Long-Term Water Quality Trends in Wisconsin Lakes

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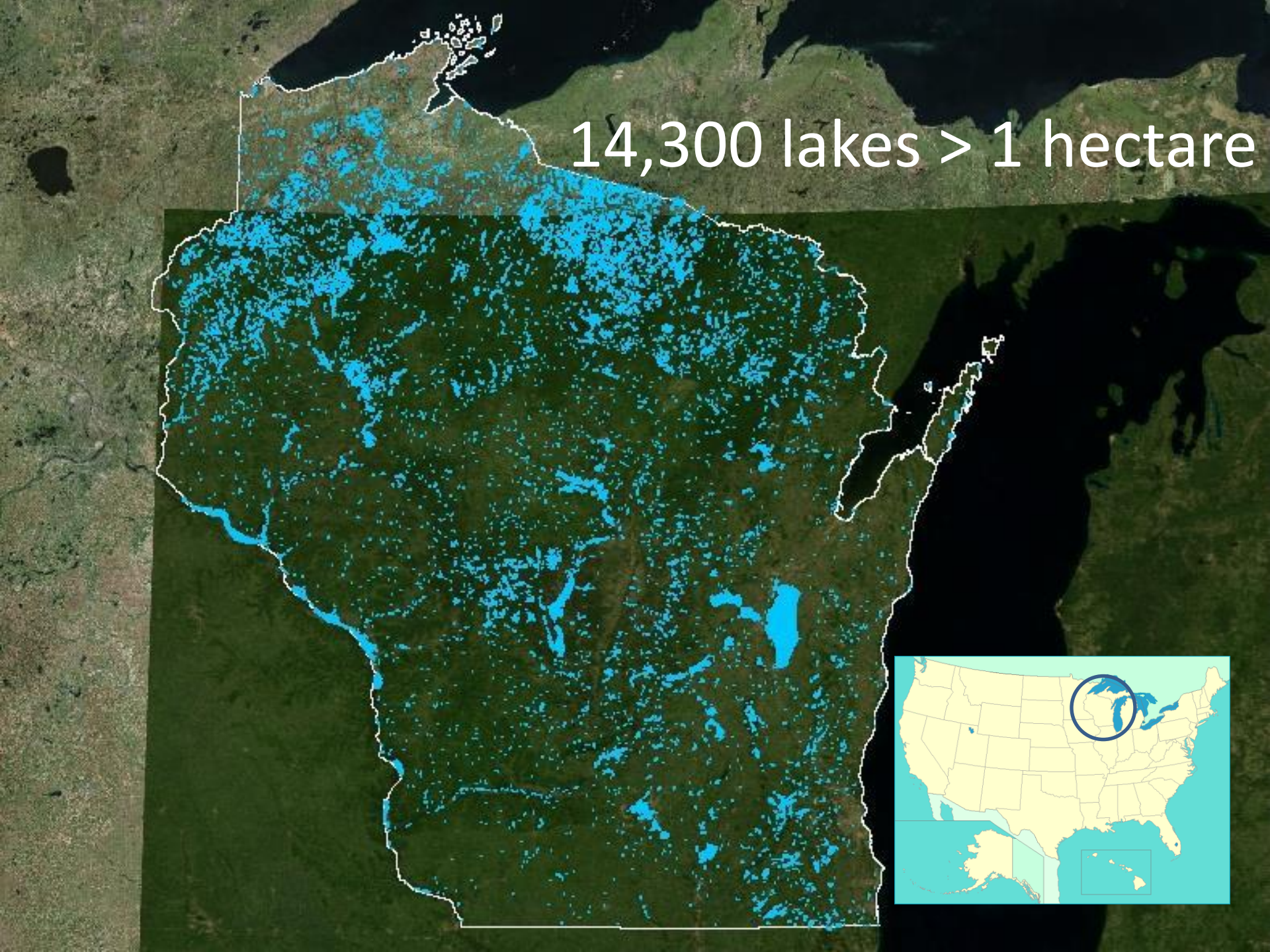
Wisconsin Department of Natural Resources


14,300 lakes > 1 hectare

Is lake water quality getting better, worse, or staying the same?

Long-Term Water Quality Monitoring

Spring and 3 X's in summer:

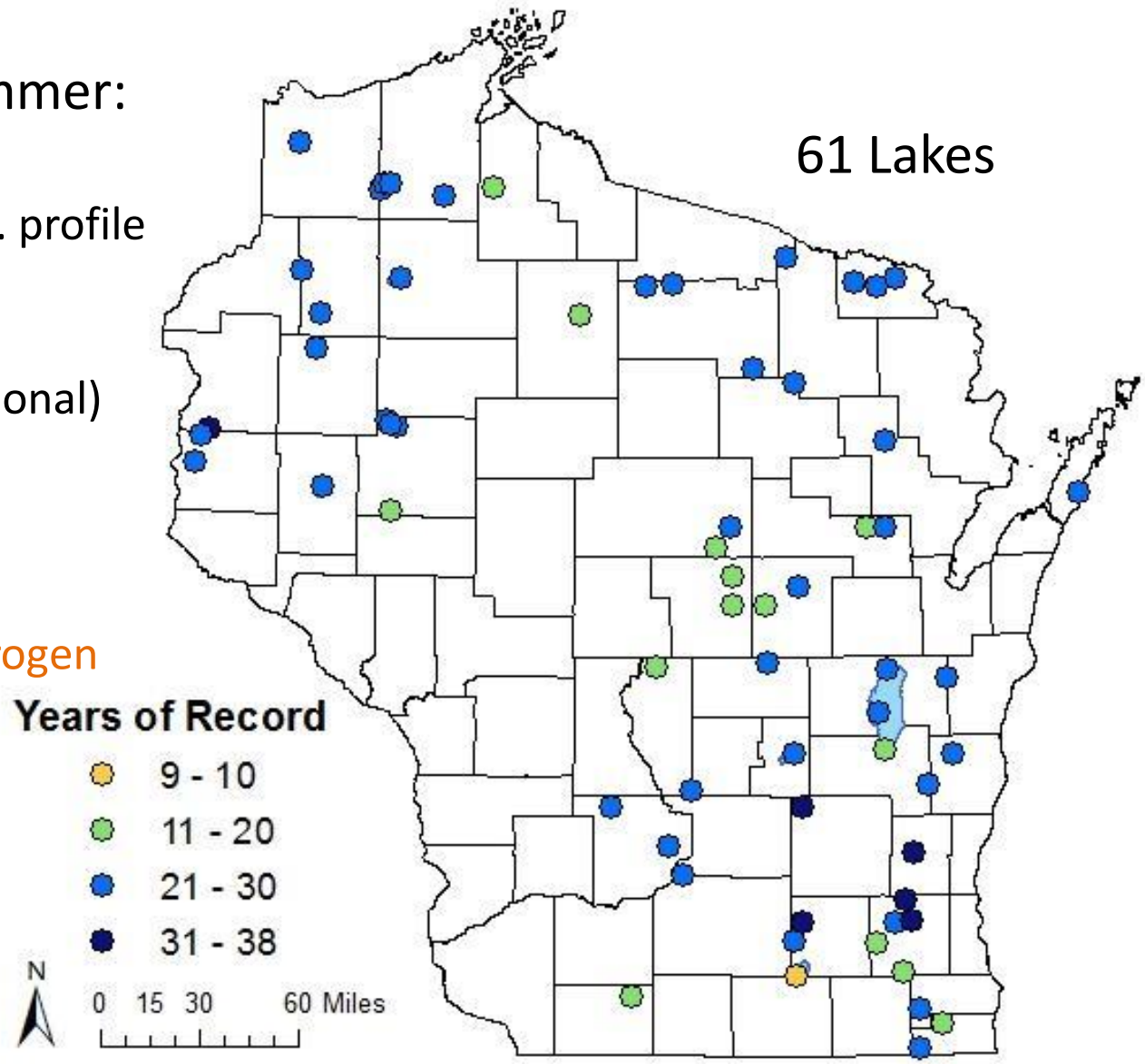
- Secchi depth
- Temperature/D.O. profile
- Total Phosphorus
- Chlorophyll *a*
- Conductivity (optional)
- pH (optional)

