Status and Trends of Water Quality in Wisconsin's Lakes, Streams, and Rivers

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AWRA Wisconsin Section Annual Meeting
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WISCONSIN
DEPT. OF NATURAL RESOURCES

Statewide Monitoring Program Objectives

"In general, a monitoring program that meets the Clean Water Act objectives should be able to answer the following five questions:

1. **What is the overall quality of waters in the State?**
2. **To what extent is water quality changing over time?**
3. **What are the problem areas and areas needing protection?**
4. **What level of protection is needed?**
5. **How effective are clean water projects and programs?"**

(From EPA's "Elements of a State Monitoring Strategy")

Monitoring Categories

“Baseline” – Statewide

- Trends sites (Lakes, Rivers)
- Probabilistic surveys (streams, AIS, NARS (coastal condition and wetlands))
- Reference sites (wadeable streams, macrophytes, large river macroinvertebrates)

“Prescribed” – Statewide and District Collaboration

- Targeted Watershed Assessments
- Directed Lake Assessment (including APM and Critical Habitat)
- 319 (Non-point) Project Evaluation
- Follow-up for Impaired Waters

“Local Needs” - District Initiated

- Cross program support
- Unique stressors, projects

Statewide Baseline Monitoring

Organized by resource type:

- Lakes
- Rivers
- Streams
- Wetlands

Metrics and Indicators:

- Physical
- Chemical
- Biological

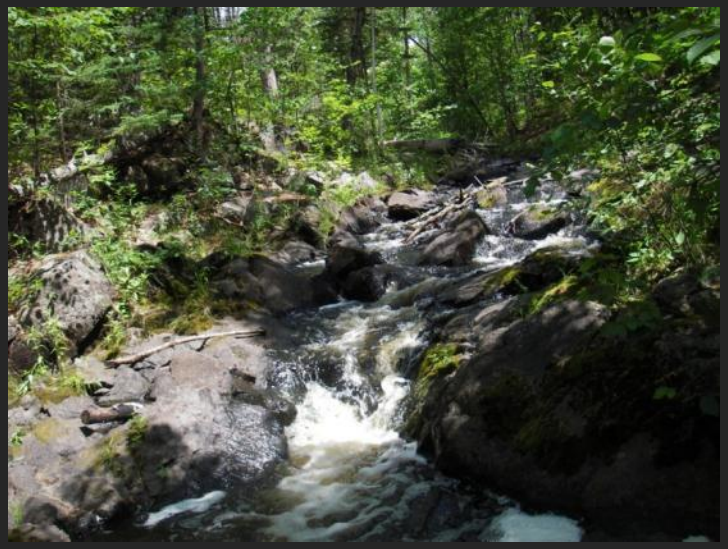
Streams Indicators and Metrics*

Large streams (>2nd order)

- Fish community characteristics
- Gamefish population dynamics
- Water chemistry:
  - Dissolved oxygen
  - pH
  - Conductivity
  - Turbidity
  - Other surface water analytes
- Macroinvertebrates
- Habitat assessment
- Total phosphorus

Small streams (1st and 2nd order)

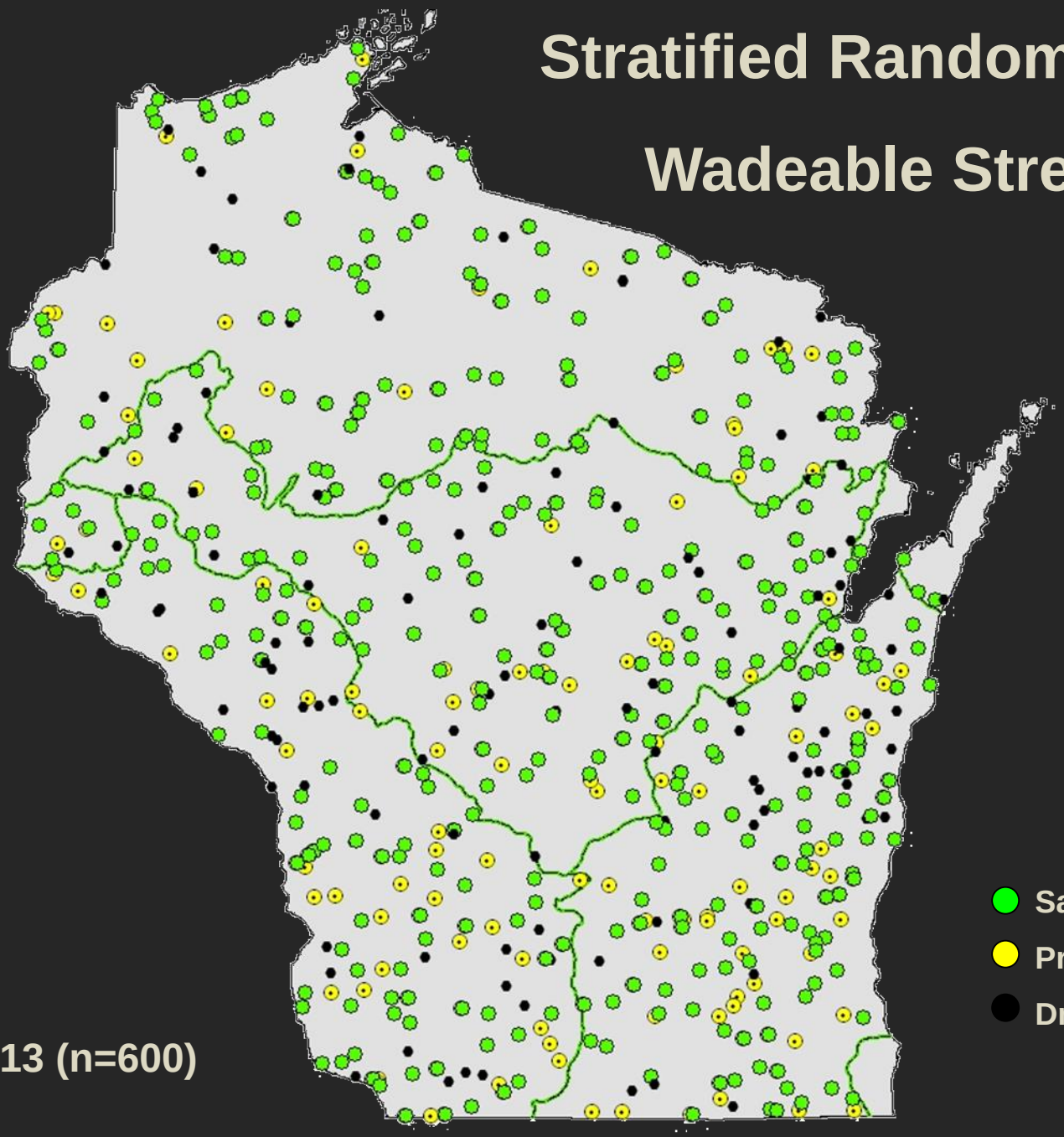
- Fish community characteristics
- Macroinvertebrates
- Total phosphorus



* Other nutrients and fish tissue contamination indicators are used as supplemental indicators for both large and small streams

Stratified Random Design

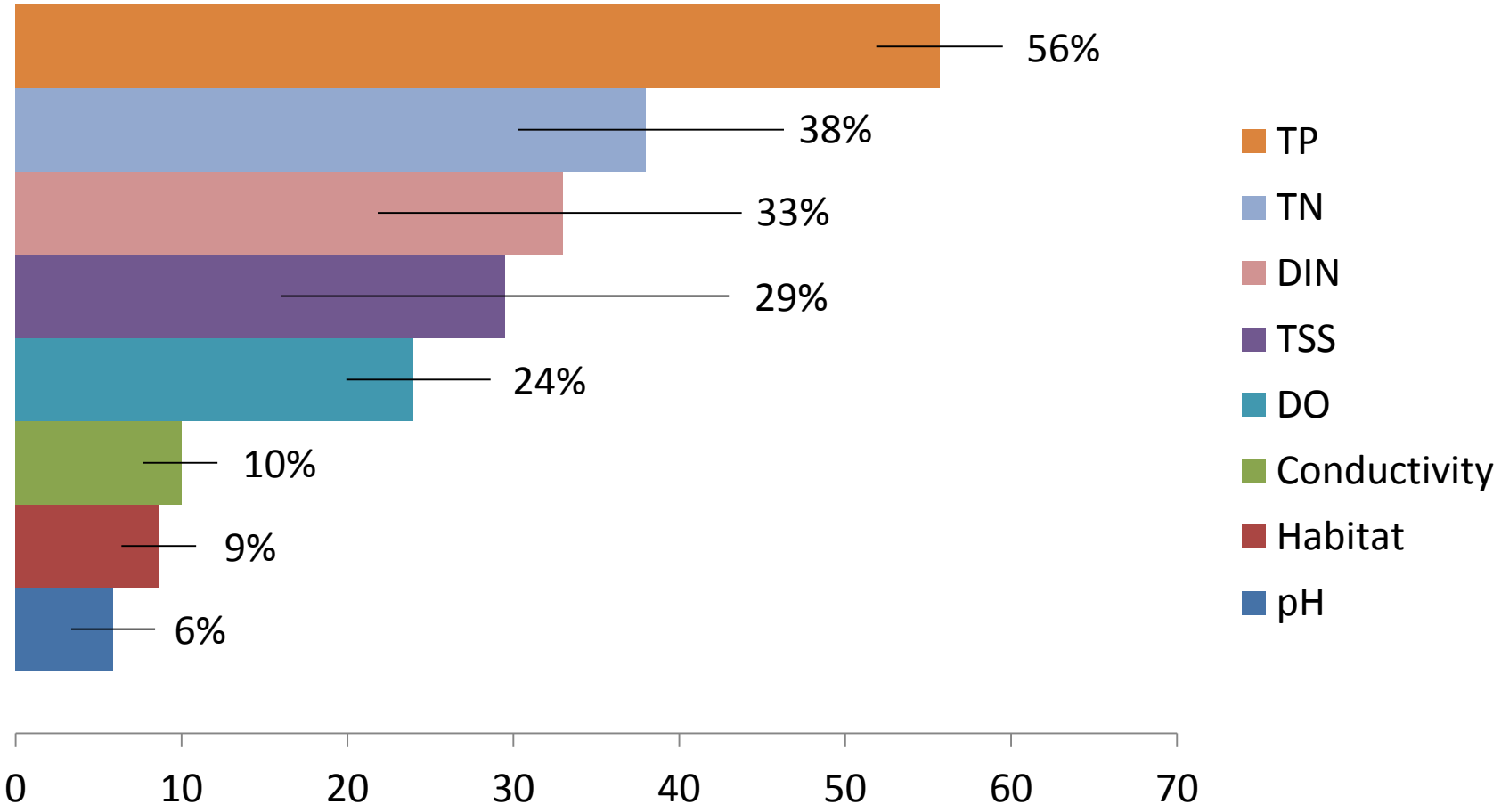
Wadeable Streams



2010 – 2013 (n=600)

