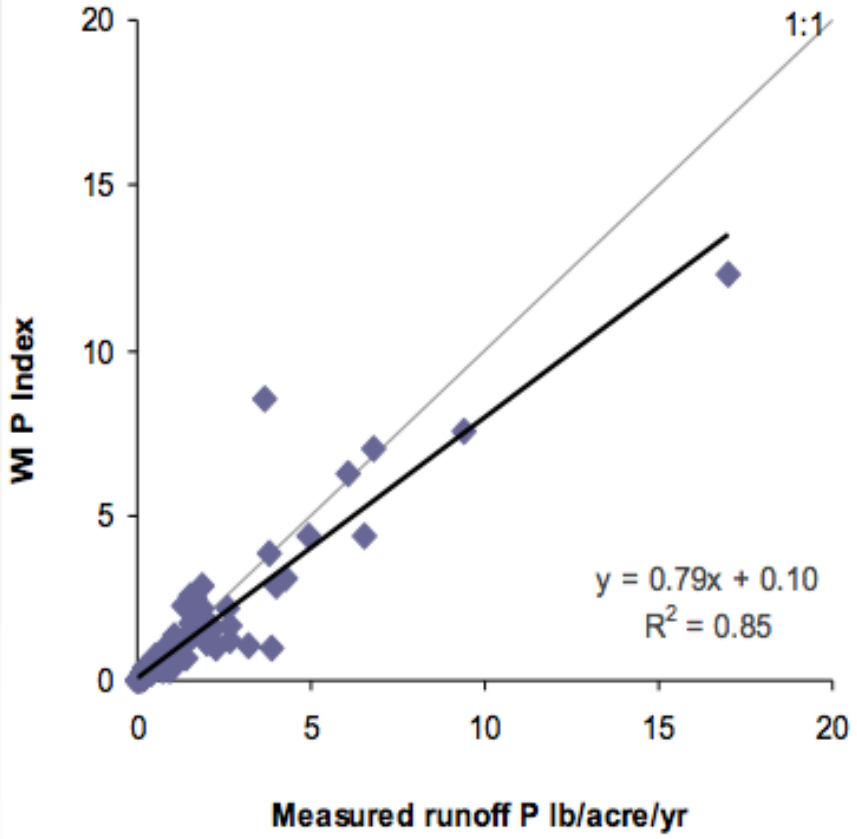
Water Quality and Agriculture

- Runoff
  - Quantity and Quality
- Stream banks
  - Shading and leaf input



Land Use Export of Phosphorus

- TMDL Goals Commonly **0.16-0.33** lb P/acre/year



Relationship between measured runoff P and the Wisconsin P Index for 86 field-years, 2003-2008.

Description	P Low		P Most Likely		P High	
	lb/mi^2	(kg/ha)	lb/mi^2	(kg/ha)	lb/mi^2	(kg/ha)
Open Water	0	(0)	0	(0)	0	(0)
Developed, Open Space	57	(0.1)	171	(0.3)	286	(0.5)
Developed, Low Intensity	29	(0.05)	57	(0.1)	143	(0.25)
Developed, Medium Intensity	171	(0.3)	286	(0.5)	457	(0.8)
Developed, High Intensity	571	(1.0)	856	(1.5)	1142	(2.0)
Barren Land	0	(0)	0	(0)	0	(0)
Deciduous Forest	29	(0.05)	54	(0.09)	103	(0.2)
Evergreen Forest	29	(0.05)	54	(0.09)	103	(0.2)
Mixed Forest	29	(0.05)	54	(0.09)	103	(0.2)
Shrub/Scrub	43*	(0.08)*	74	(0.13)*	123*	(0.22)*
Grassland/Herbaceous	57	(0.1)	97	(0.17)	143	(0.25)
Pasture/Hay	57	(0.1)	171	(0.30)	286	(0.5)
Cultivated Crops	286	(0.5)	571	(1.0)	1713	(3.0)
Woody Wetlands	0	(0)	0	(0)	0	(0)
Emergent Herbaceous Wetlands	0	(0)	0	(0)	0	(0)

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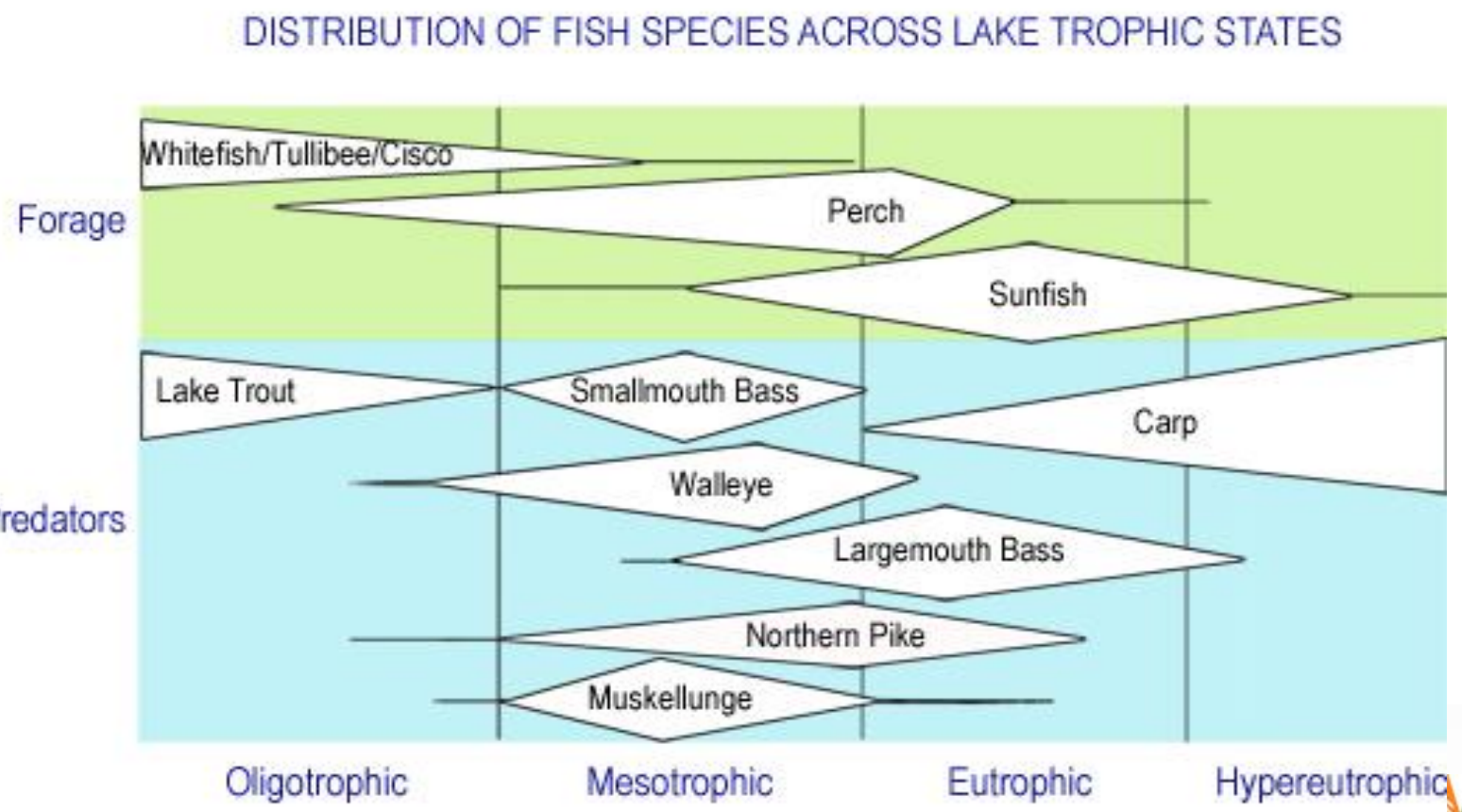
Biological Change and Assimilative Capacity