1 X in summer:

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

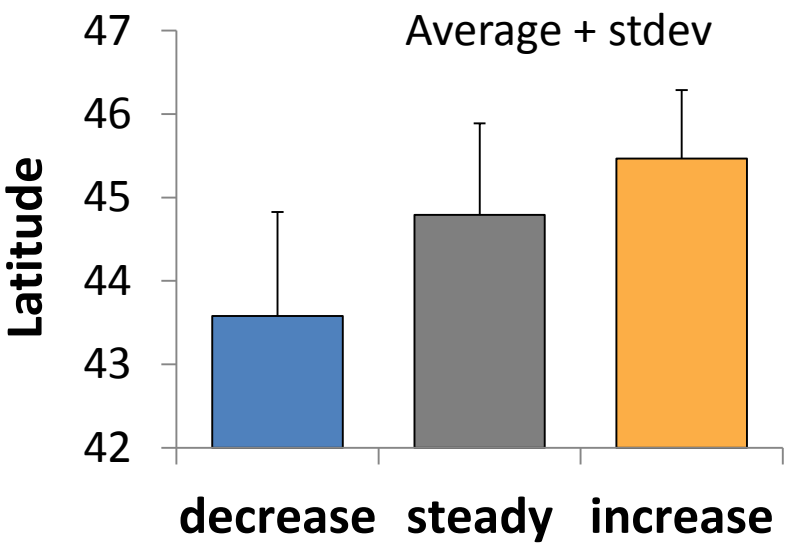
5 year cycle:

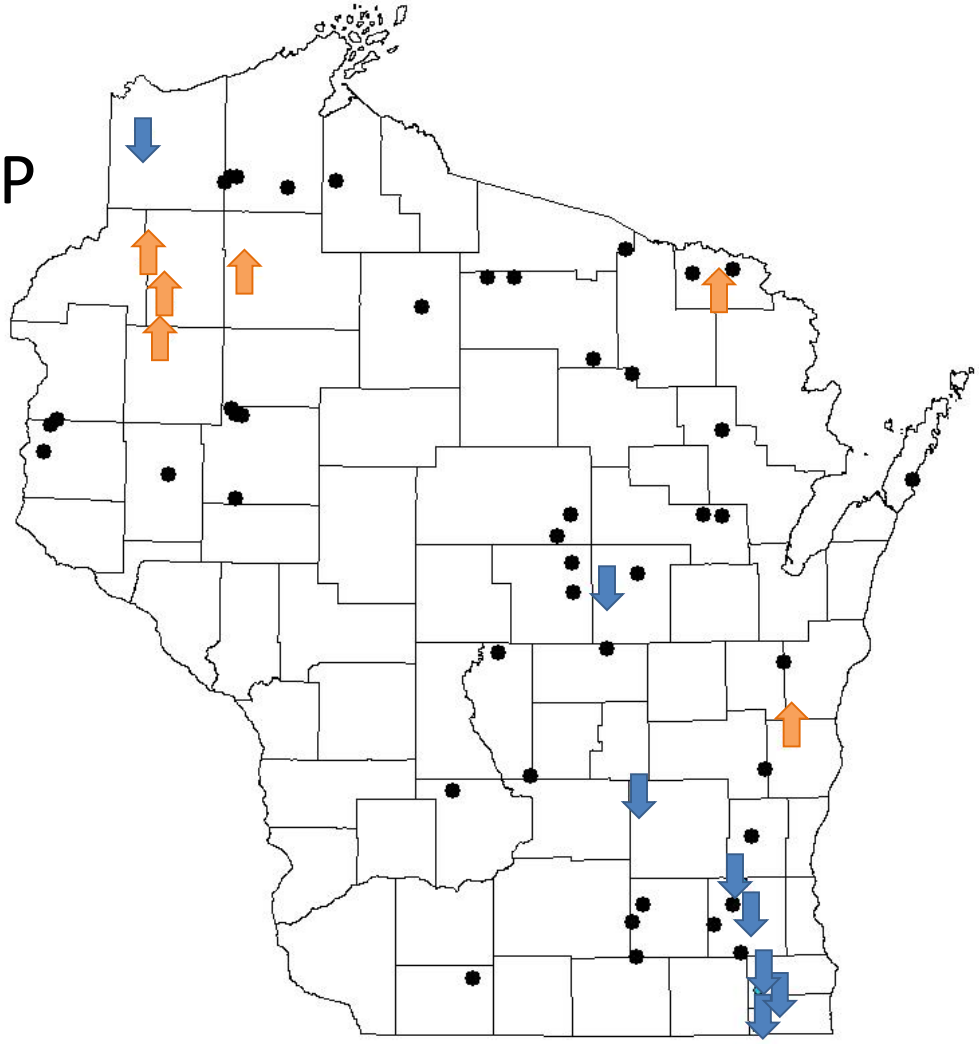
- Ca
- Mg



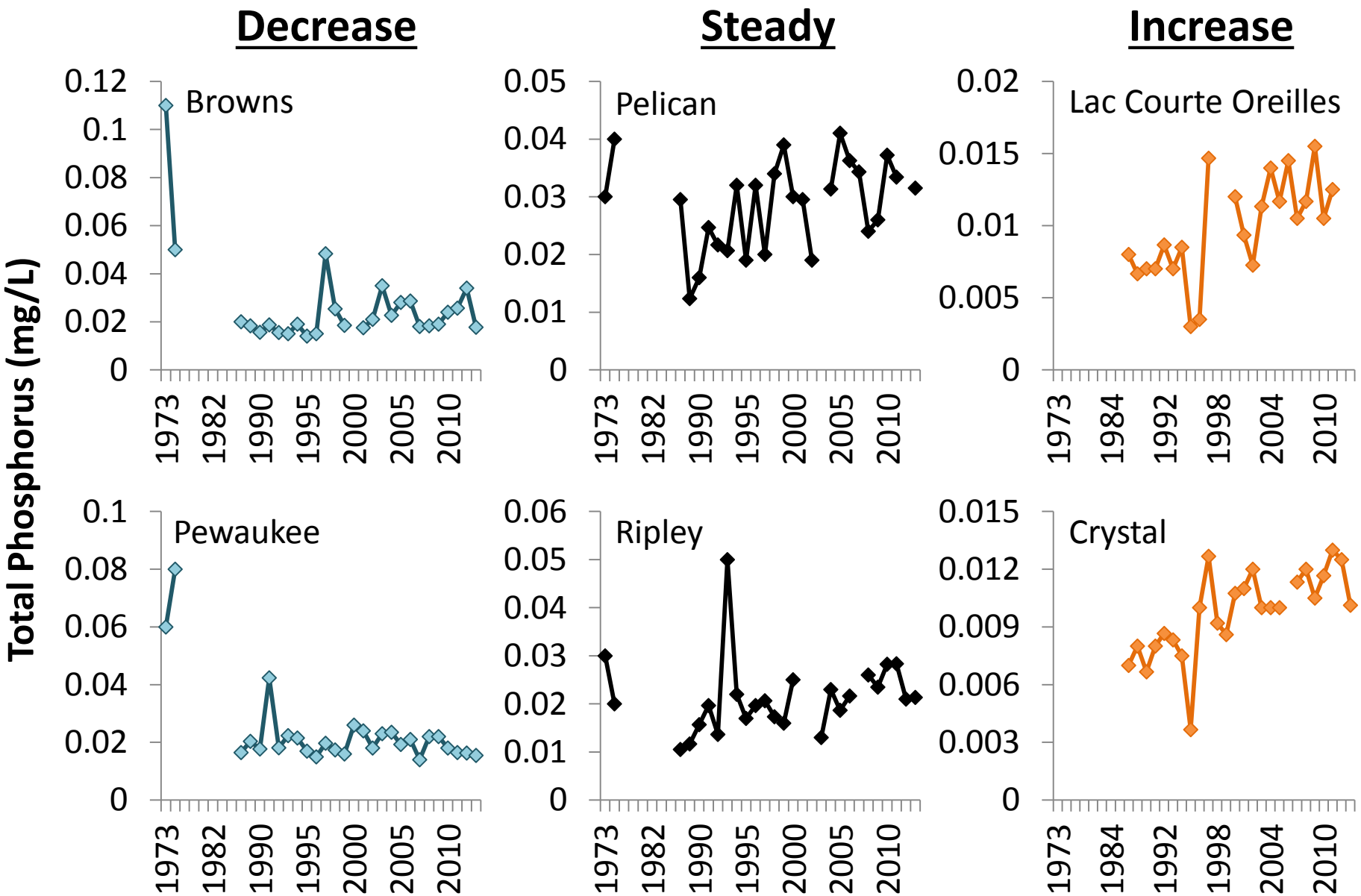
Trends in Total Phosphorus Over Time

- 8 lakes decreasing TP
- 46 lakes no change in TP