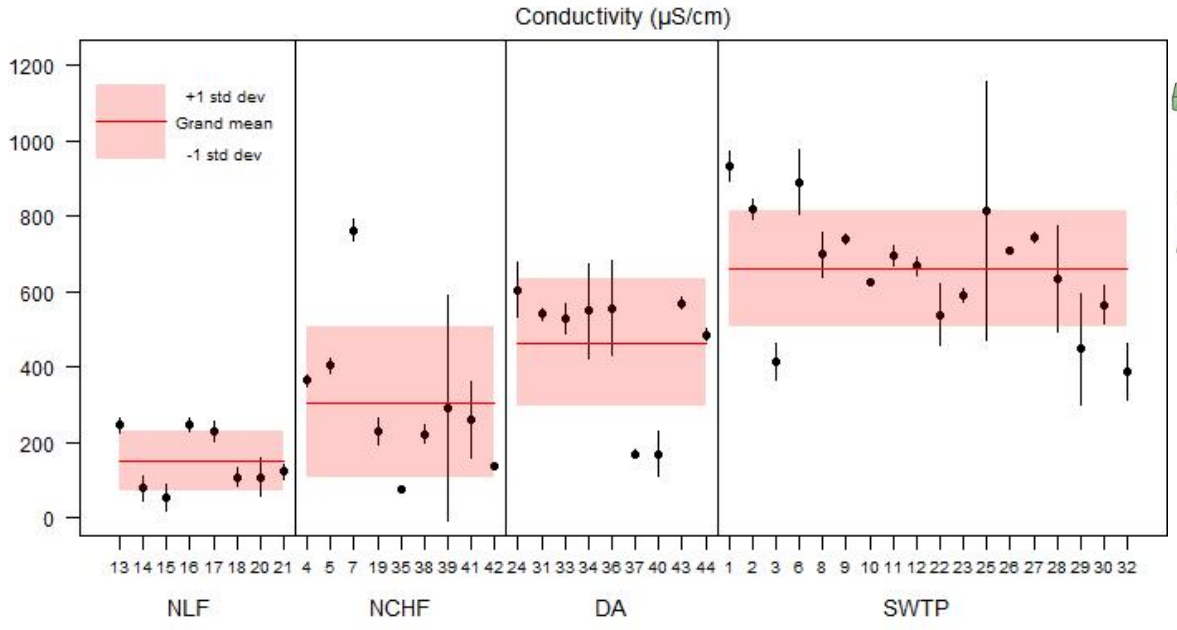
What is the overall quality of waters in the State? Statewide Condition

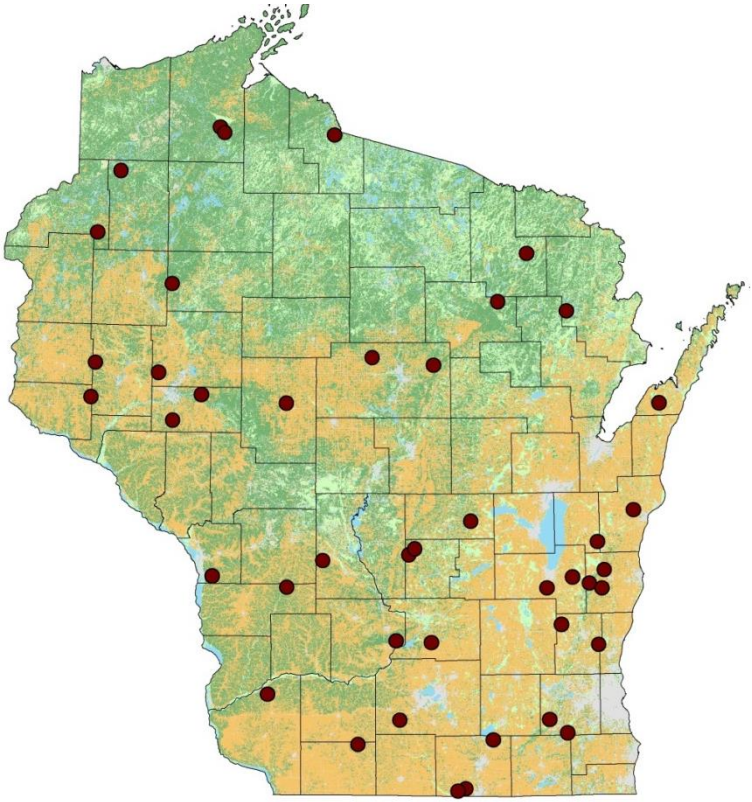
- NCSR - Percent of Wadeable Stream Miles in Wisconsin Considered in Poor Condition by Stressor



What level of protection is needed? Setting Expectations

- **Wadeable Trend Reference Sites**
  - **44 sites visited yearly for biology and chemistry**
  - **Track inter annual variation**
  - **Determine regionally based expectations**

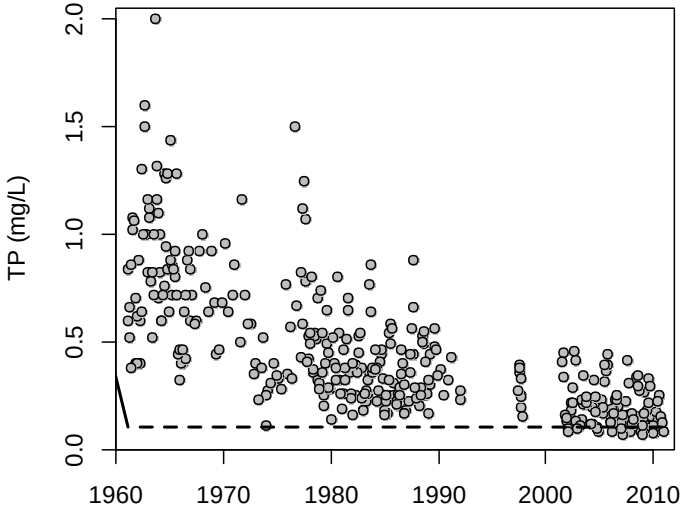


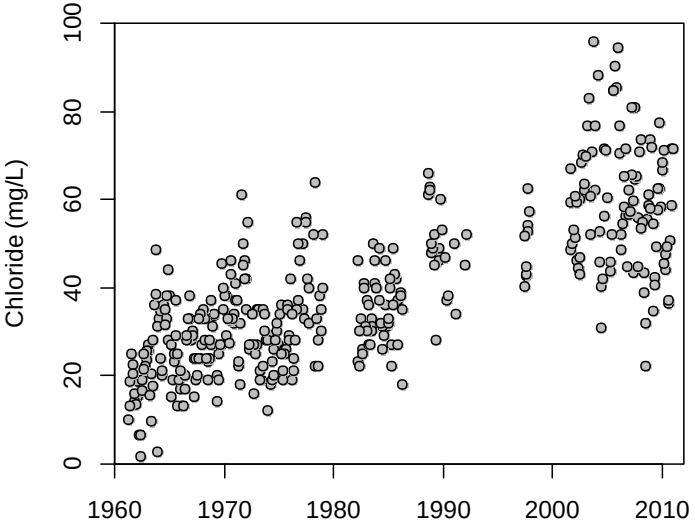


Long-Term Trends in Water Quality in Wisconsin

- Have policies and practices aimed at improving water quality worked?
- What water quality parameters have changed the most?
- What areas of the state have seen the biggest improvements or declines?
- Can we identify and head off worsening trends before they become critical?