Bigger Fish → **Different Fish** → **No Fish**



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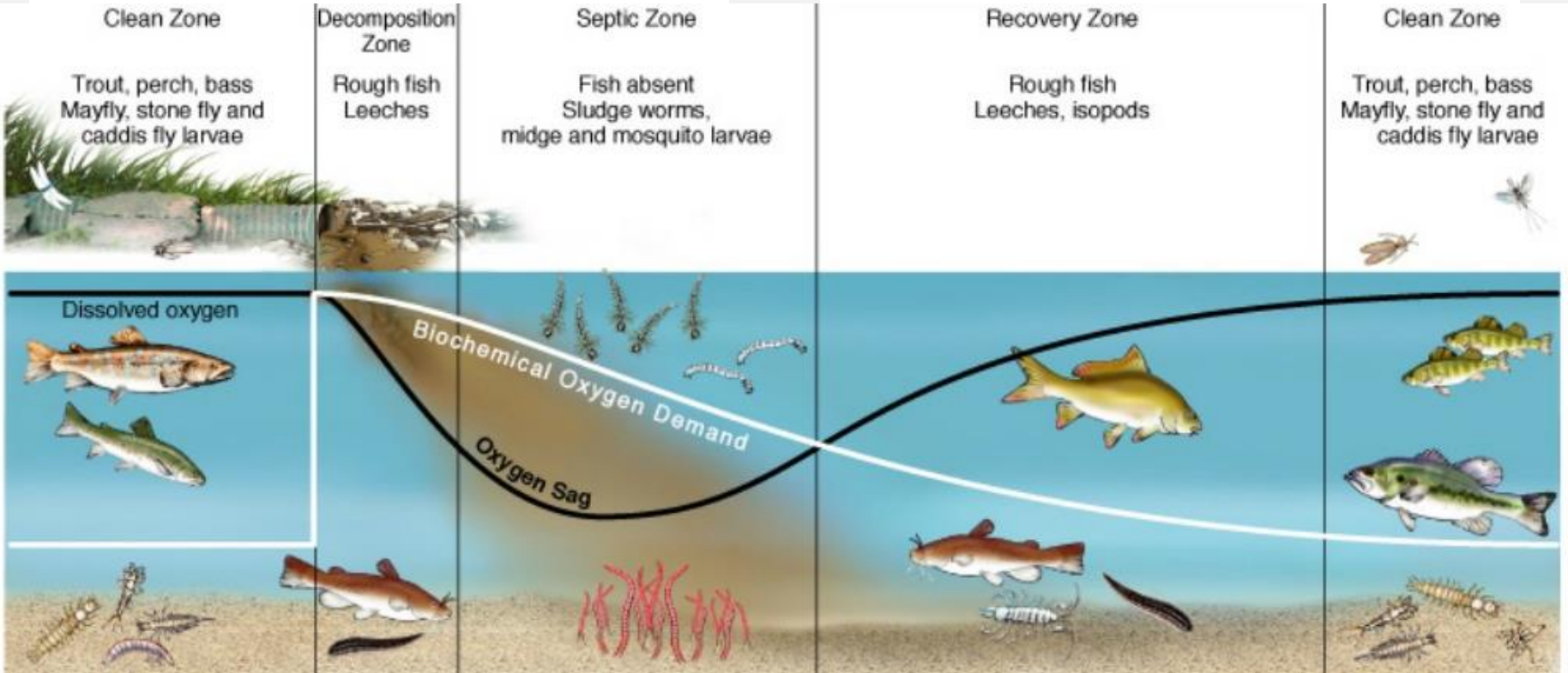