- 6 lakes increasing TP





Trends in Total Phosphorus Over Time



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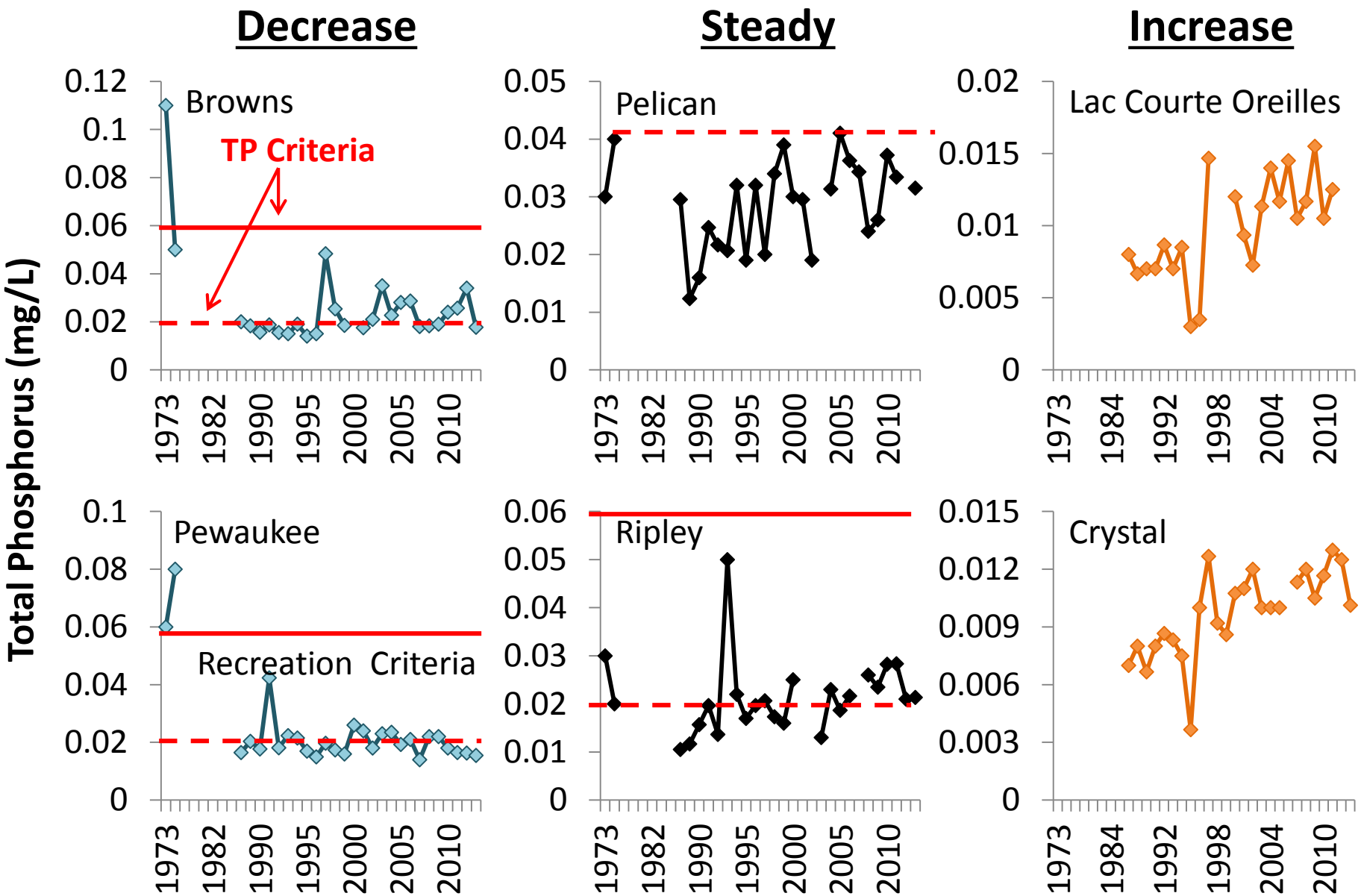
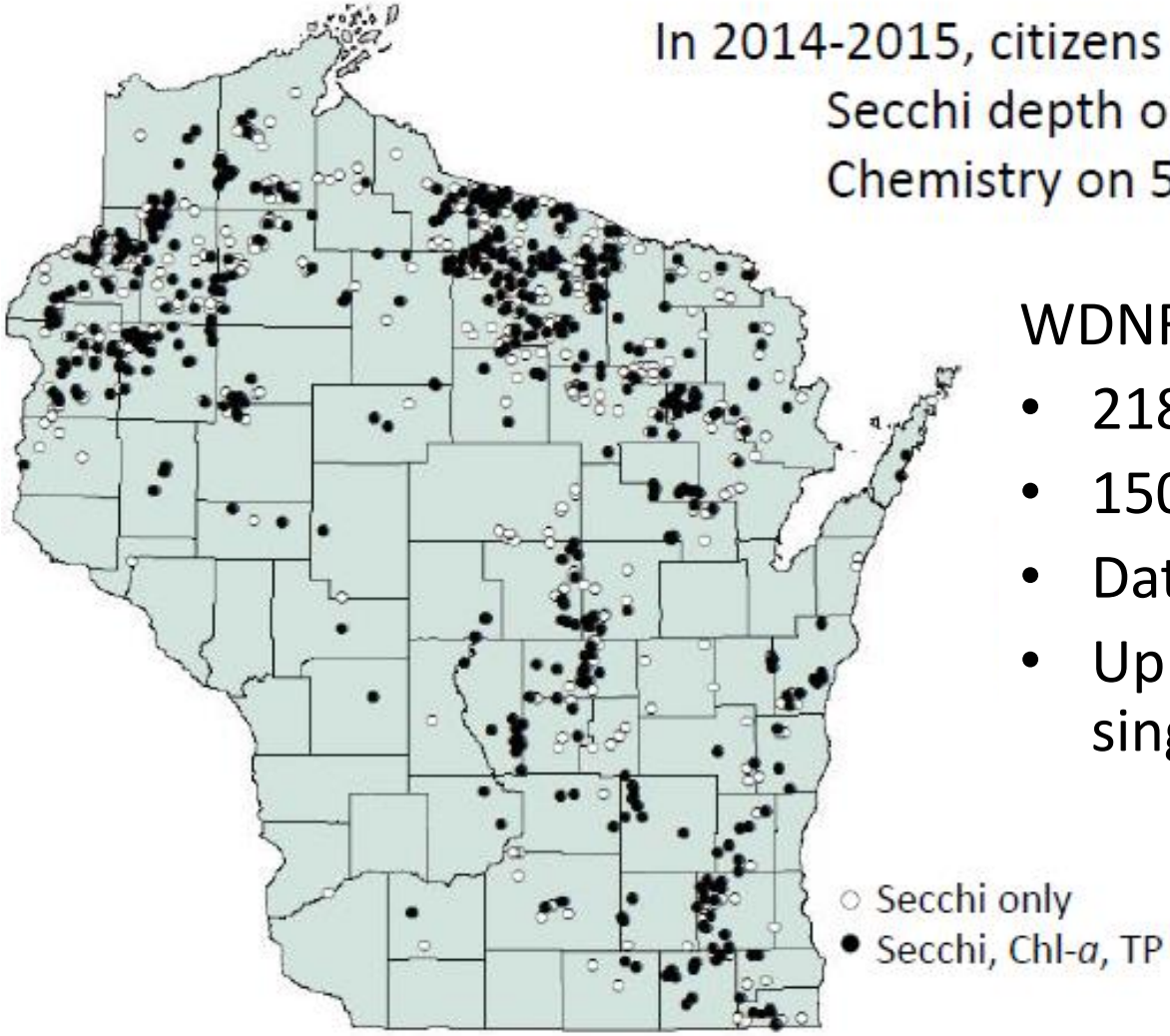