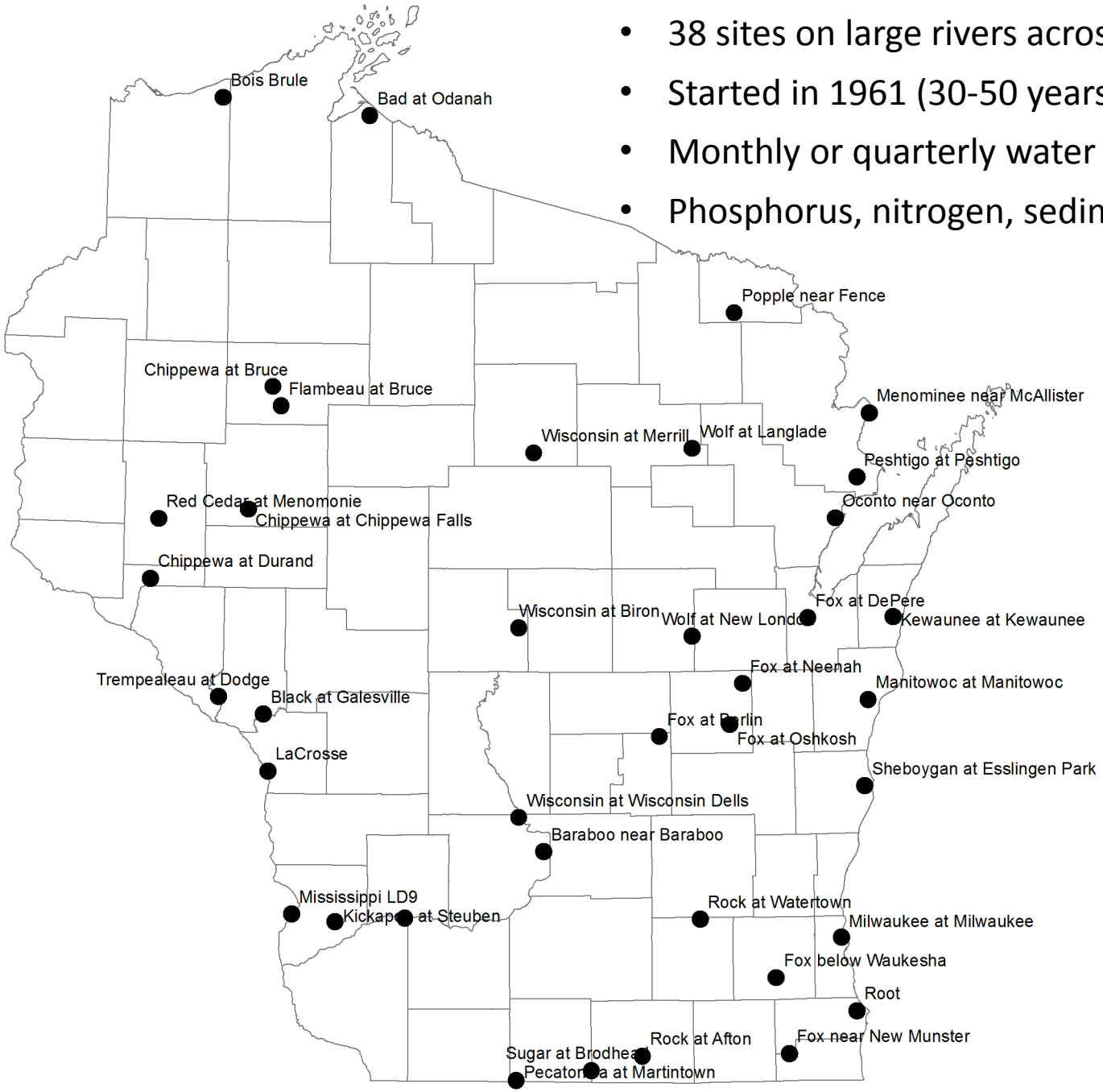
Rock River at Afton, WI



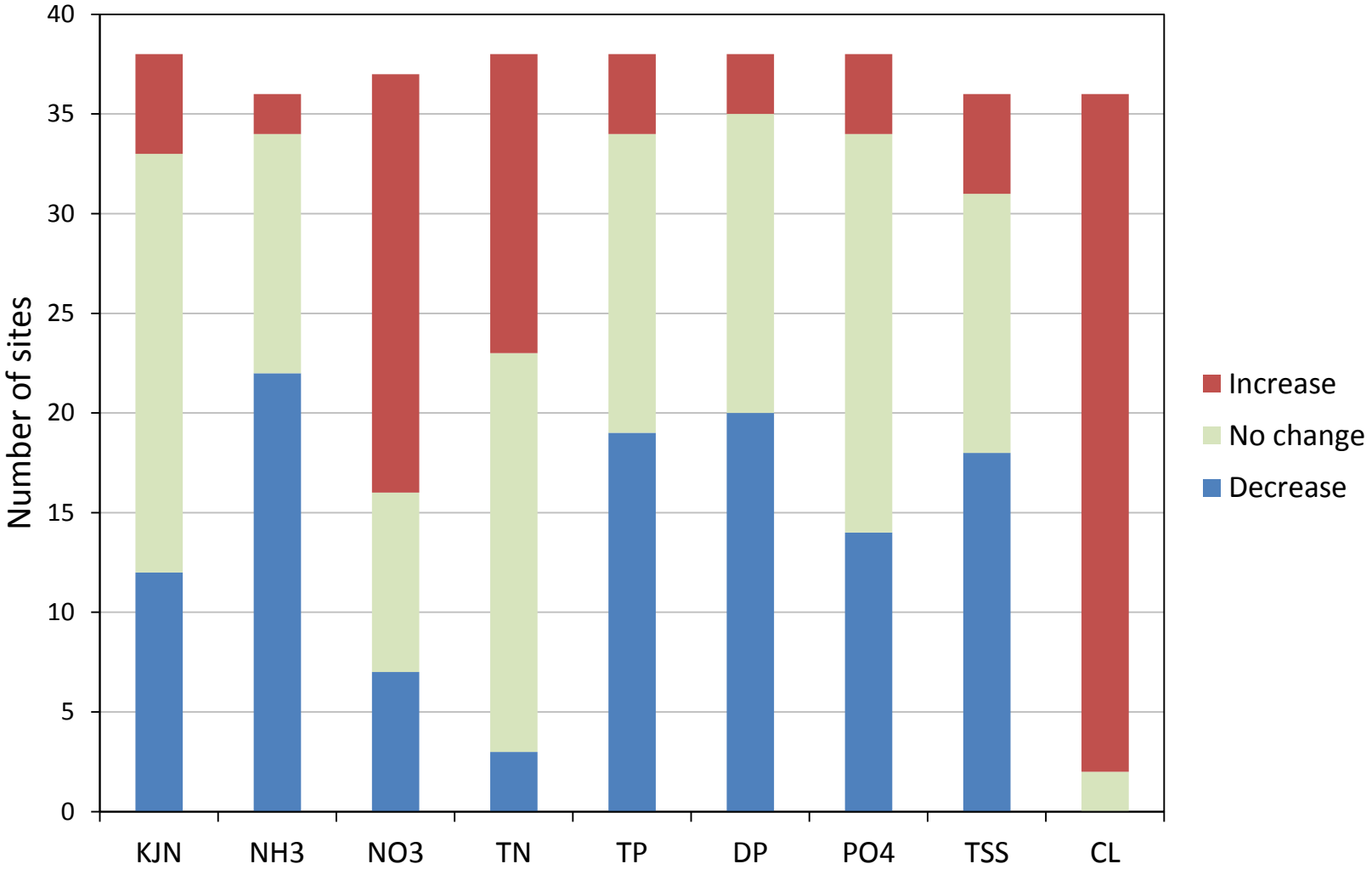


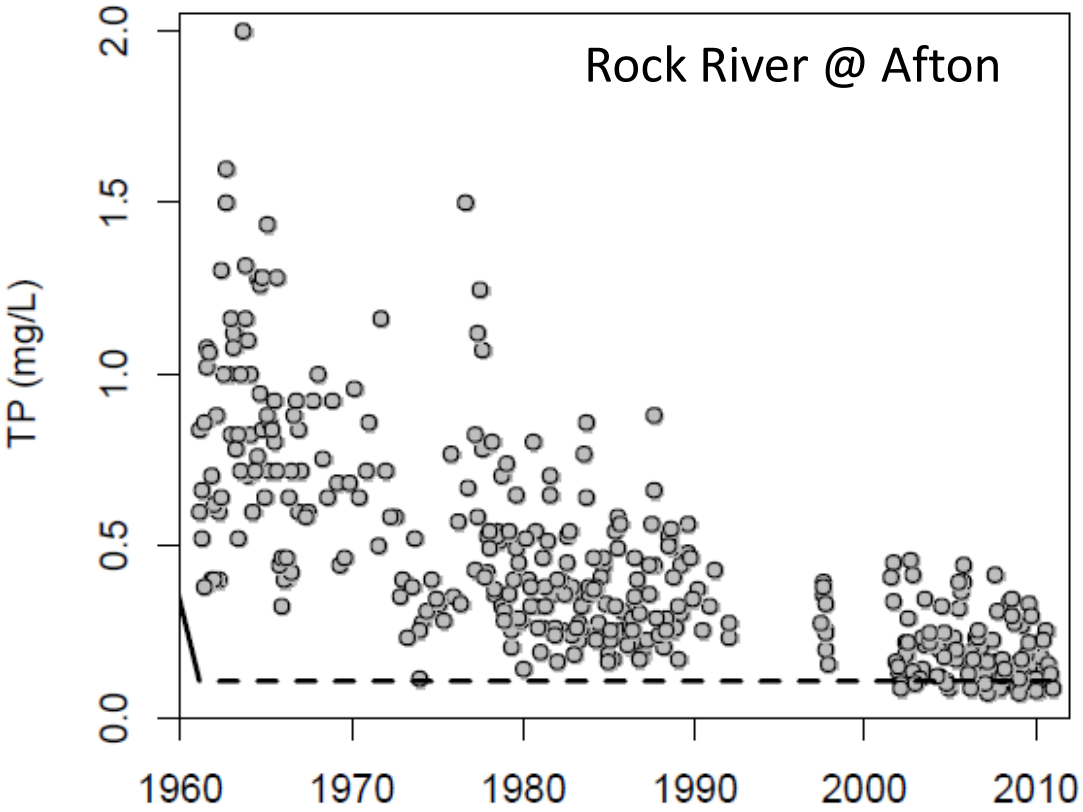
Long Term Trends Monitoring Program

- 38 sites on large rivers across Wisconsin
- Started in 1961 (30-50 years per site!)
- Monthly or quarterly water quality samples.
- Phosphorus, nitrogen, sediment, chloride

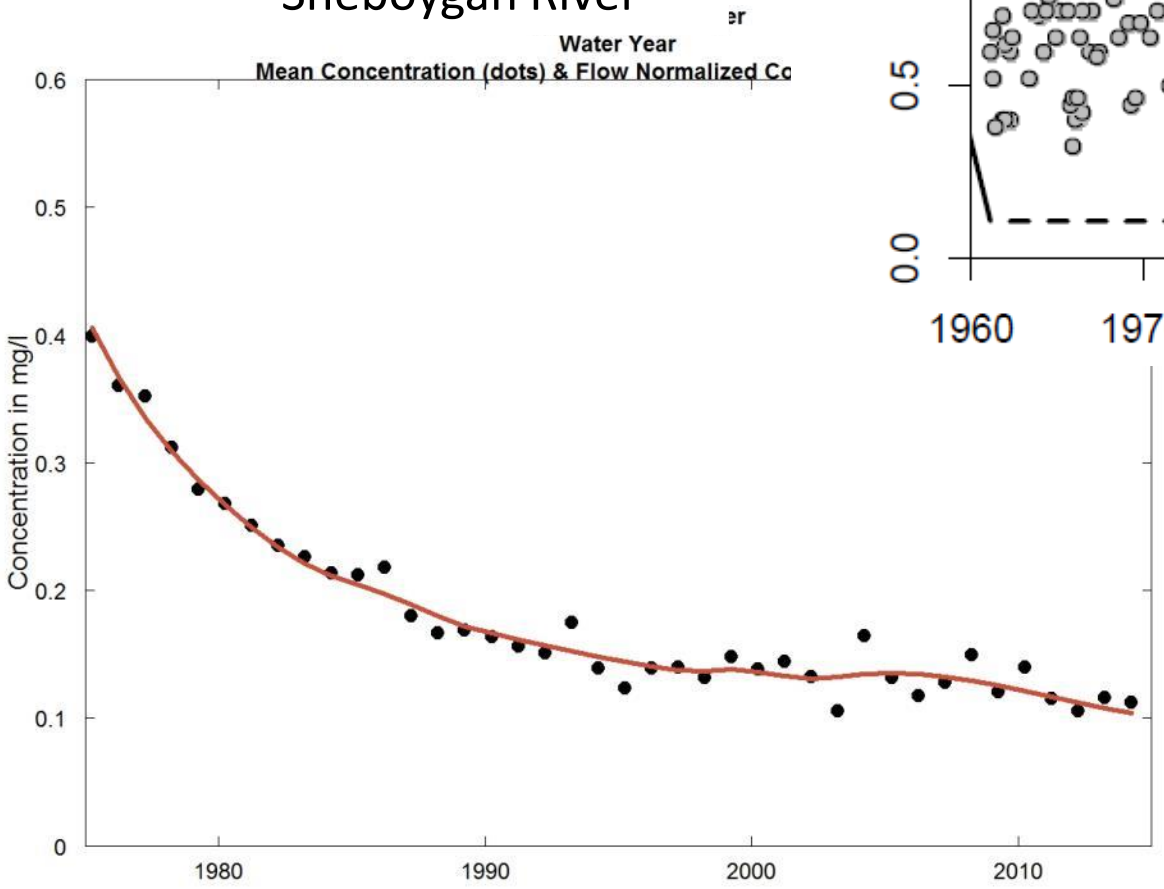


River Water Quality Trend Summary, 1961-2010





Sheboygan River



Phosphorus Reduction Actions in Wisconsin

1933 Soil Conservation

1972 Clean Water Act

Runoff program

1977 Great Lakes Water Quality Agreement

1984 Regulate Concentrated Animal Feeding Operations

1992 Discharge <1 mg/L phosphorus statewide

2002 Runoff performance standards and prohibitions

2007 Tighten rules for large animal farms

2010 Fertilizer phosphorus ban
Dish detergent < 0.5% phosphorus by weight
Phosphorus criteria for all surface waters
Phosphorus budgets for impaired watersheds