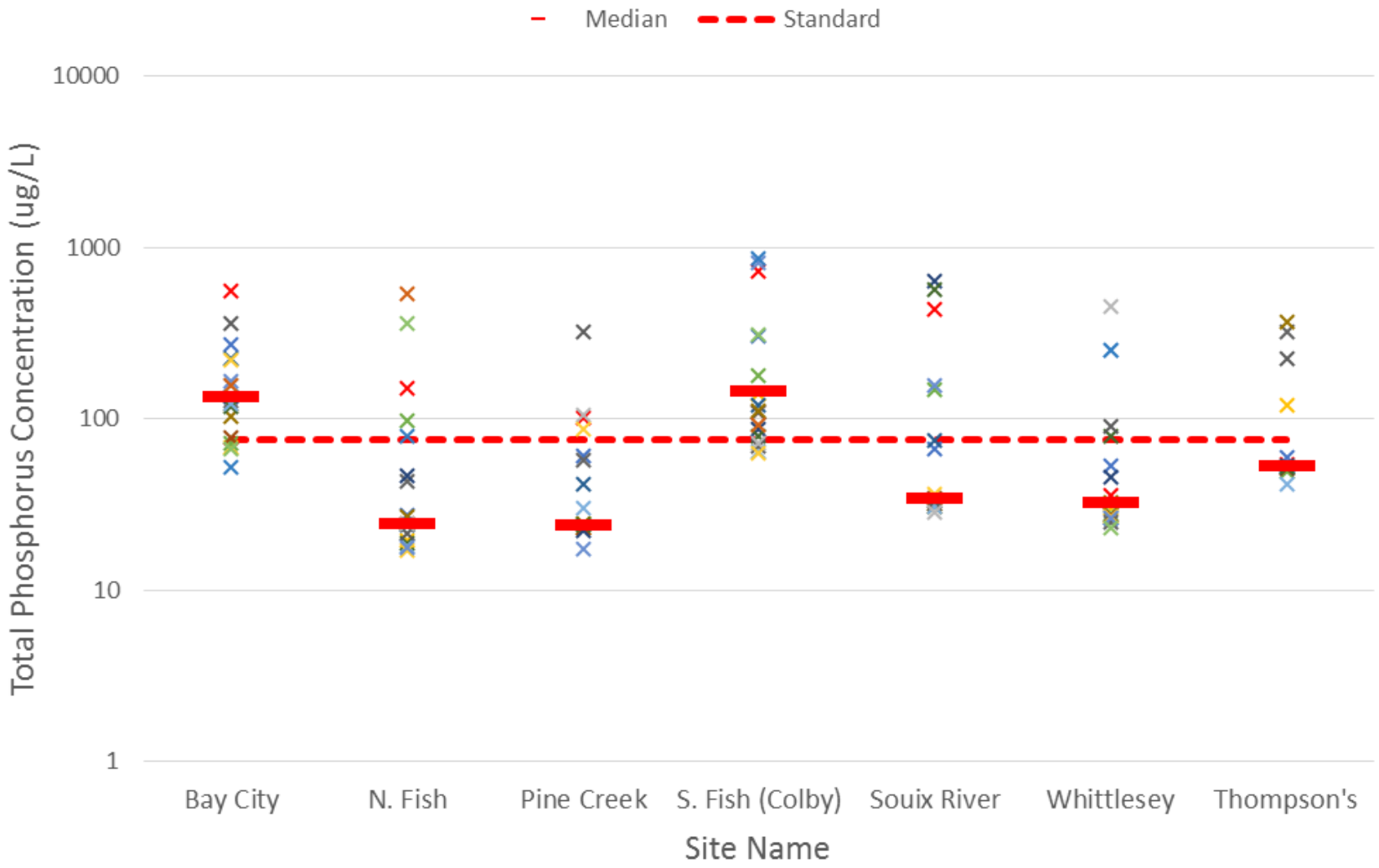
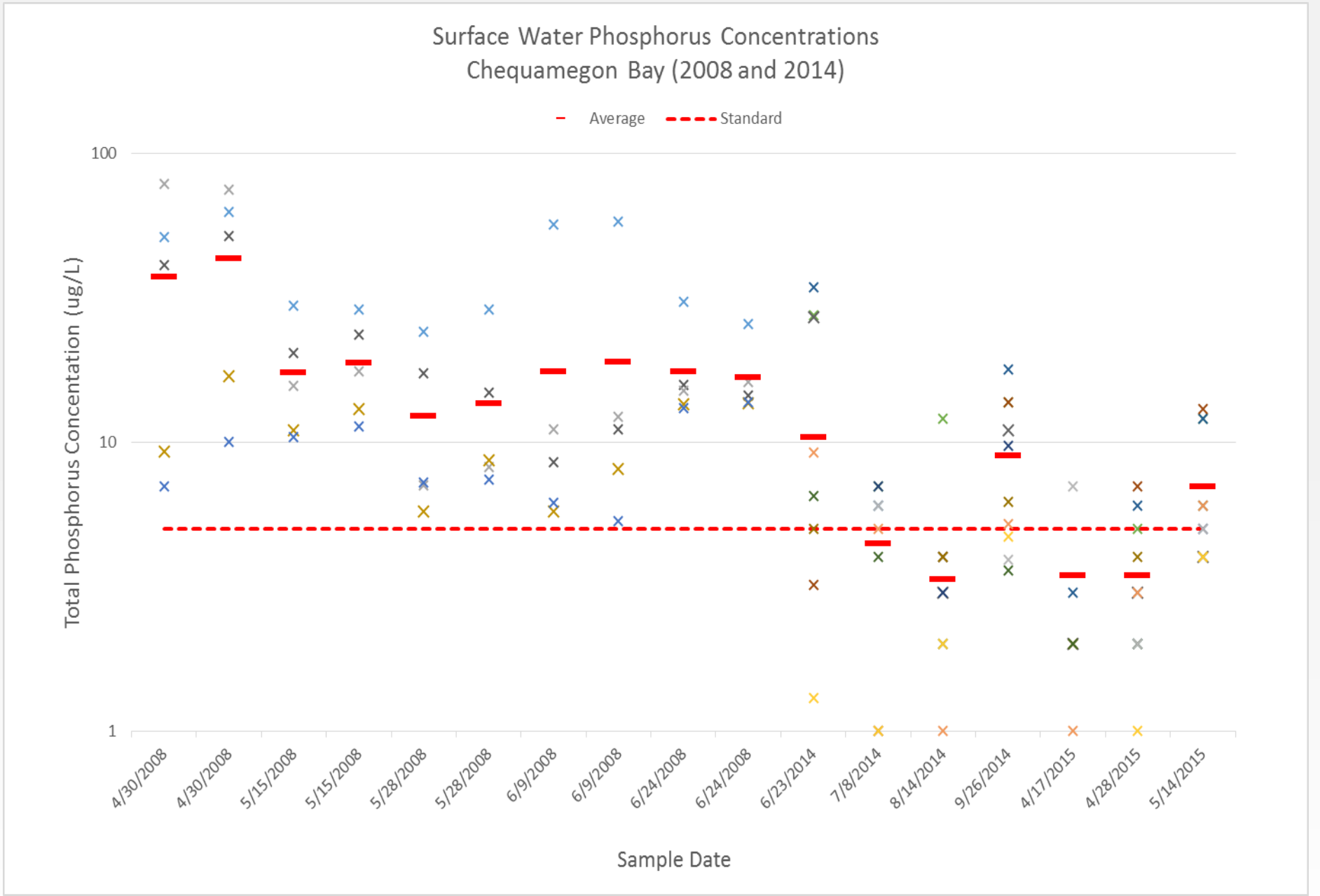
Water Quality Change is…