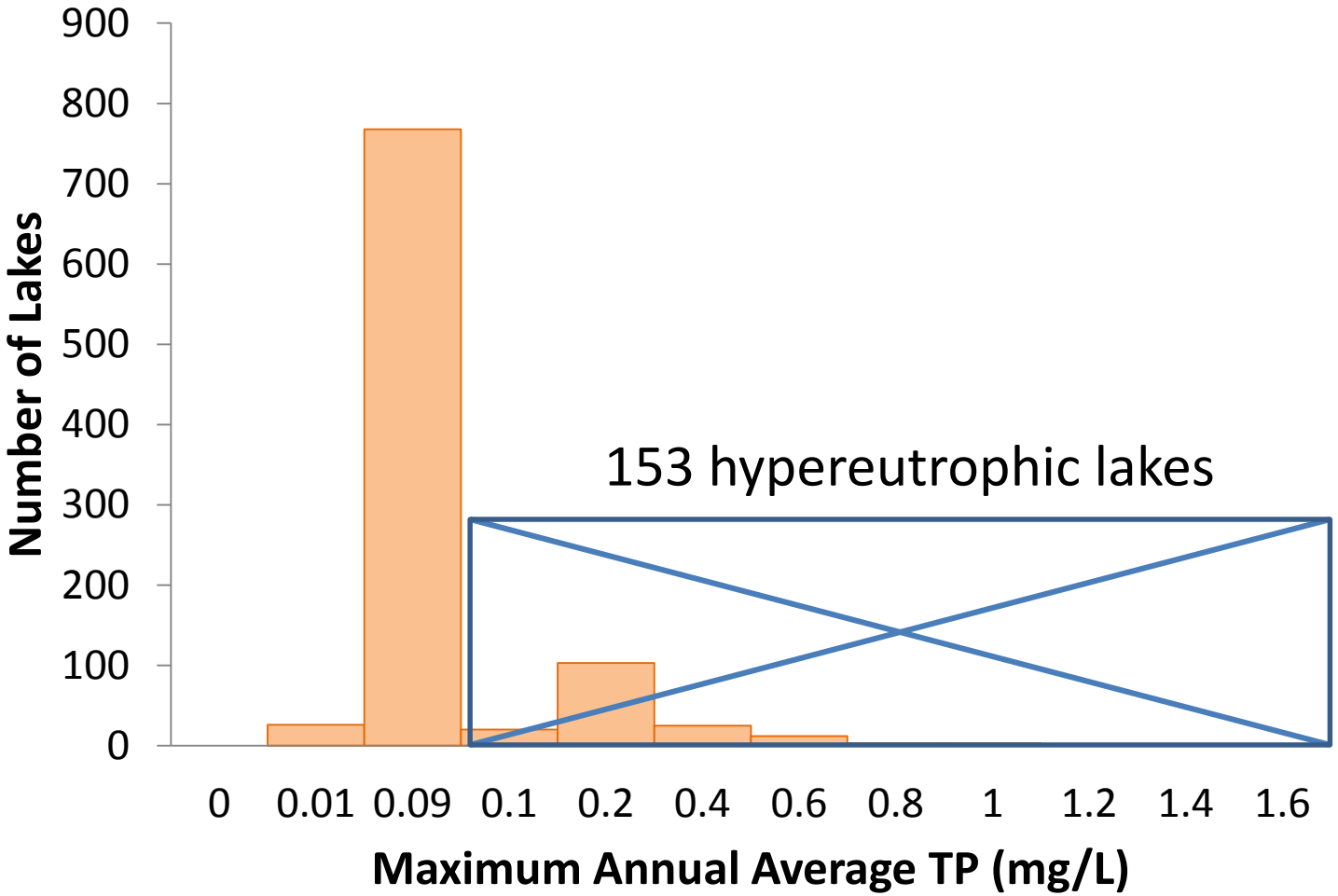
Expand analysis to all WDNR data



WDNR Data Download:

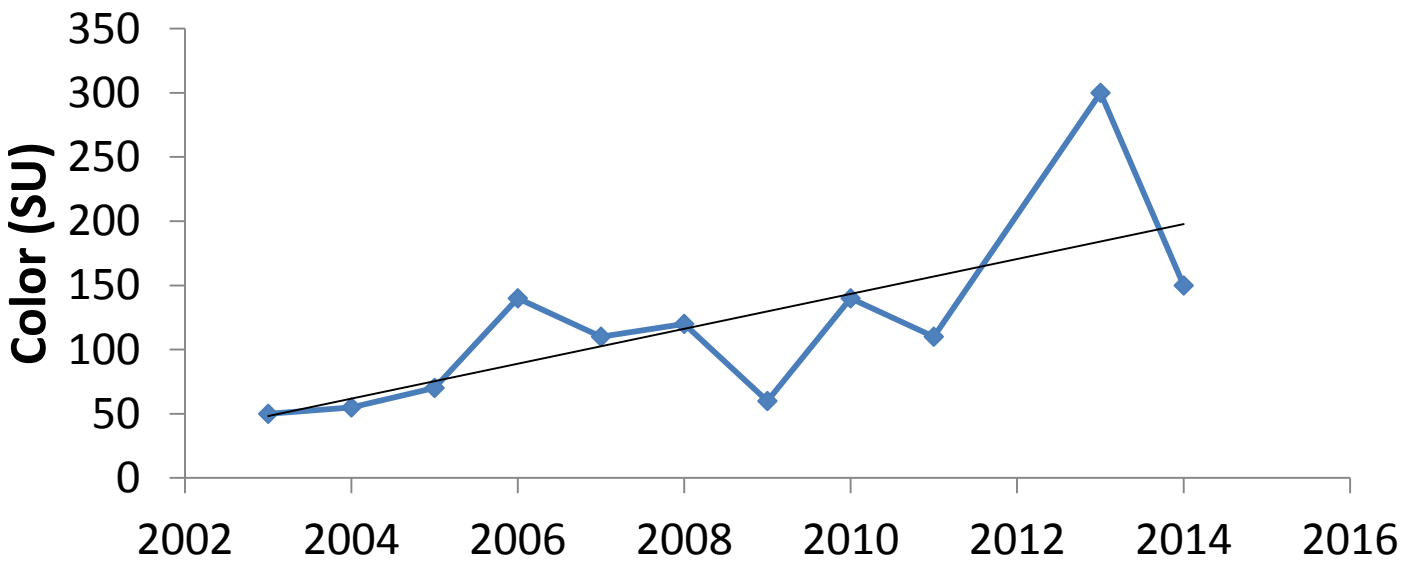
- 218,300 records
- 1501 lakes
- Data from 1968 - 2015
- Up to 34 years of data on a single lake