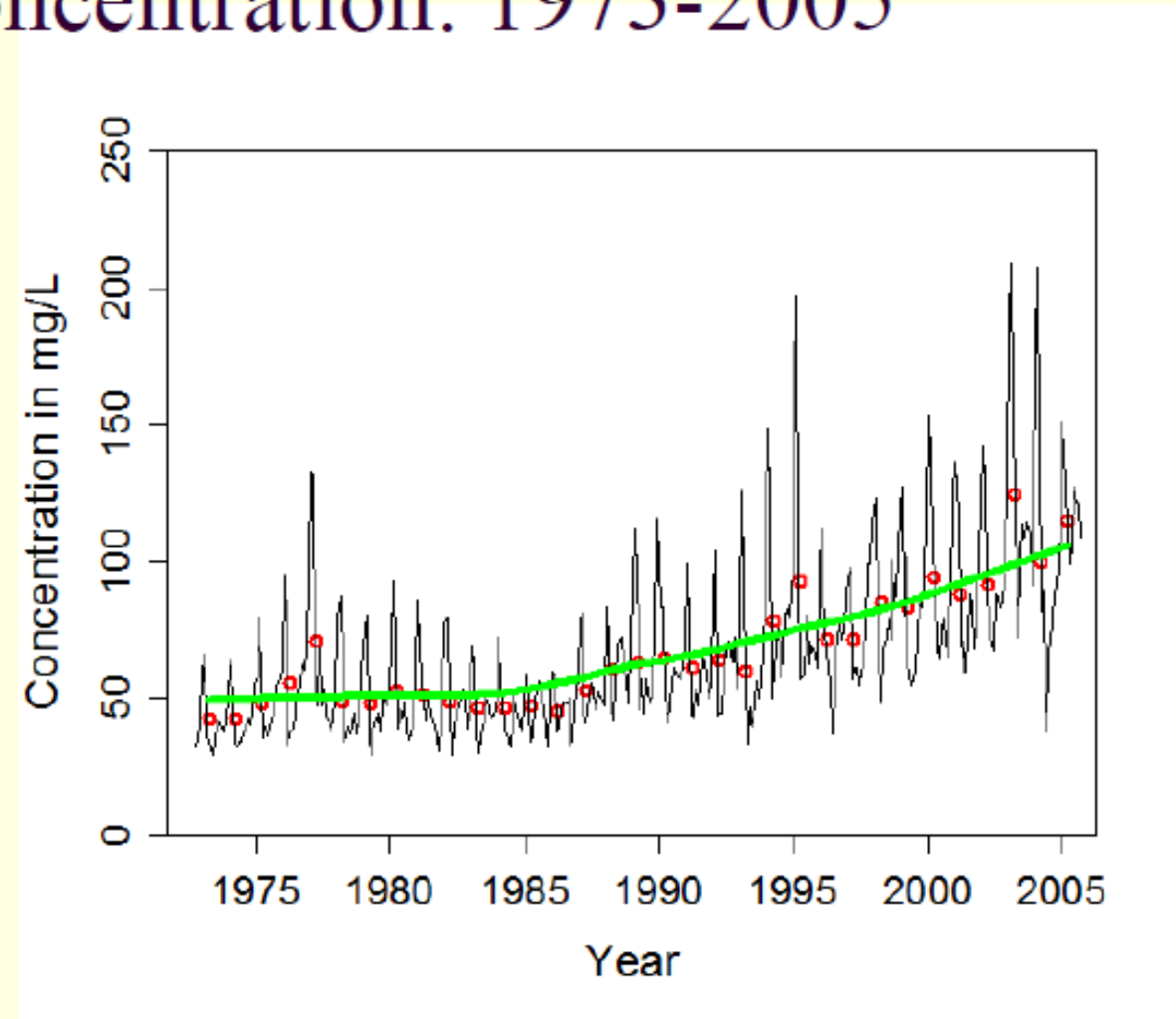
Wastewater Treatment

CAFO's


State
New phosphorus restrictions approved

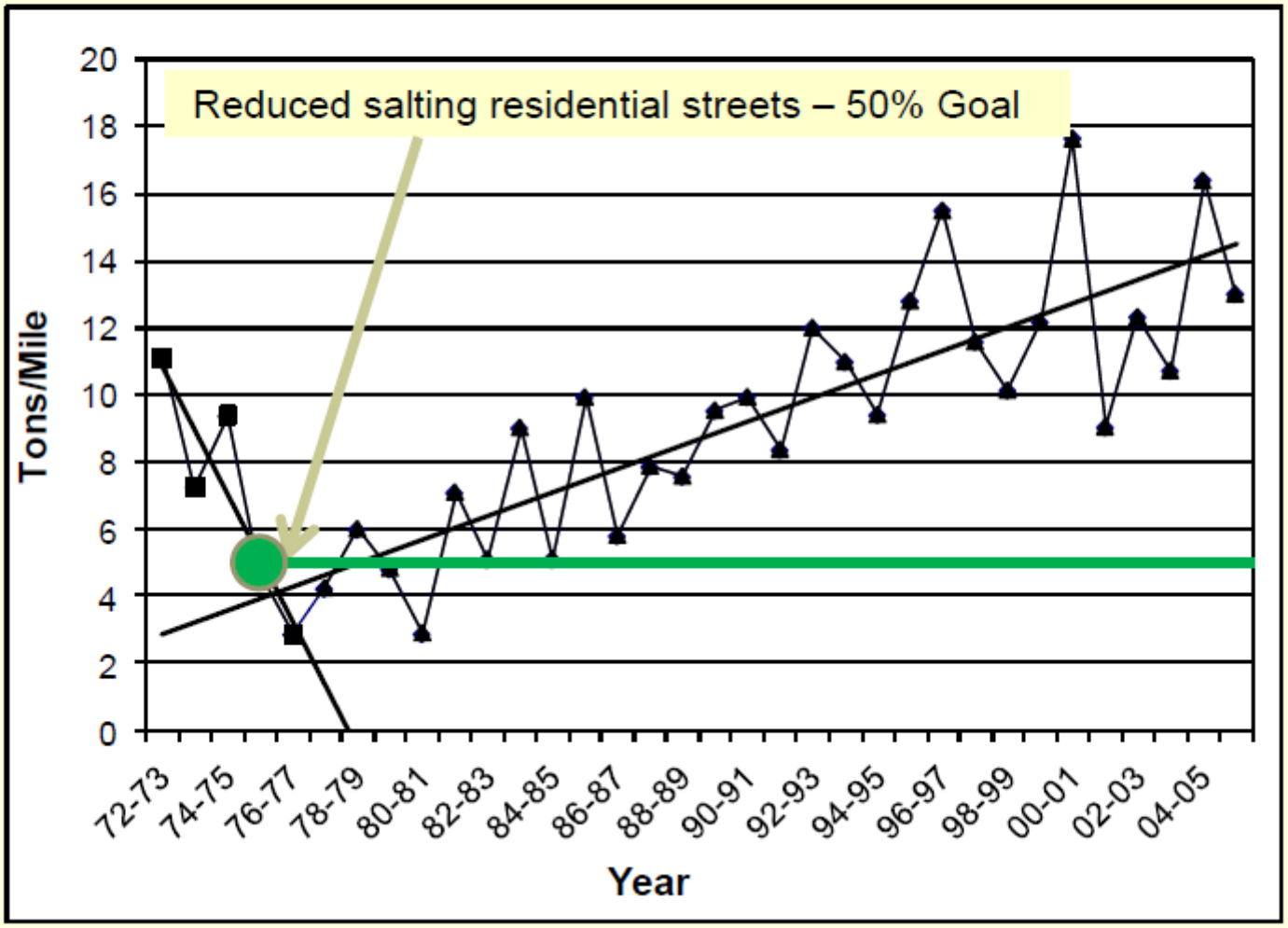
Phosphorus bans

Milwaukee River Chloride Concentration: 1973-2005

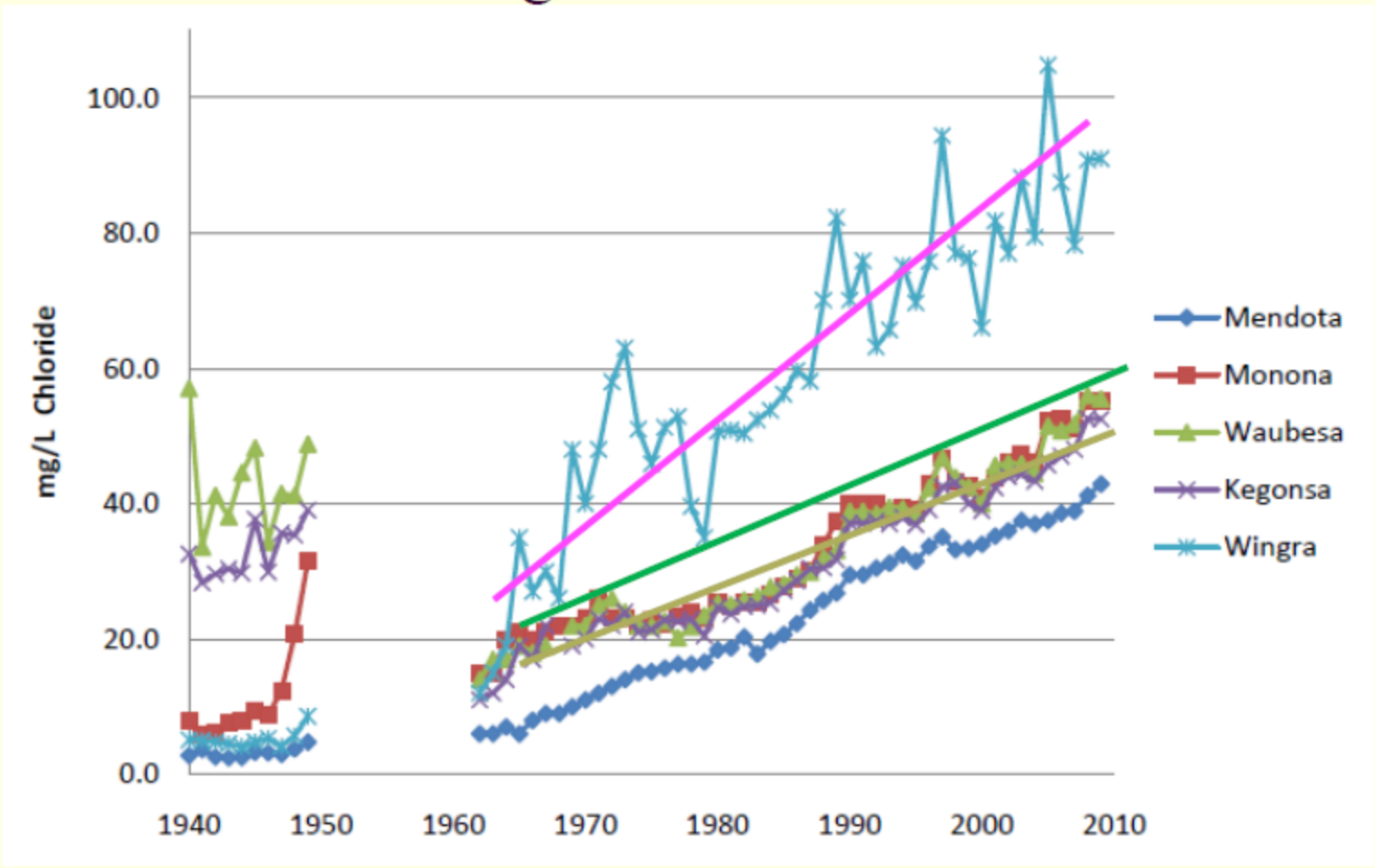


Source: USGS. Long term monitoring data for chloride and streamflow was used as input to the Weighted Regression on Time Discharge and Season (WRTDS) model. Contact: Steve Corsi, USGS