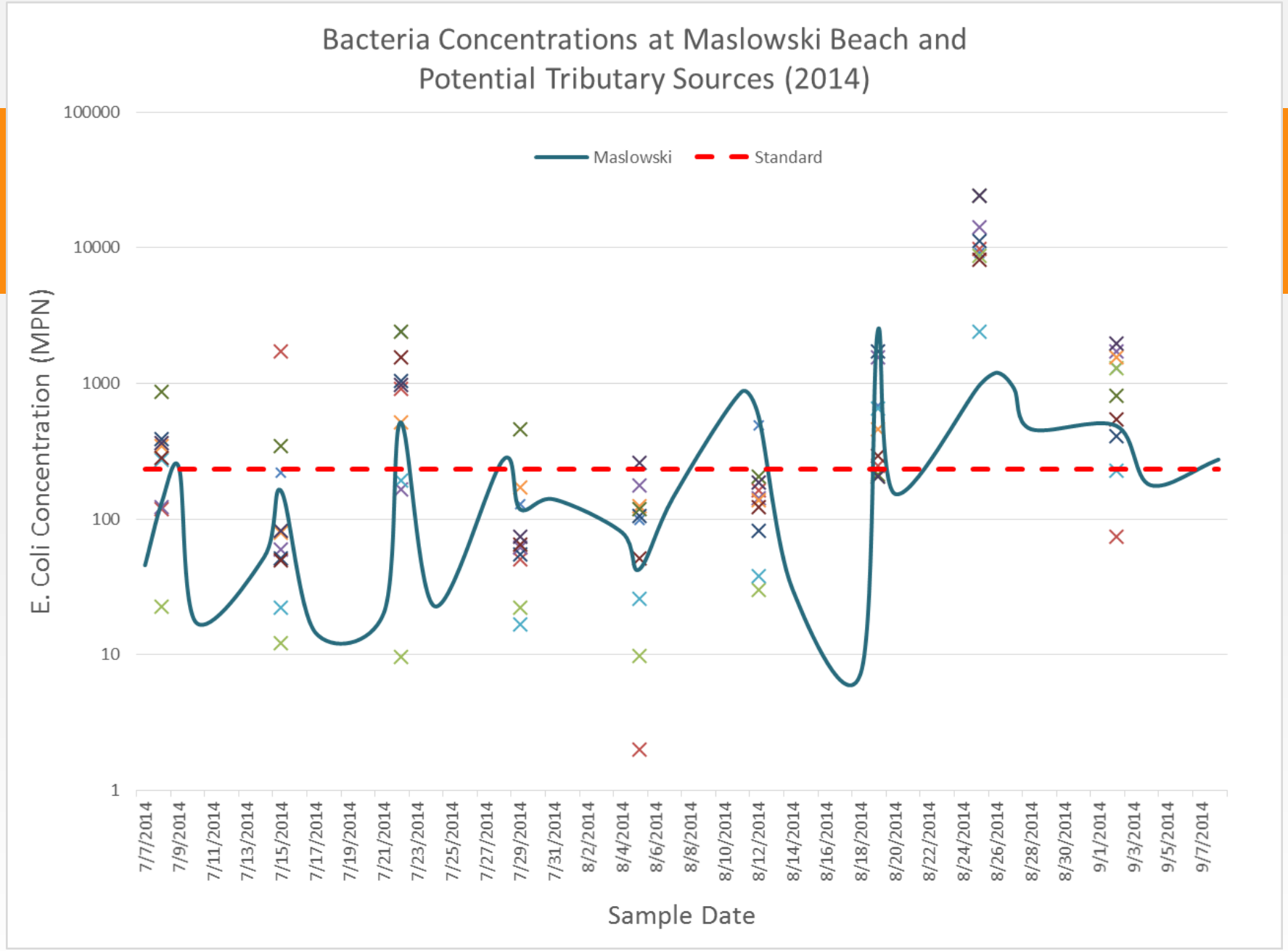
- Gradual and often difficult to measure
- Dependent on scale



Instream Phosphorus Concentrations - Chequamegon Bay Tributaries (2014)

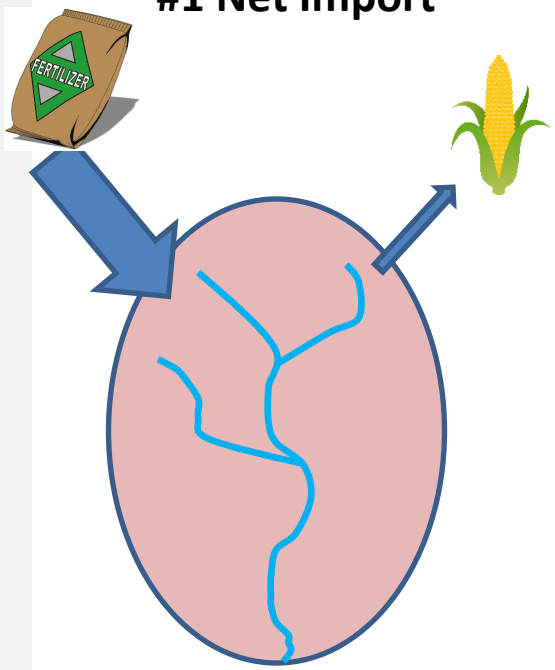


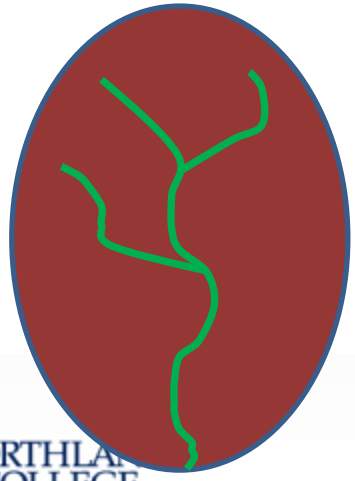

Surface Water Phosphorus Concentrations
Chequamegon Bay (2008 and 2014)
Average
Standard
100
10
1
Total Phosphorus Concentation (ug/L)
4/30/2008
4/30/2008
5/15/2008
5/15/2008
5/28/2008
5/28/2008
6/9/2008
6/9/2008
6/24/2008
6/24/2008
6/23/2014
7/8/2014
8/14/2014
9/26/2014
4/17/2015
4/28/2015
5/14/2015
Sample Date