Exclude hypereutrophic lakes (≥ 0.1 mg/L) from Total Phosphorus analysis

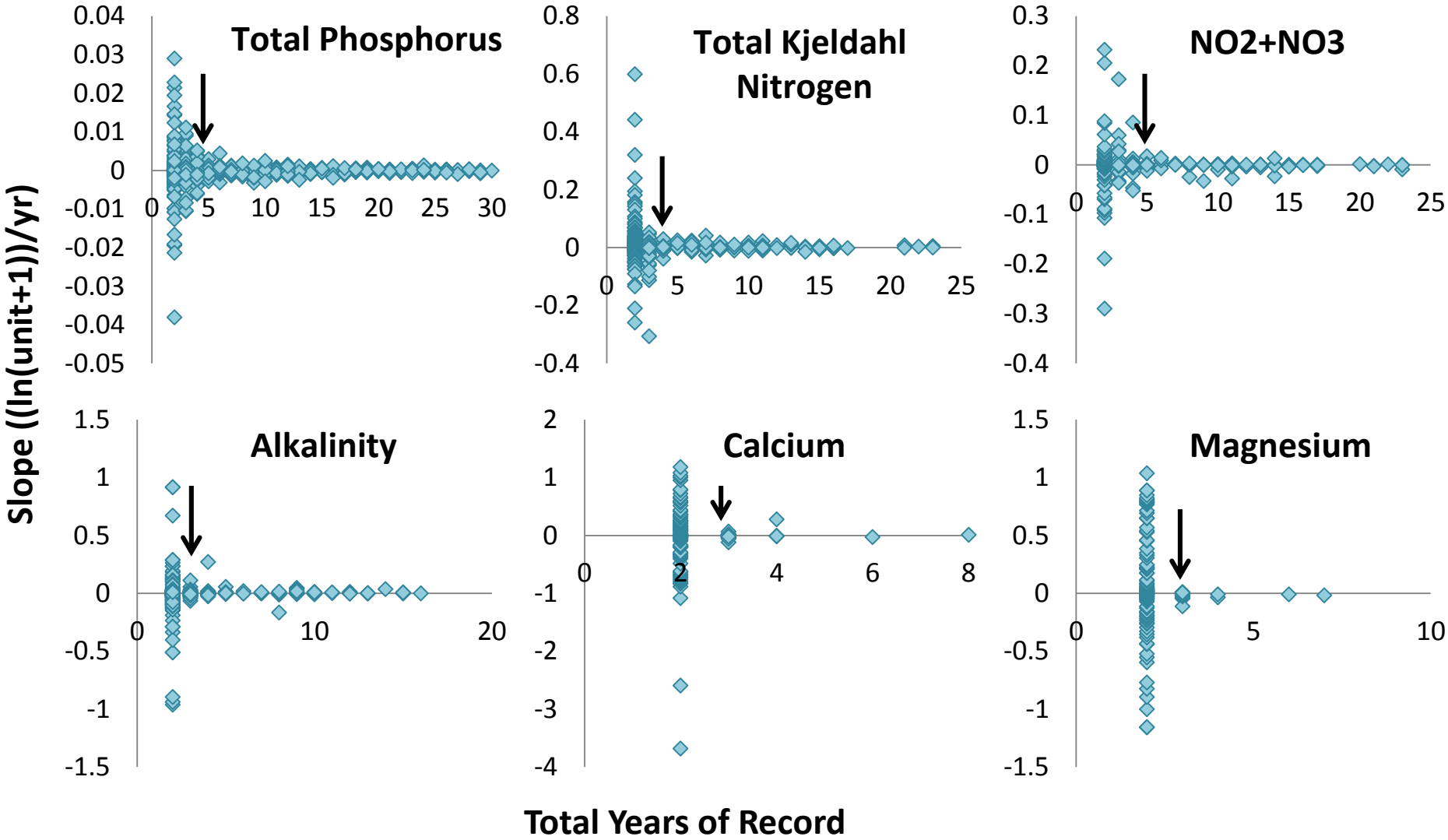


Simple linear regressions

- June 15 – September 15
- Annual Average
- Natural logarithm of concentration