Salt Use Per Mile of Maintained Street in Madison, Wisconsin



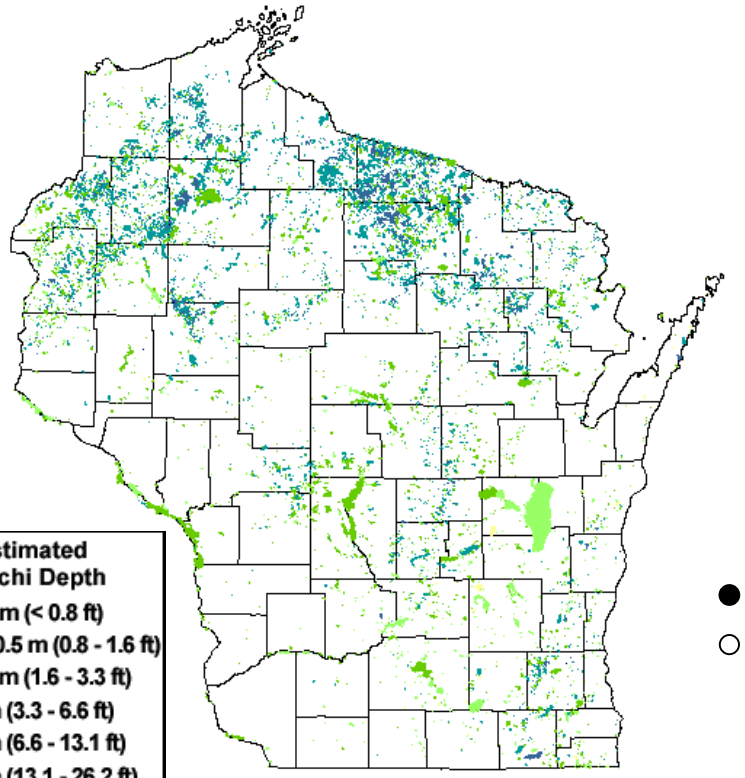
Chloride in the Madison-Area Lakes: The Yahara Chain – WDNR Chronic = 395 mg/l and Acute = 757 mg/l Chloride



Statewide Lake Monitoring & Assessment

Satellite Secchi

8000 lakes each year

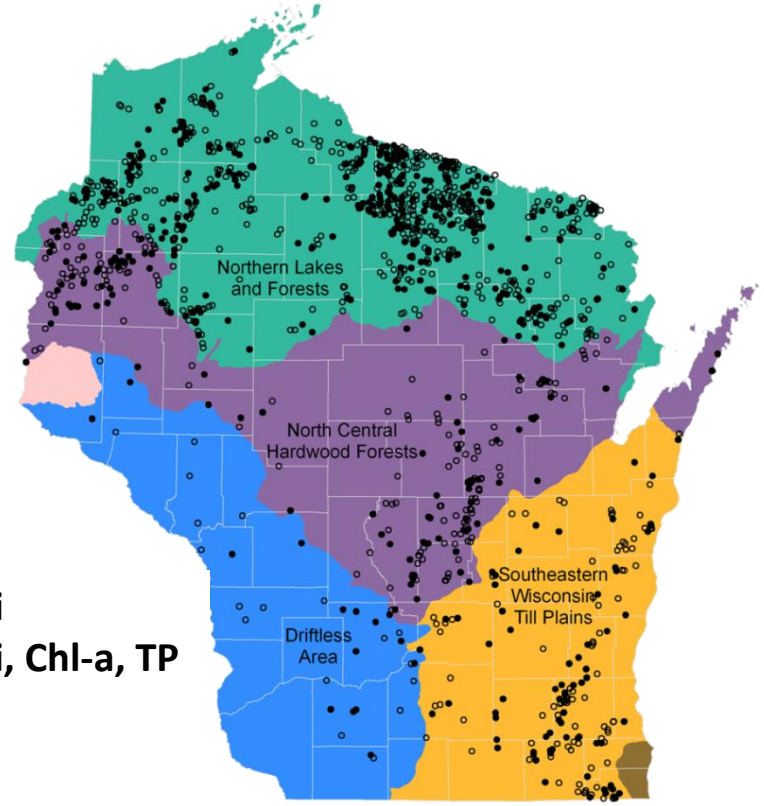


Trophic State Index	Estimated Secchi Depth
> 80	< 0.25 m (< 0.8 ft)
70 to 80	0.25 - 0.5 m (0.8 - 1.6 ft)
60 to 70	0.5 - 1 m (1.6 - 3.3 ft)
50 to 60	1 - 2 m (3.3 - 6.6 ft)
40 to 50	2 - 4 m (6.6 - 13.1 ft)
30 to 40	4 - 8 m (13.1 - 26.2 ft)
< 30	> 8 m (> 26.2 ft)

Citizen Lake Monitoring

900 Secchi lakes each year

550 chemistry lakes each year

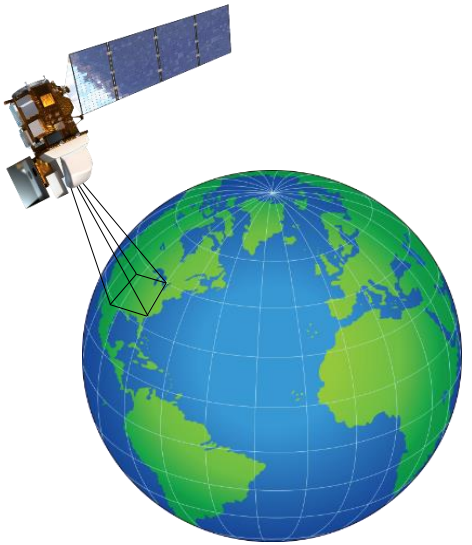


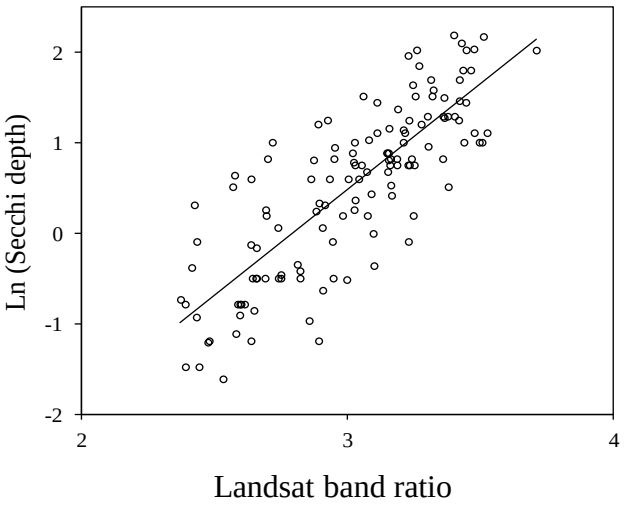
● **Secchi**

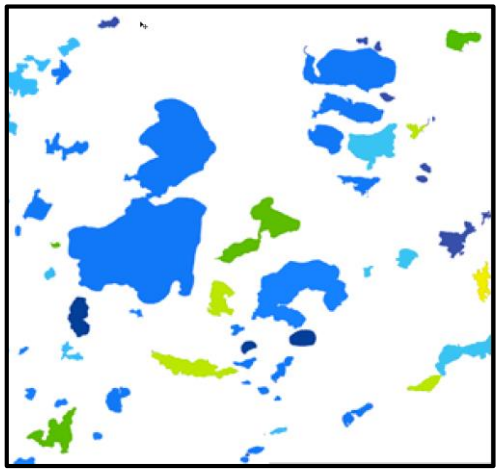
○ **Secchi, Chl-a, TP**

Longest records are 24 years!

Lake clarity can be assessed regionally by coupling Secchi measurements with satellite observations.