Bacteria Concentrations at Maslowski Beach and Potential Tributary Sources (2014)
Maslowski
Standard
E. Coli Concentration (MPN)
100000
10000
1000
100
10
1
7/7/2014
7/9/2014
7/11/2014
7/13/2014
7/15/2014
7/17/2014
7/19/2014
7/21/2014
7/23/2014
7/25/2014
7/27/2014
7/29/2014
7/31/2014
8/2/2014
8/4/2014
8/6/2014
8/8/2014
8/10/2014
8/12/2014
8/14/2014
8/16/2014
8/18/2014
8/20/2014
8/22/2014
8/24/2014
8/26/2014
8/28/2014
8/30/2014
9/1/2014
9/3/2014
9/5/2014
9/7/2014
Sample Date

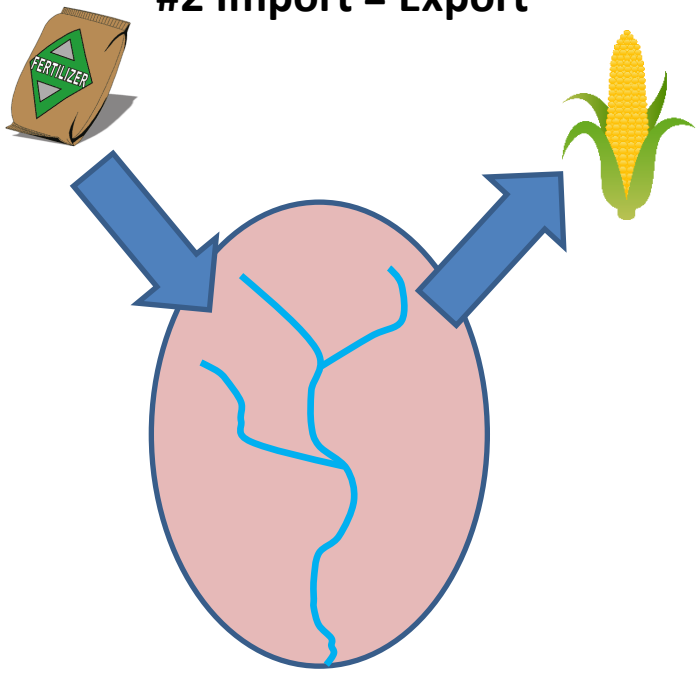
Watershed Phosphorus Budget

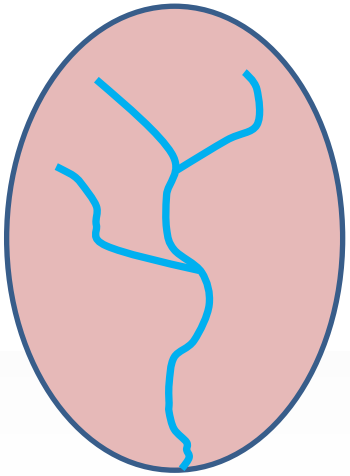
#1 Net Import



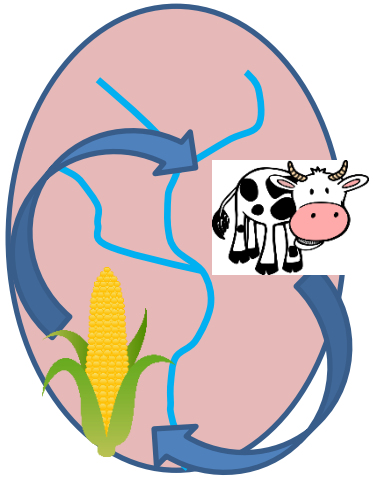


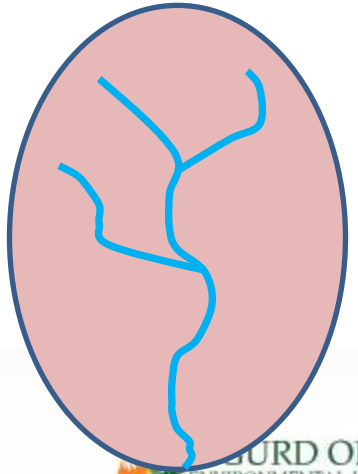
#2 Import = Export



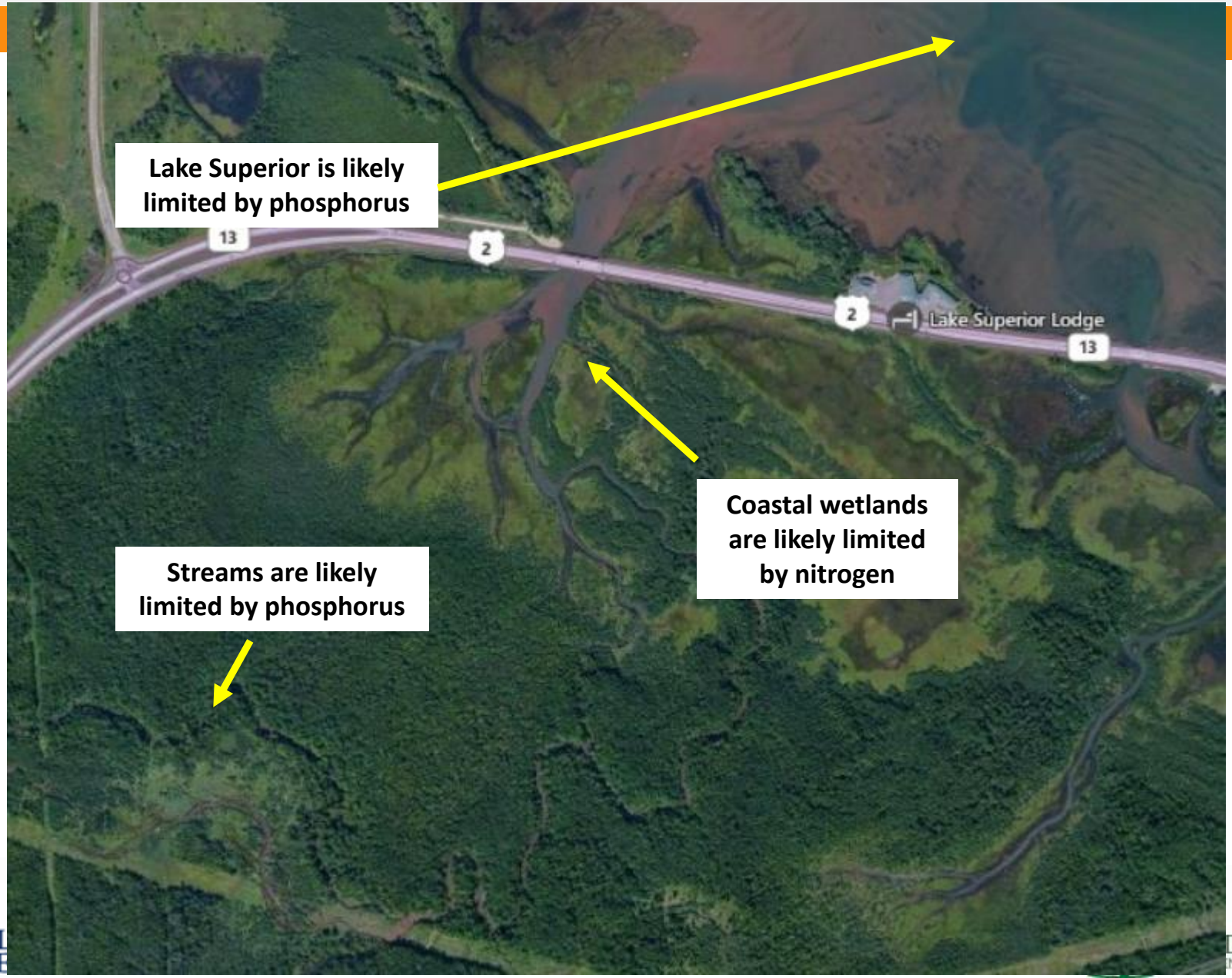


#3 "Recycling"