Limit trend analysis to lakes with at least 3-5 years of data



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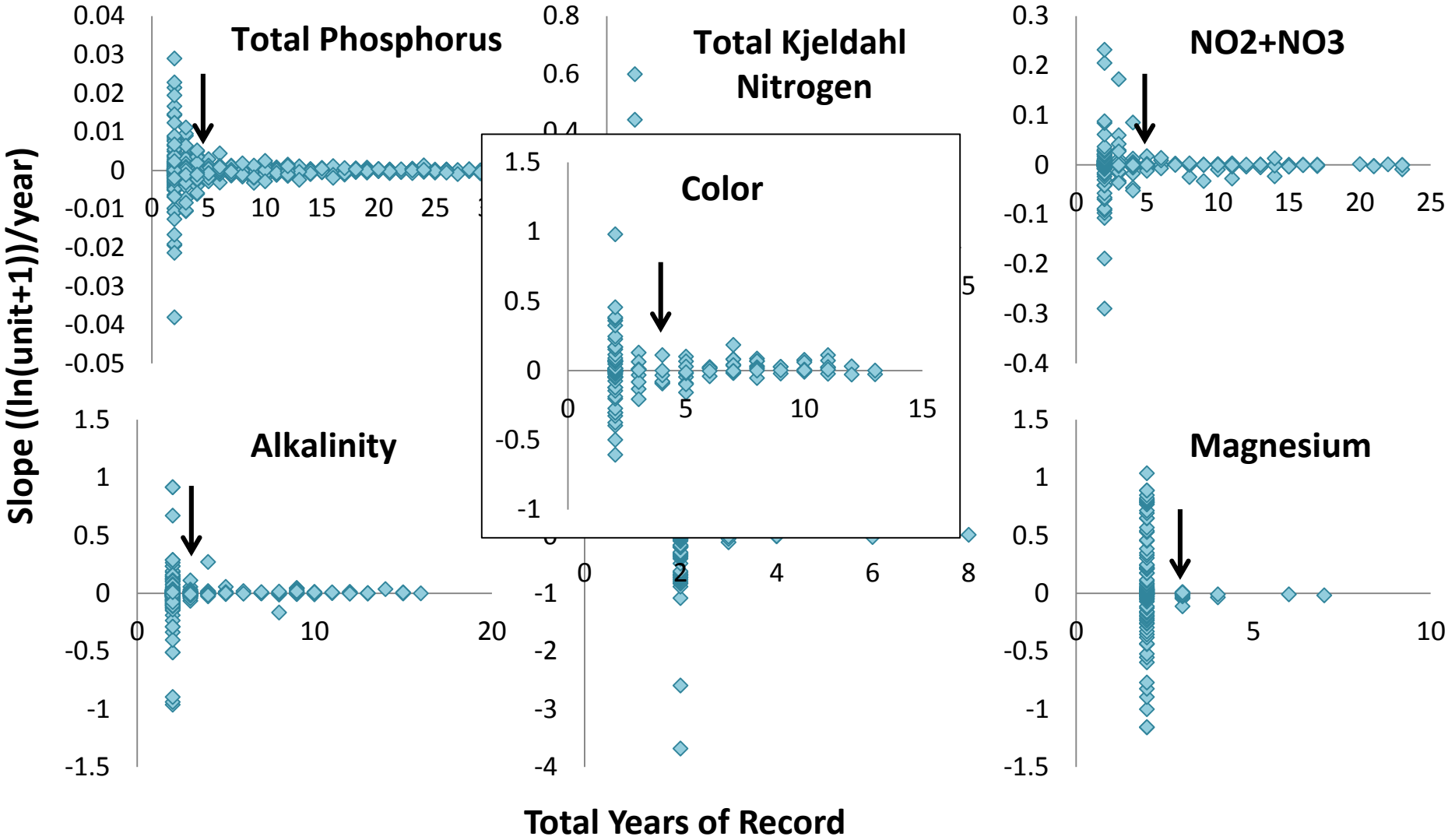
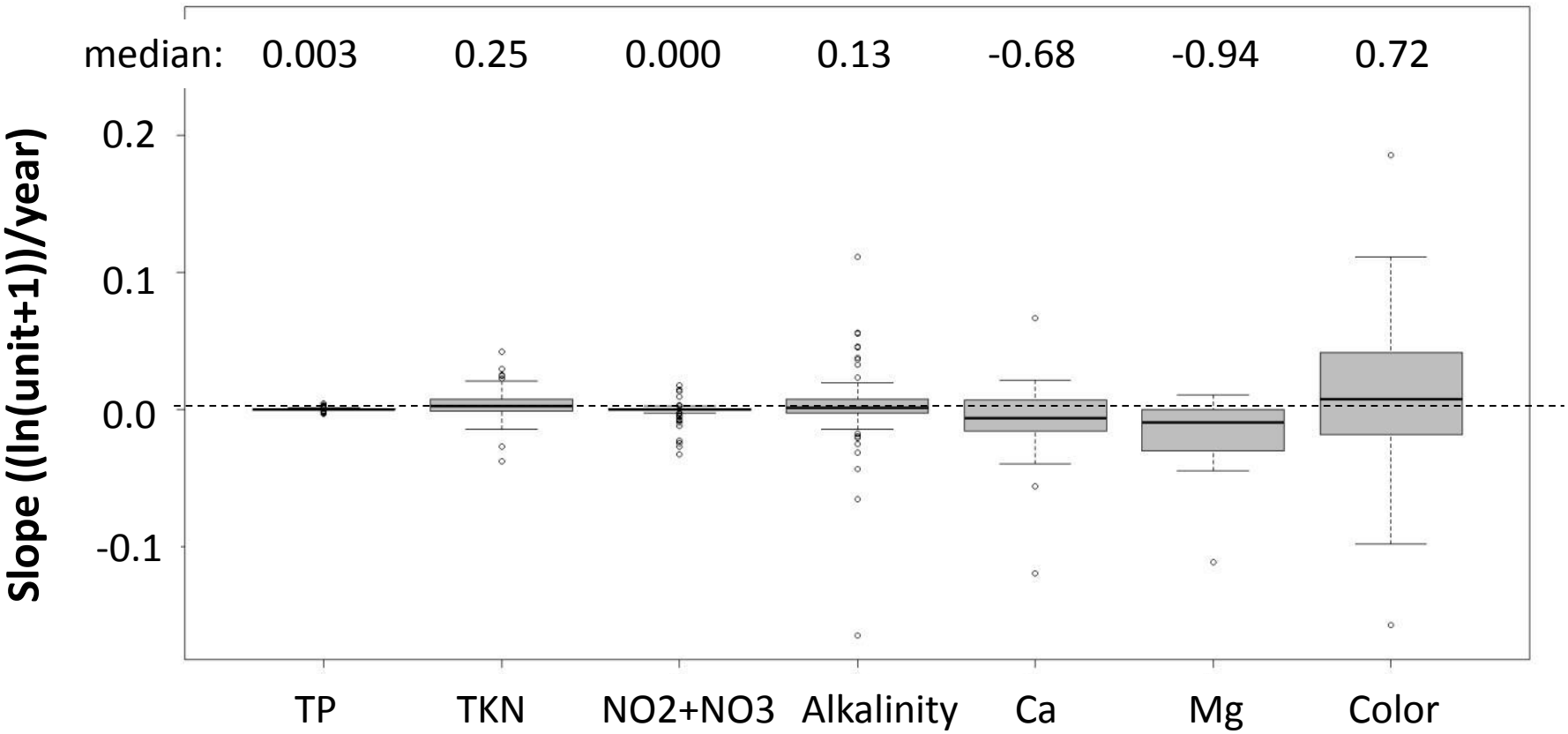
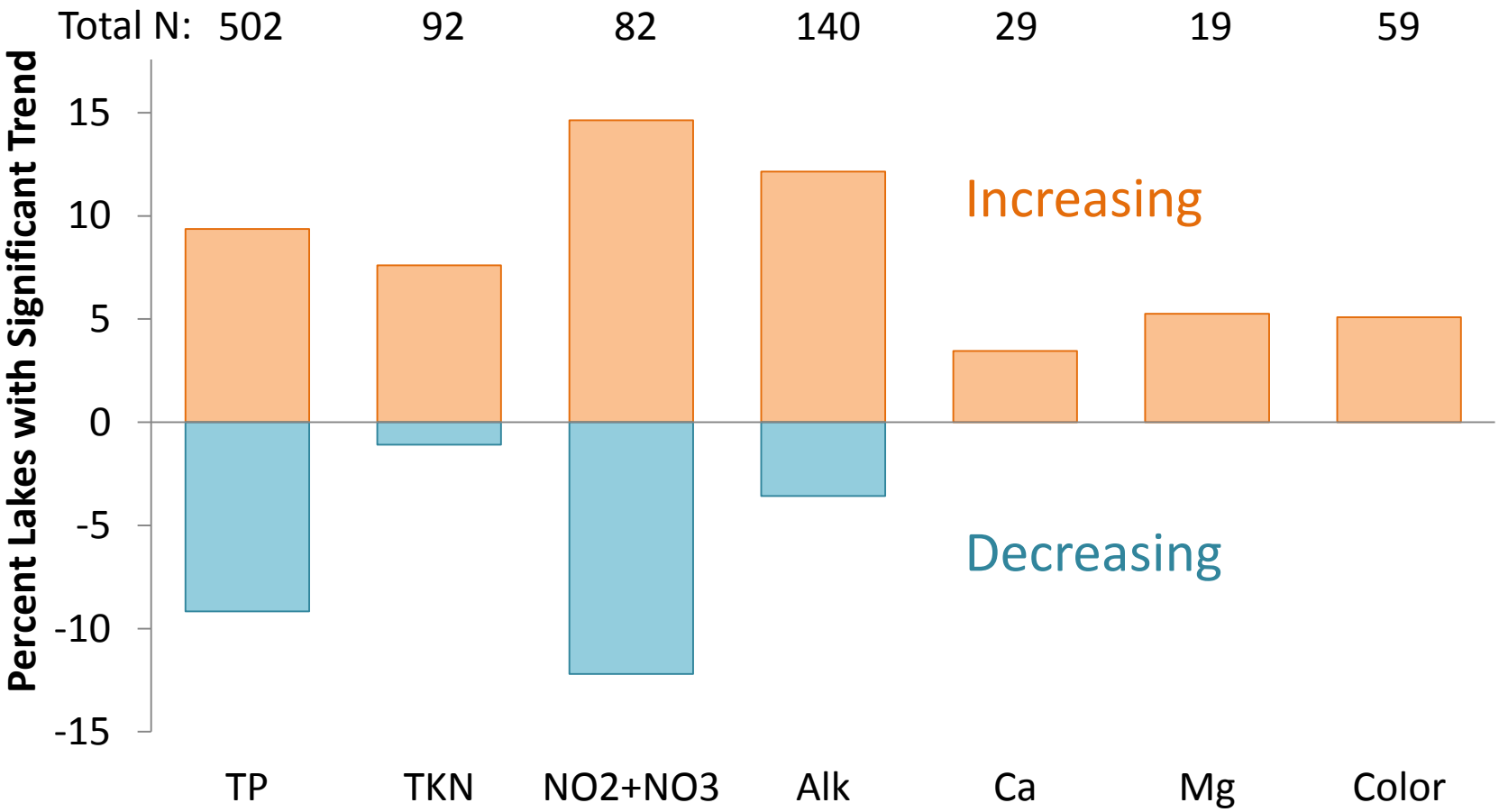