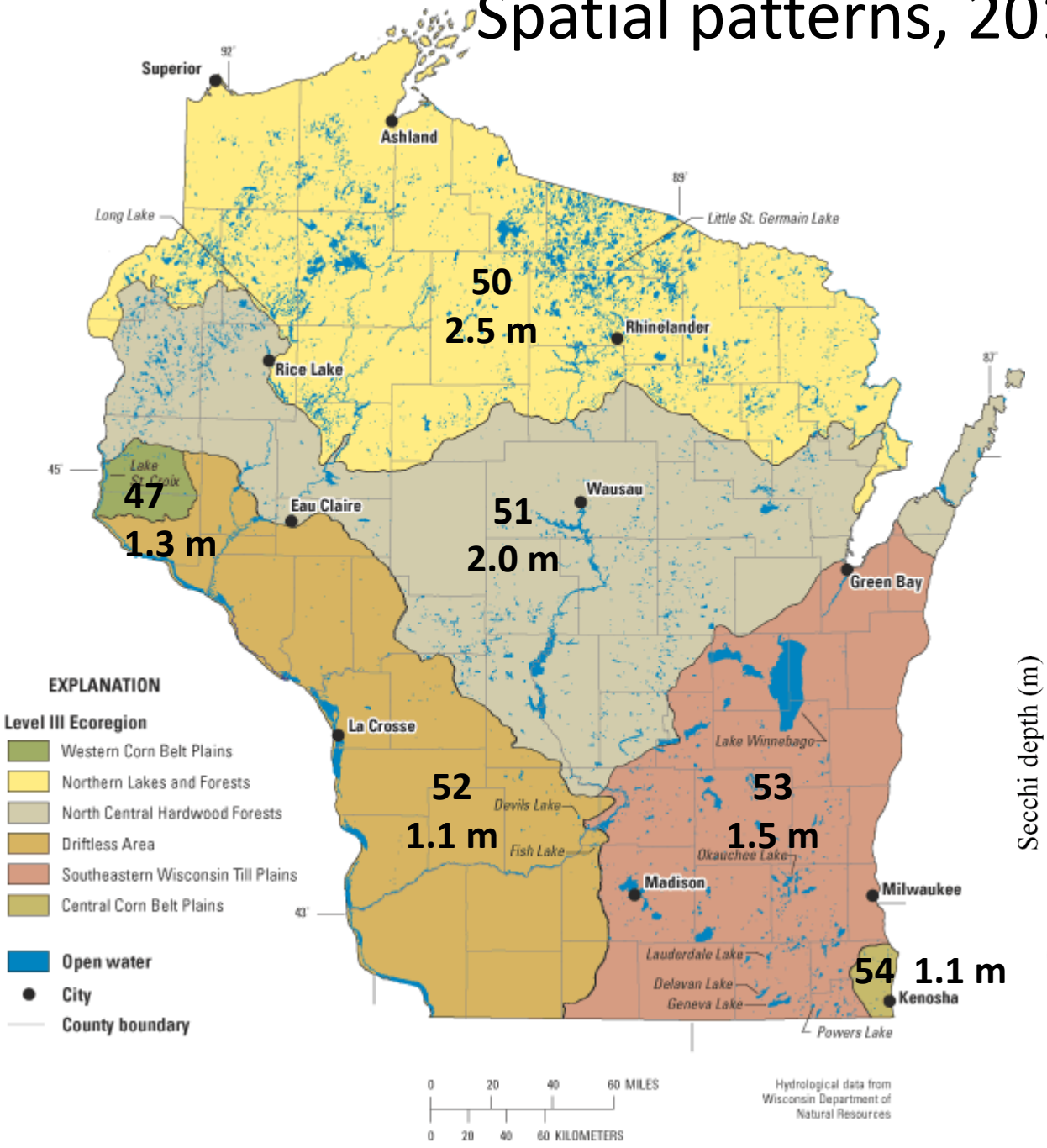




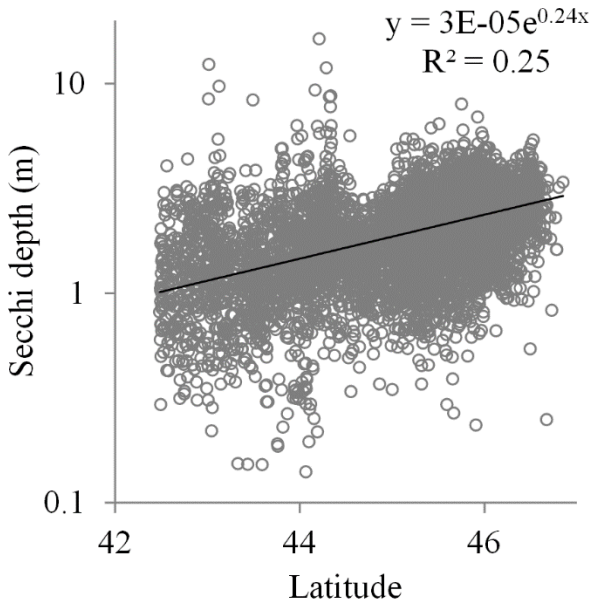


Courtesy Kevin Rose and Steve Greb

Spatial patterns, 2010



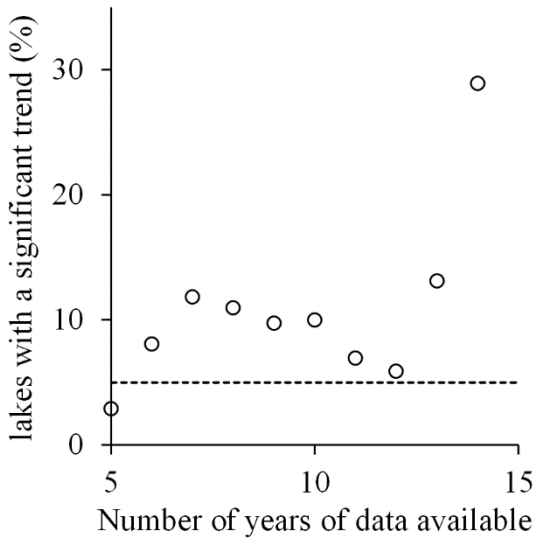
Eco-region	Secchi (m)	# of lakes
47	1.3	31
50	2.5	4672
51	2.0	1811
52	1.1	333
53	1.5	806
54	1.1	13



Rose et al 2016

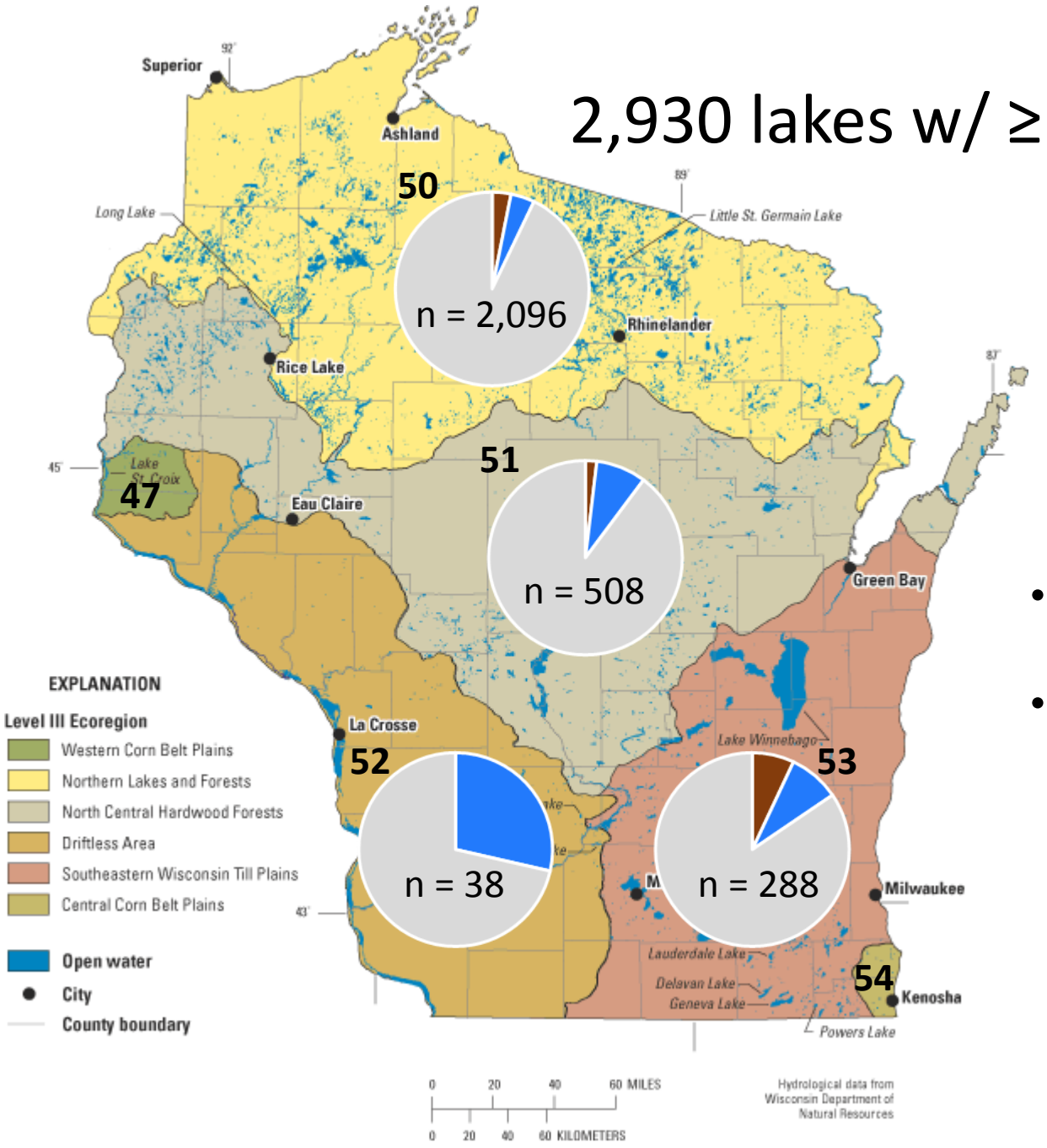
Many lakes had significant long term trends in clarity.

- 2,930 lakes with ≥ 10 years of data
  - 257 (8.8 %) have significant long term trends
  - 97 (3.3 %) negative trend
  - 160 (5.5 %) positive trend
- As the length of record increases:
  - Fewer lakes have negative trends
  - More lakes have positive trends



Rose et al 2016

2,930 lakes w/ ≥ 10 years of data



- 8.8% (257) exhibited long term trends.
- More trends were positive than negative.

Rose et al 2016

Long-Term Water Quality Monitoring

Spring and 3 X's in summer:

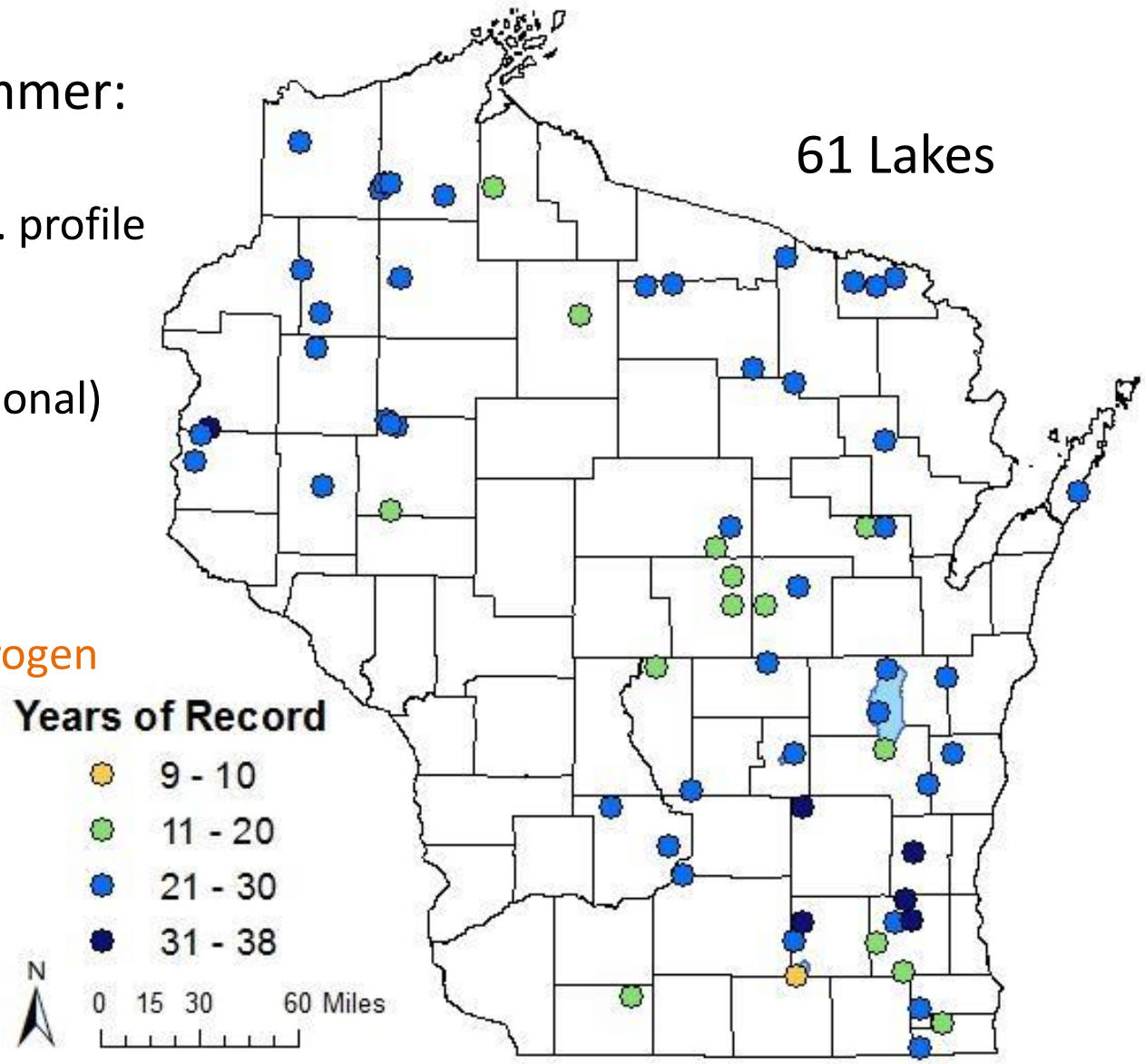
- Secchi depth
- Temperature/D.O. profile
- Total Phosphorus
- Chlorophyll *a*
- Conductivity (optional)
- pH (optional)