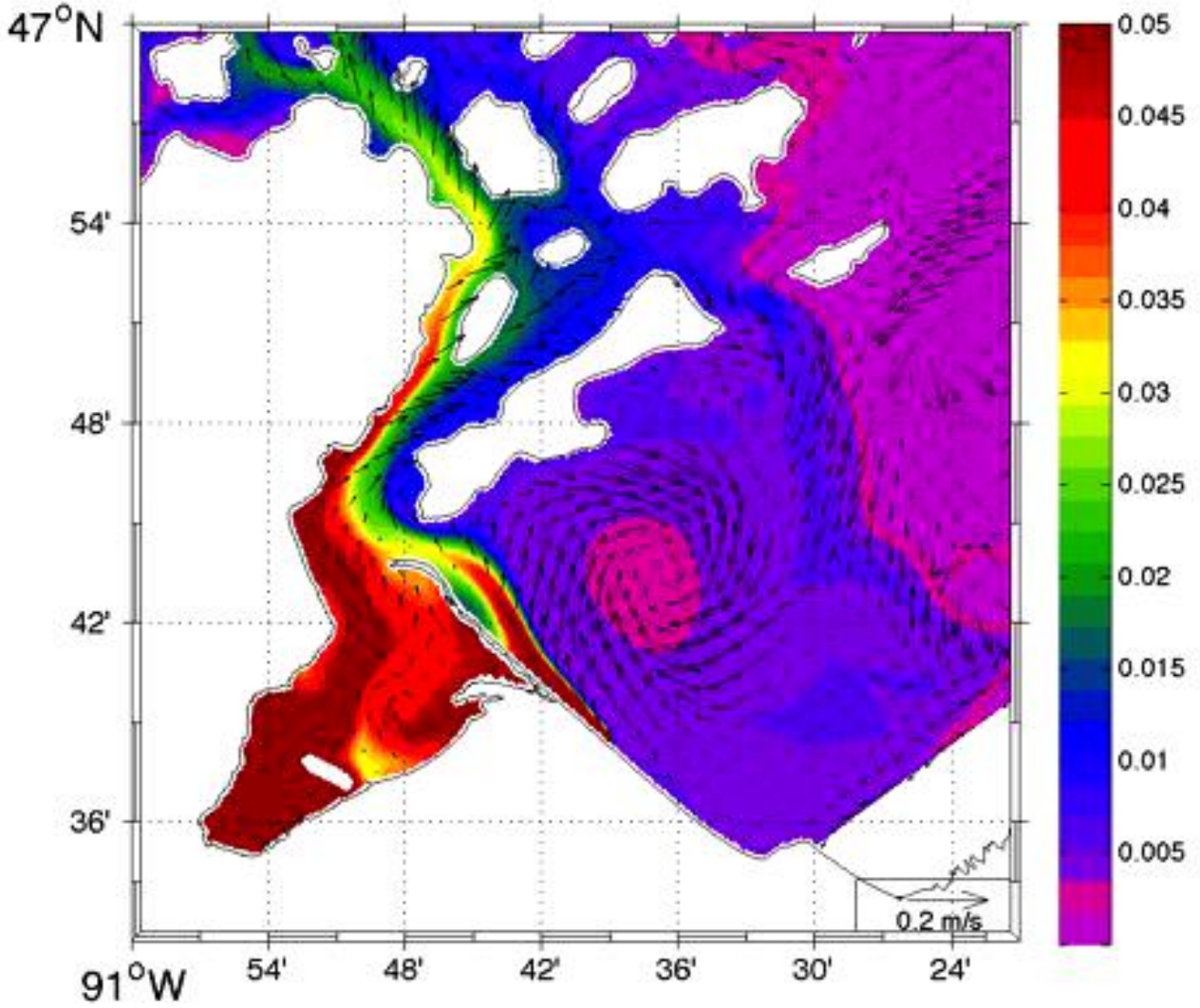




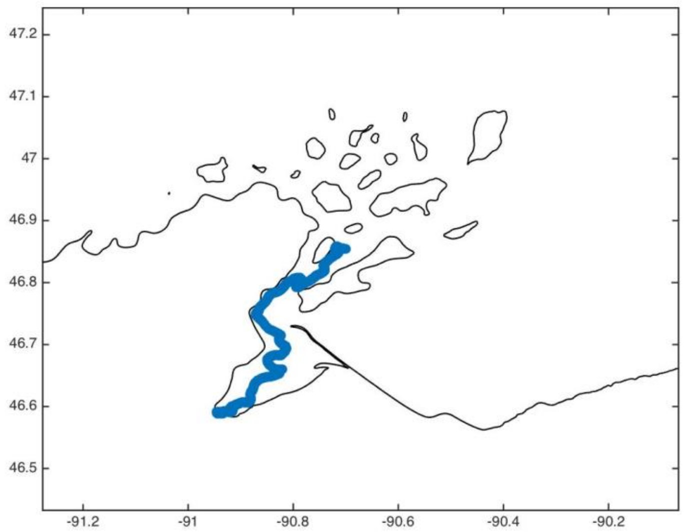
Nutrient Limitation Varies

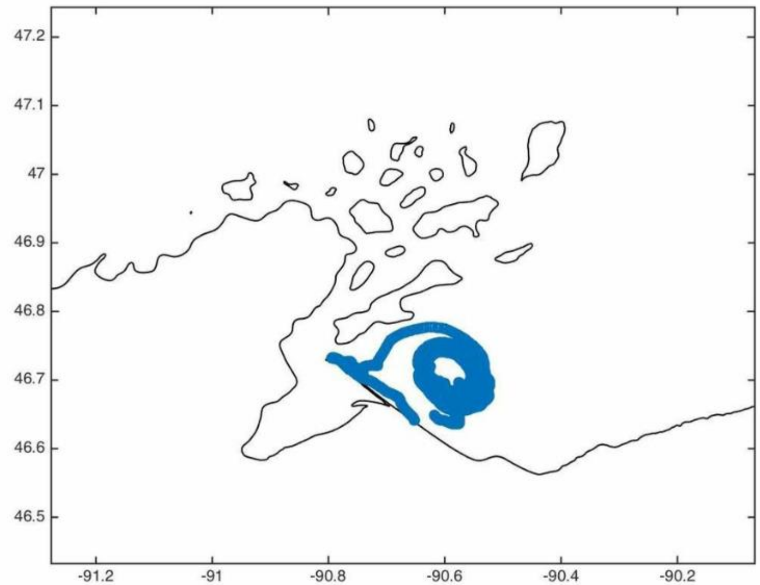


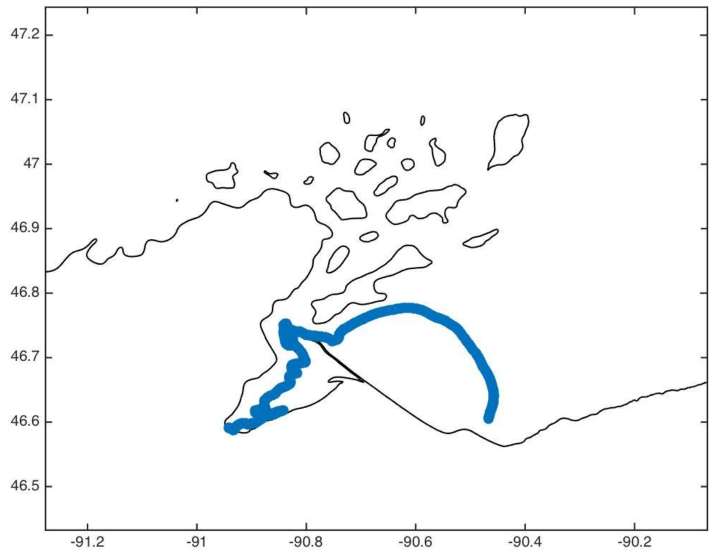
Currents in Chequamegon Bay

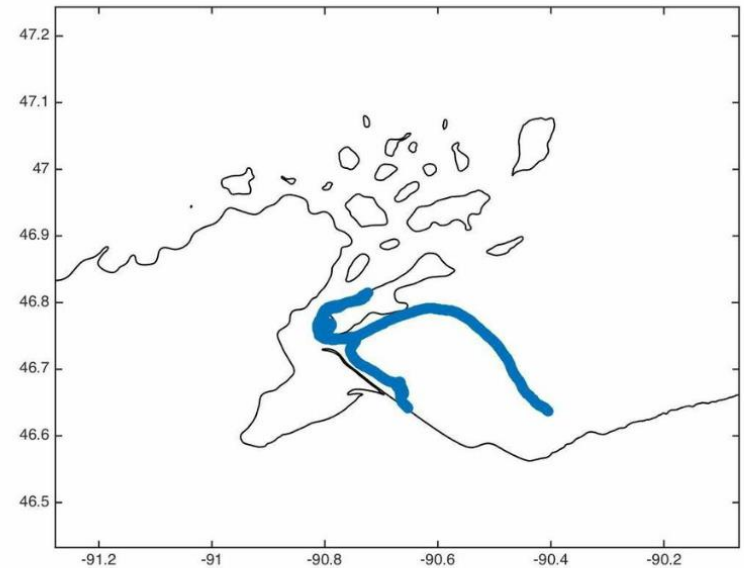


Currents in Chequamegon Bay



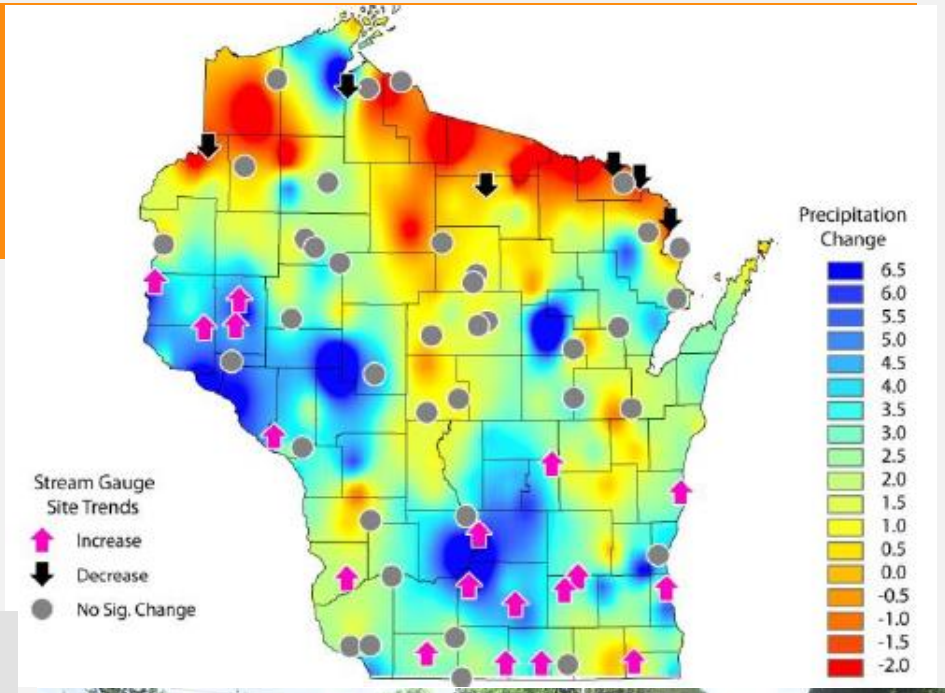


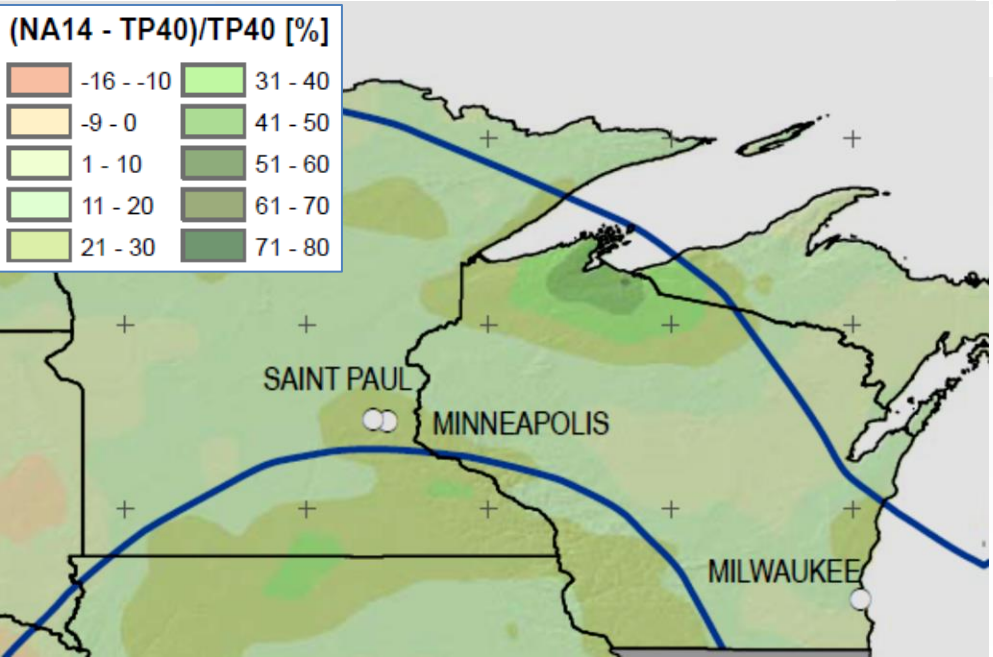




Precipitation Changes