1 X in summer:

- Color
- Total Kjeldahl Nitrogen
- NO2+NO3
- Alkalinity

5 year cycle:

- Ca
- Mg

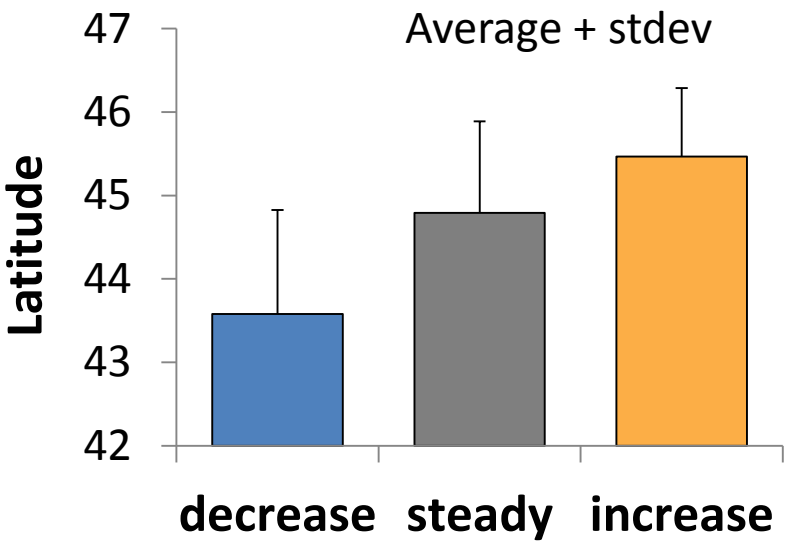


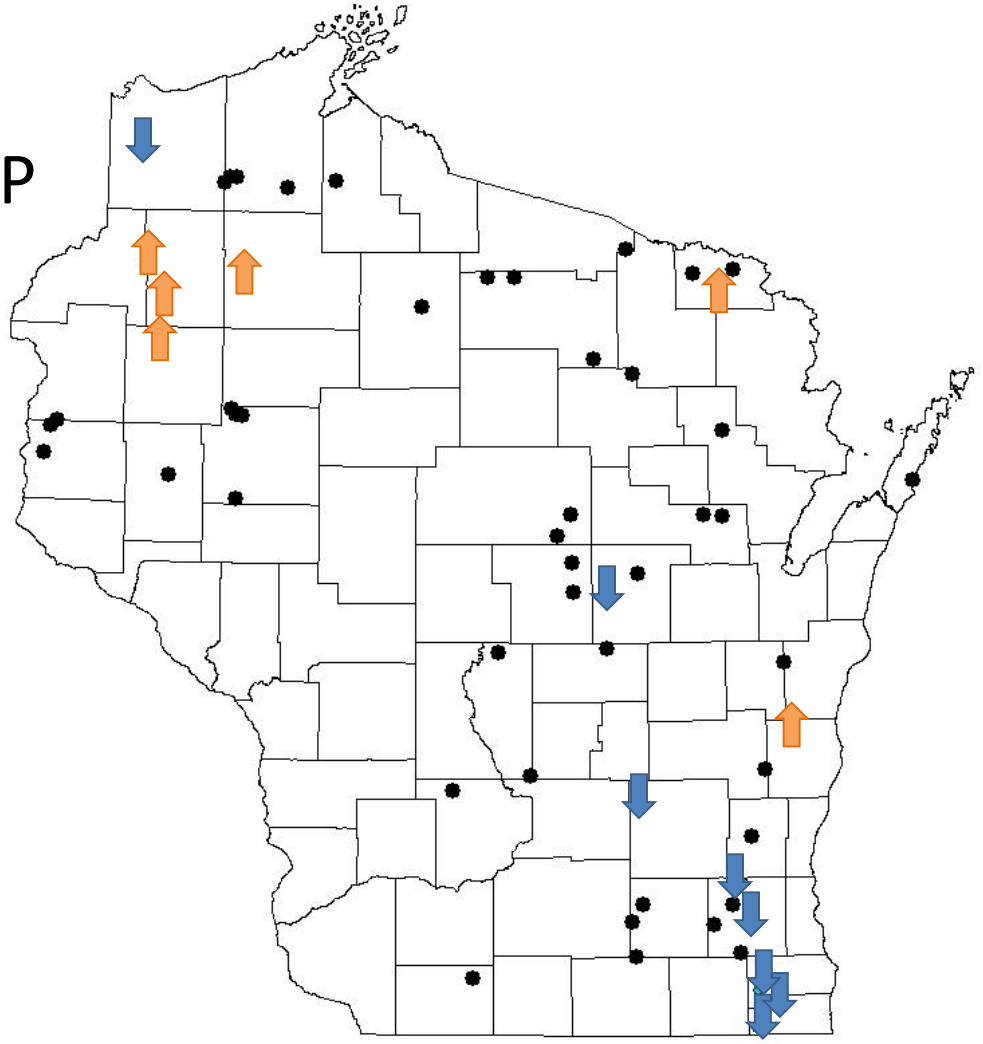
Trends in Total Phosphorus Over Time

8 lakes decreasing TP

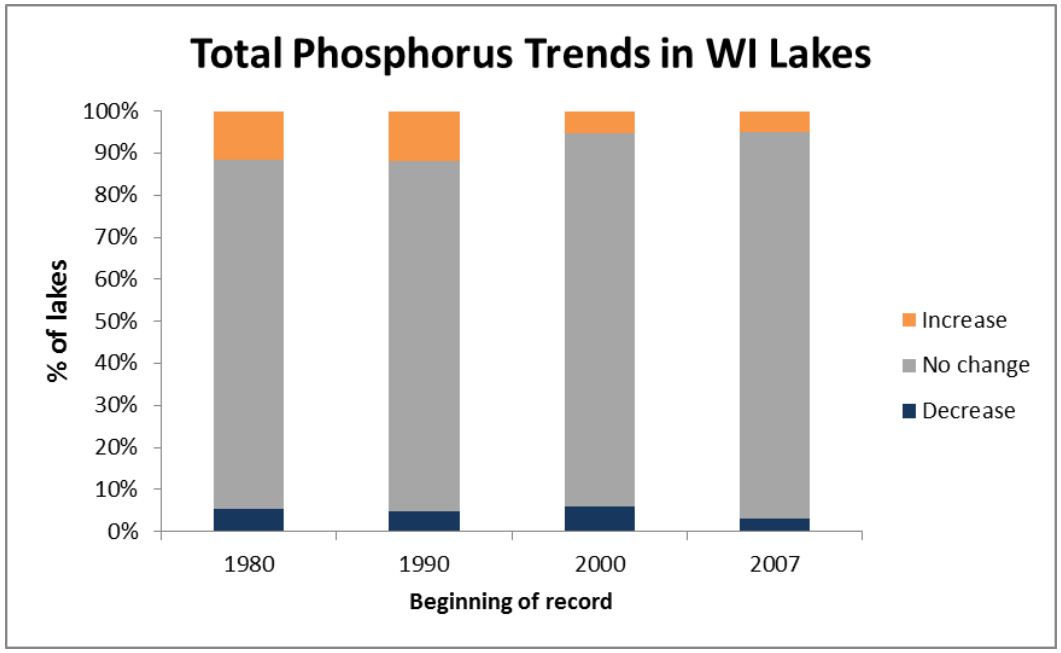
46 lakes no change in TP

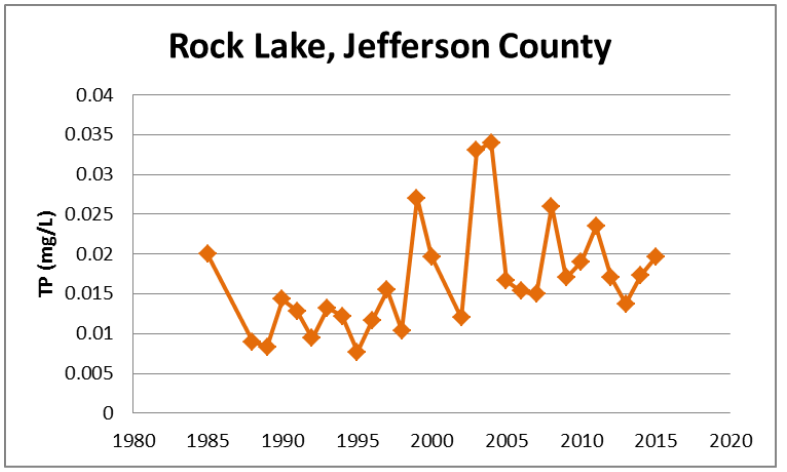
6 lakes increasing TP

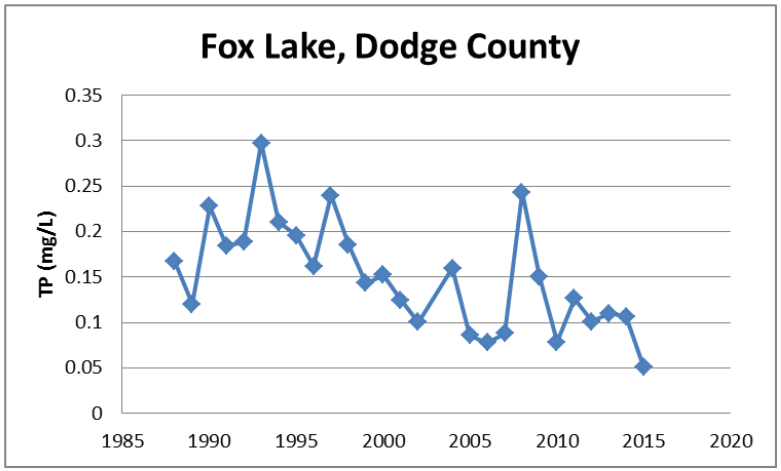




Depends on time scale





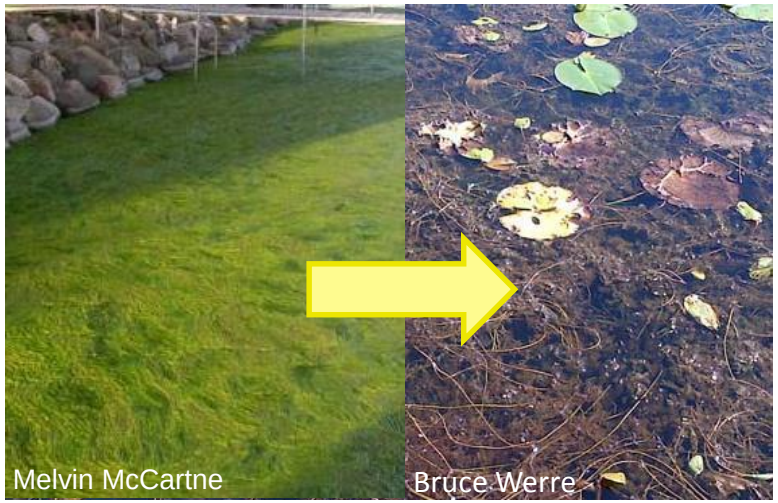


Reasons for Phosphorus Decline

Urbanization of Agricultural Land

Septic to Municipal Sewage

Algal to Plant-Dominated Lake



Best Management Practices

Reasons for Increasing Phosphorus

Agriculture

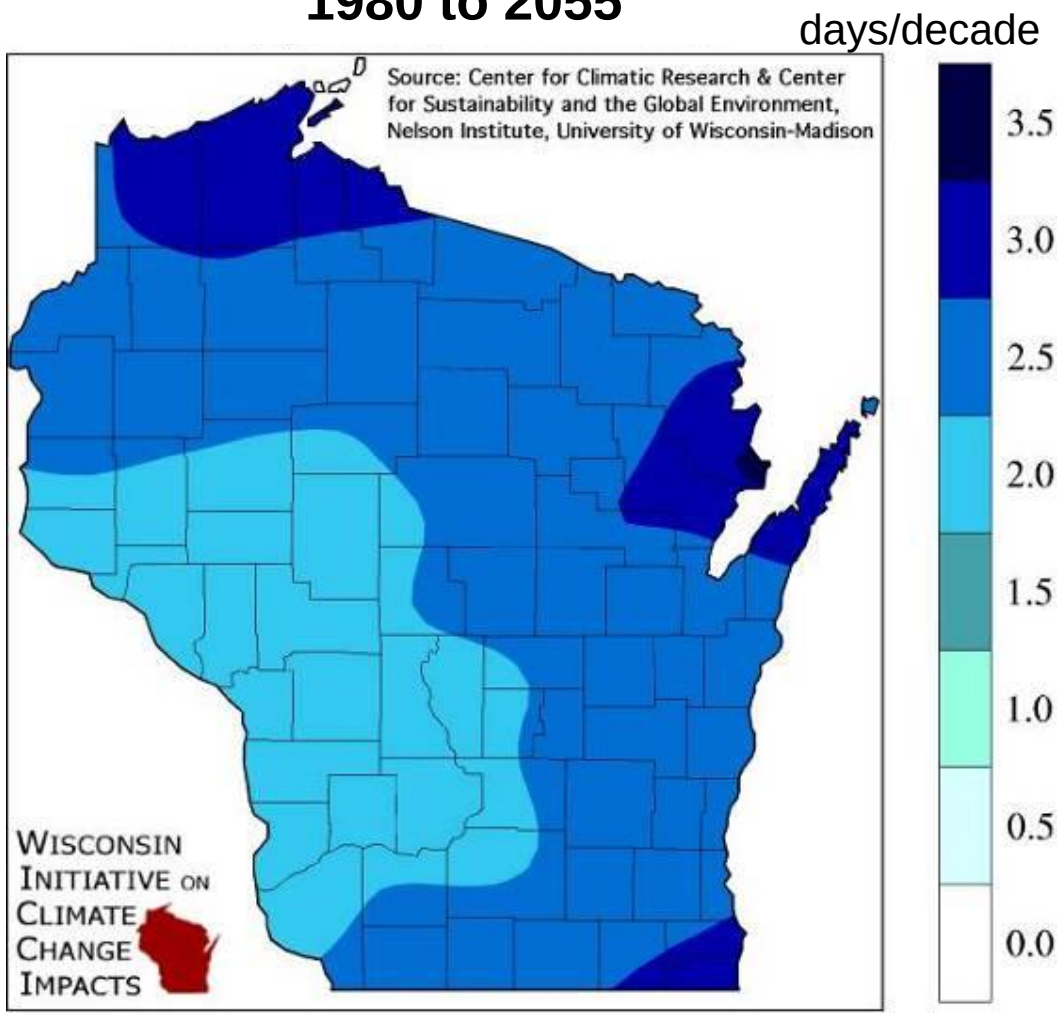
Lake Shore Development

Plant to Algal-Dominated Lake

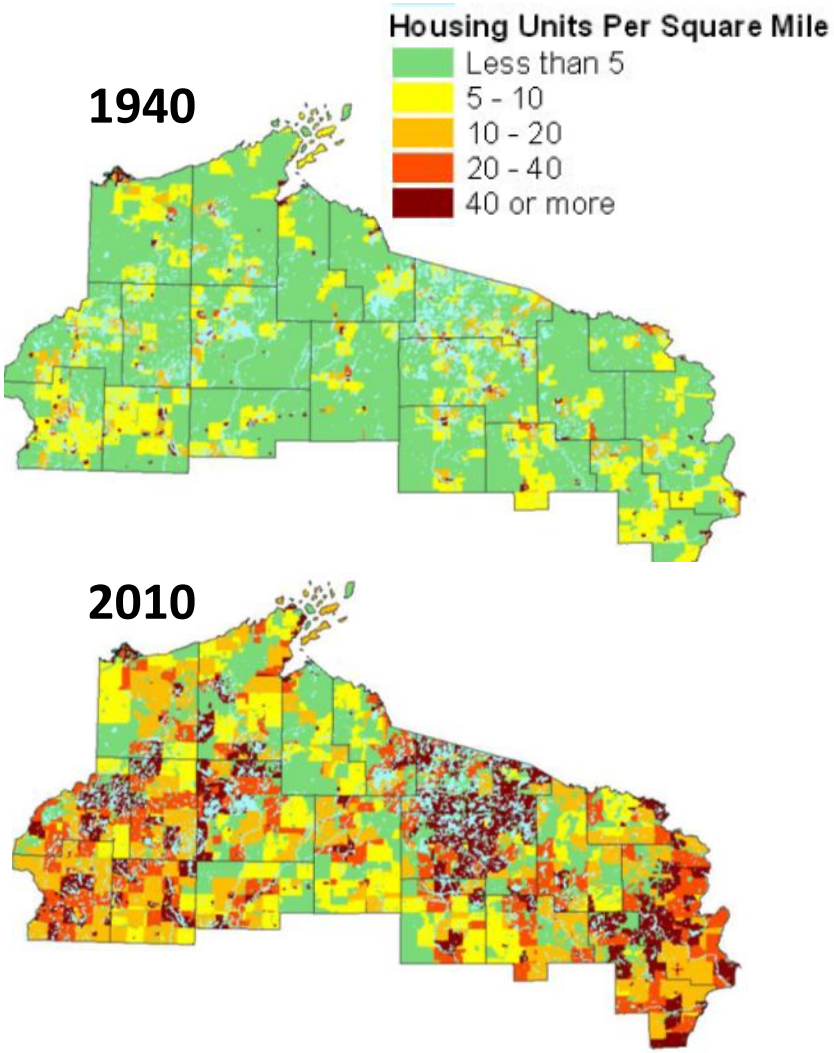
Climate and Water Levels

Future Nutrient Loading Threats

Projected Change in Frequency of 2" Precipitation Events 1980 to 2055



Increase in Housing Density



Summary

- Water quality conditions have improved since 1960's – sediments, phosphorus
- Recent increases in phosphorus in more remote areas – subtle changes masked in more disturbed areas
- Increasing chloride and nitrate concentrations – impacts to biota may become more apparent in the future
- Management practices can make a difference!

Wisconsin water monitoring

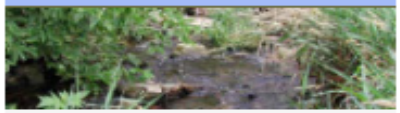
http://dnr.wi.gov/topic/surfacewater/monitoring.html

Discover how water and fisheries biologists determine aquatic health.

Find data and reports describing water condition near you!

Learn how monitoring and assessments are used in planning and management.

Strategy & Reports

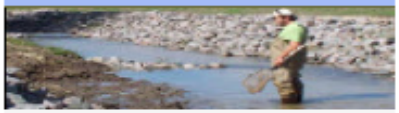


- Monitoring Strategy 2015-2020
- Strategy Executive Summary