- More rain, at a greater intensity, than previously thought





Climate Change

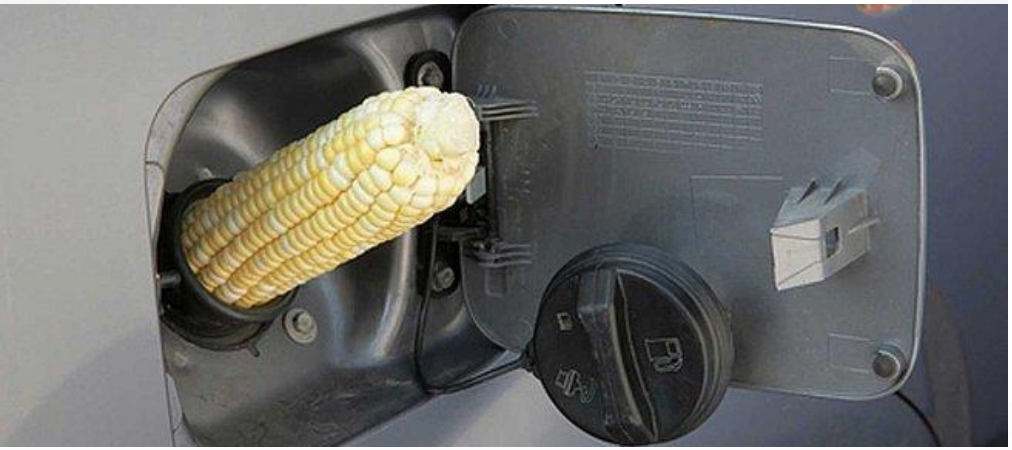
Wetter **Warmer**

Soil-Water Paradox

- Soil and nutrient runoff benefit very few people
- …yet soil and nutrient loss from agricultural systems has increased over time

Agricultural Policy Considerations

- Zoning and land use planning
  - Watershed scale
  - Ownership structure
- Data support systems for land owners
  - Private vs. public data access



- Agricultural demand is an important driver of water quality

Summary

1. Agricultural impacts to water are highly variable and dependent on scale
2. Lake Superior and Chequamegon Bay have unique water quality considerations
3. Measuring change in water quality condition is challenging
4. Successful policies benefit both landowners and general public