- Monitoring Reports
- SWIMS Database
- Water Condition Viewer

River health

- Long-Term Trend Water Quality Network
- Biotic Index Baseline Study
- National Rivers and Streams Assessment
- Priorities for 2016

Stream condition



- Trend Reference Streams
- Natural Community Stratified Design
- Targeted Watershed Approach
- Citizen Stream Monitoring
- Targeted Watershed Site Selection Tool
- Priorities for 2016

Lake health

- National Lakes Assessment
- Aquatic Plant Reference Lakes
- Citizen Lake Monitoring Network
- Satellite Secchi Monitoring
- Directed Lake Surveys
- Lake Level Monitoring
- Priorities for 2016

Wetland health

- Floristic Quality Assessment Benchmark Surveys
- Wetland Rapid Assessment Methodology (WRAM v.2)
- Watershed Approach Wetland Functional Assessments (WAWFA)
- Priorities for 2016

Cross program monitoring

- Aquatic Invasive Species
- Mississippi River Studies
- Great Lakes Studies
- Total Maximum Daily Load Analyses
- Water Quality Standards
- WPDES Program
- Source Water Monitoring
- Fish Tissue

Search Waters

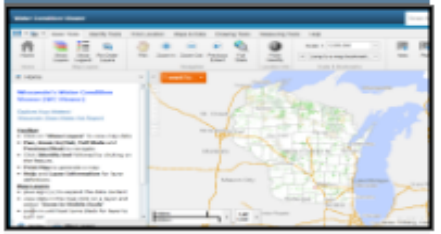
Go!

Monitoring Strategy Update

Read the latest update to Wisconsin's Water Resources Monitoring Strategy which sets the direction for resource allocation for monitoring for the next 5 to 10 years.

See how biologists collect data in the field for analysis back at the lab. Learn why specific groups of fish -- and which bugs found under riffles -- are so important for understanding Wisconsin Streams. More videos at DNR YouTube channel.

Water Condition Viewer



Launch the **Water Condition Viewer** , an interactive mapping tool, to look up monitoring results and assessment decisions.

Contact information

Lisa Helmuth
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Monitoring Program