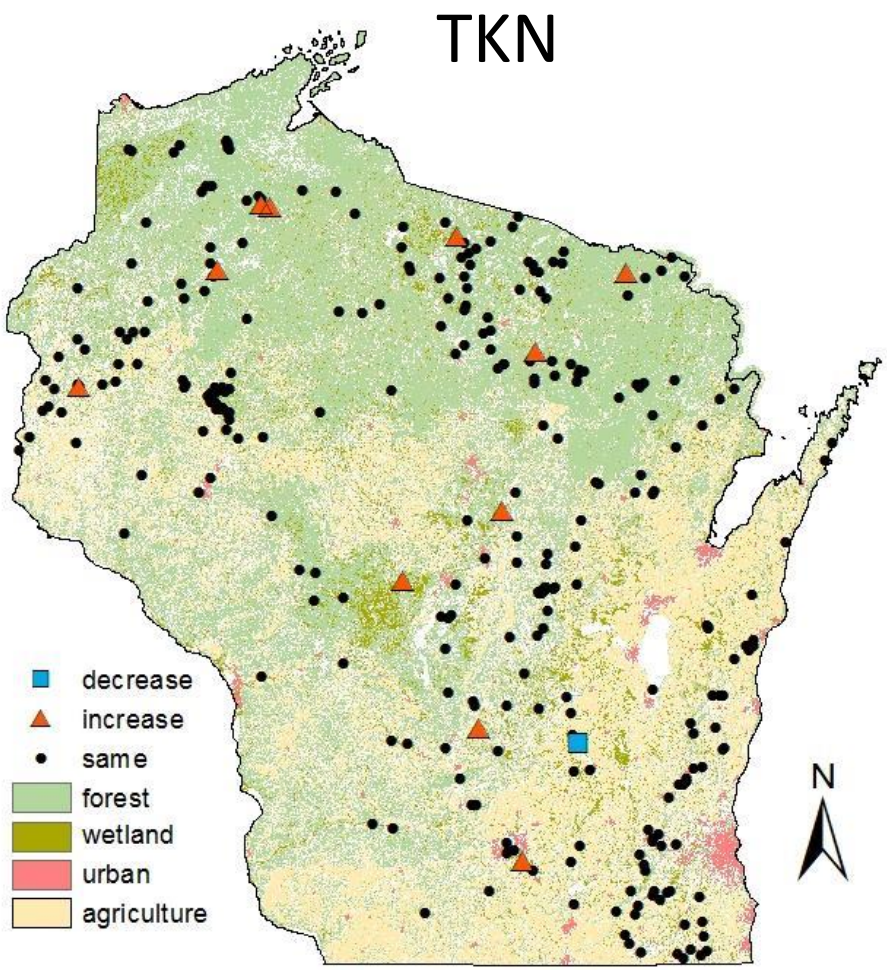
Trend Slopes Near 0 on Most Lakes

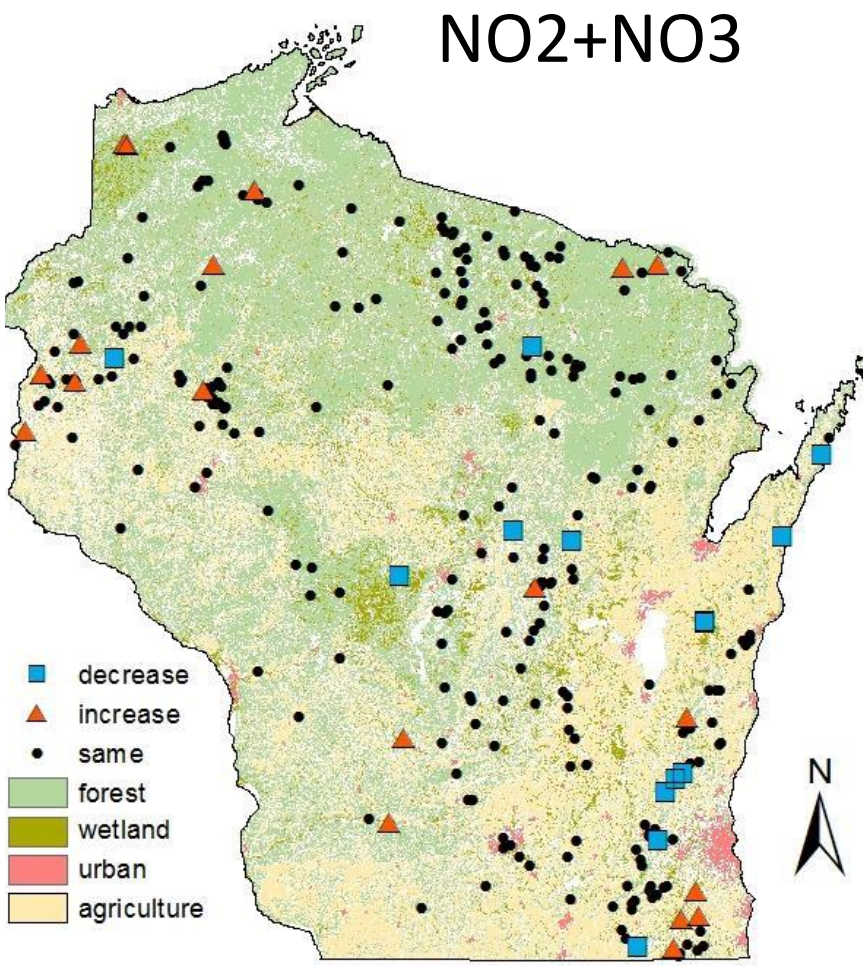


3%-27% of lakes had a significant trend



No Spatial Pattern in Temporal Trends





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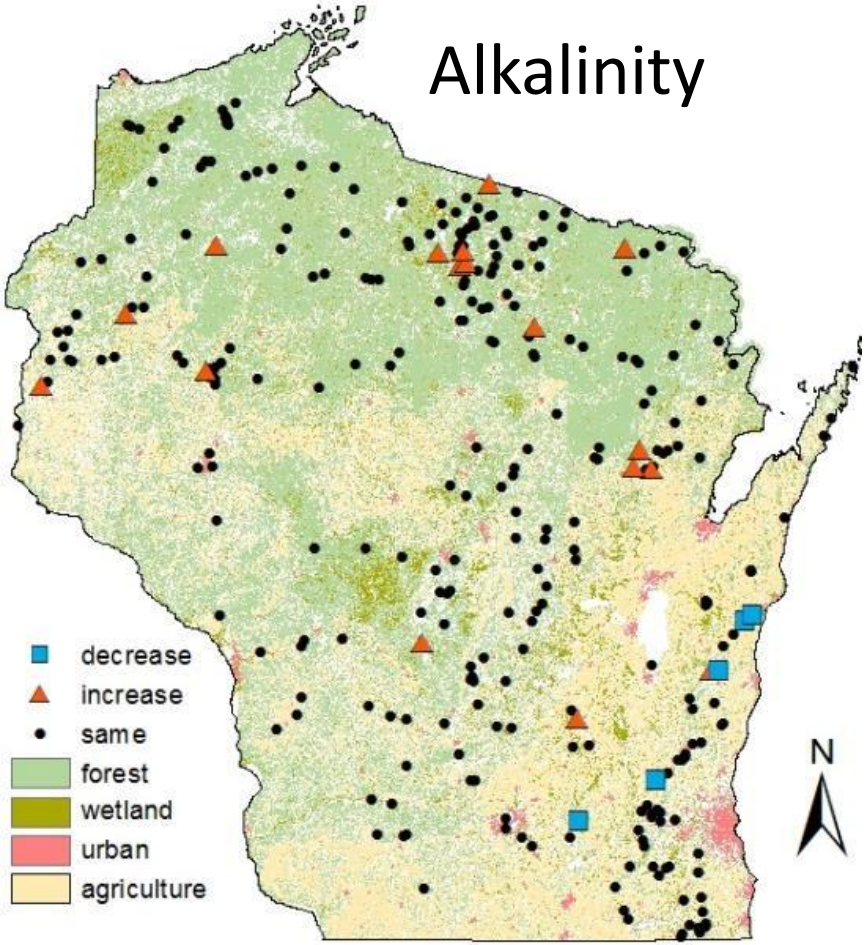

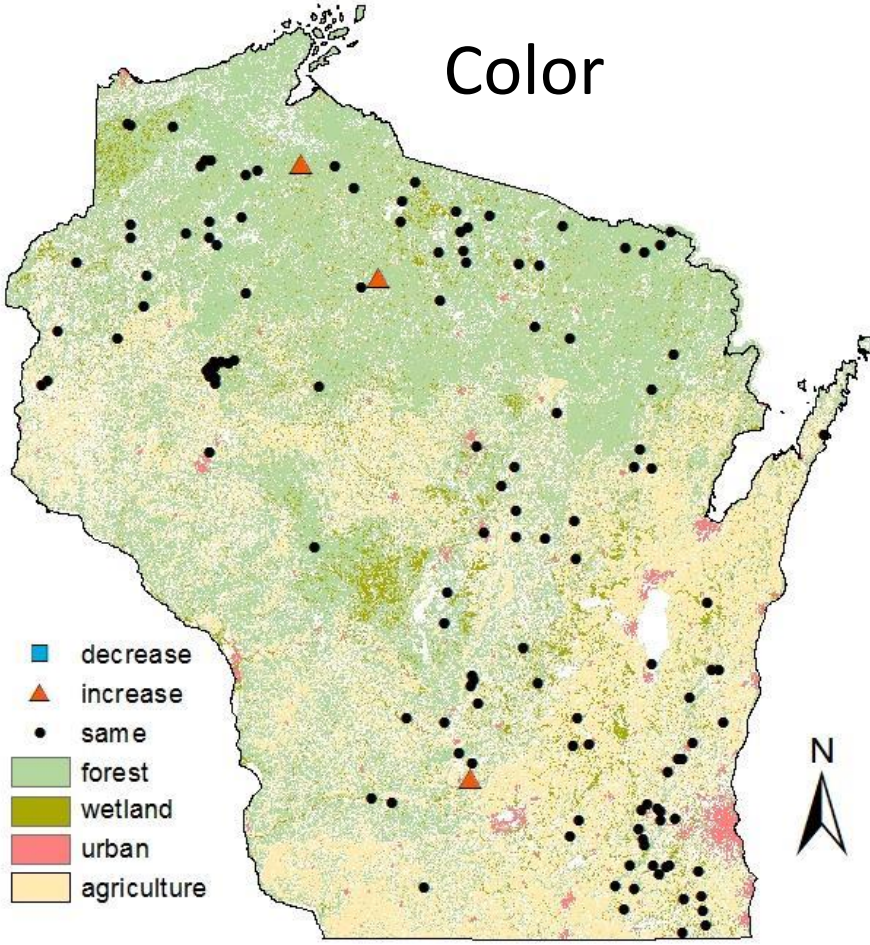

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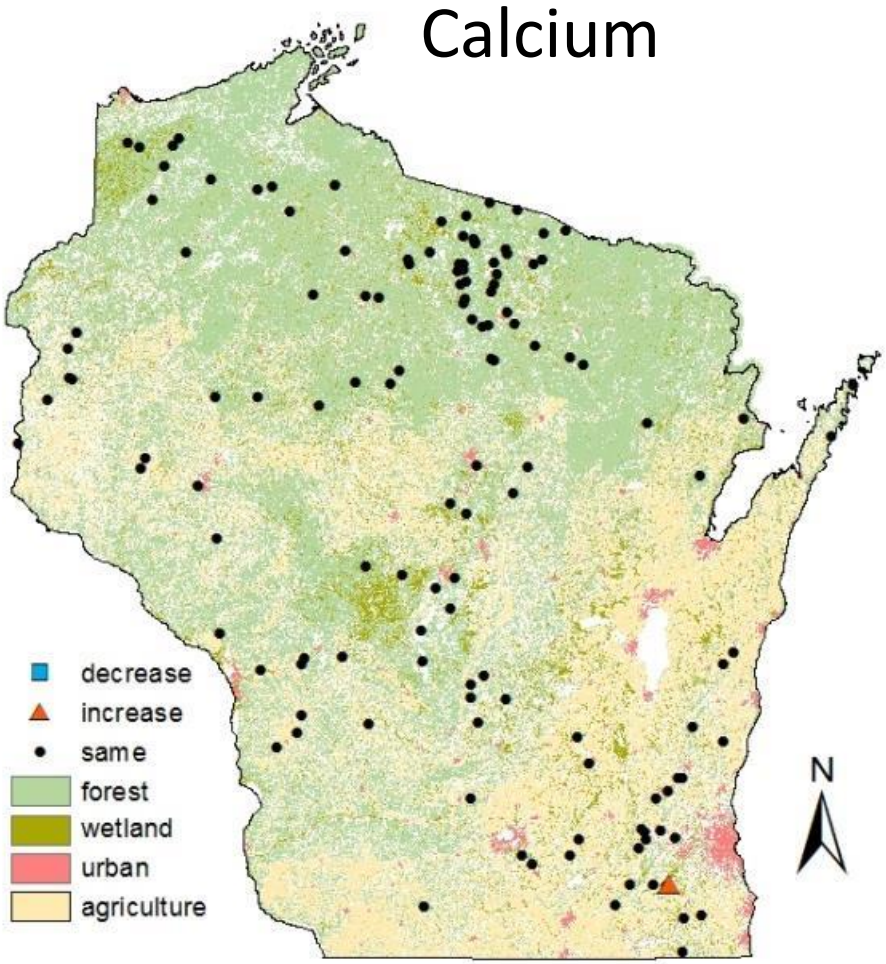

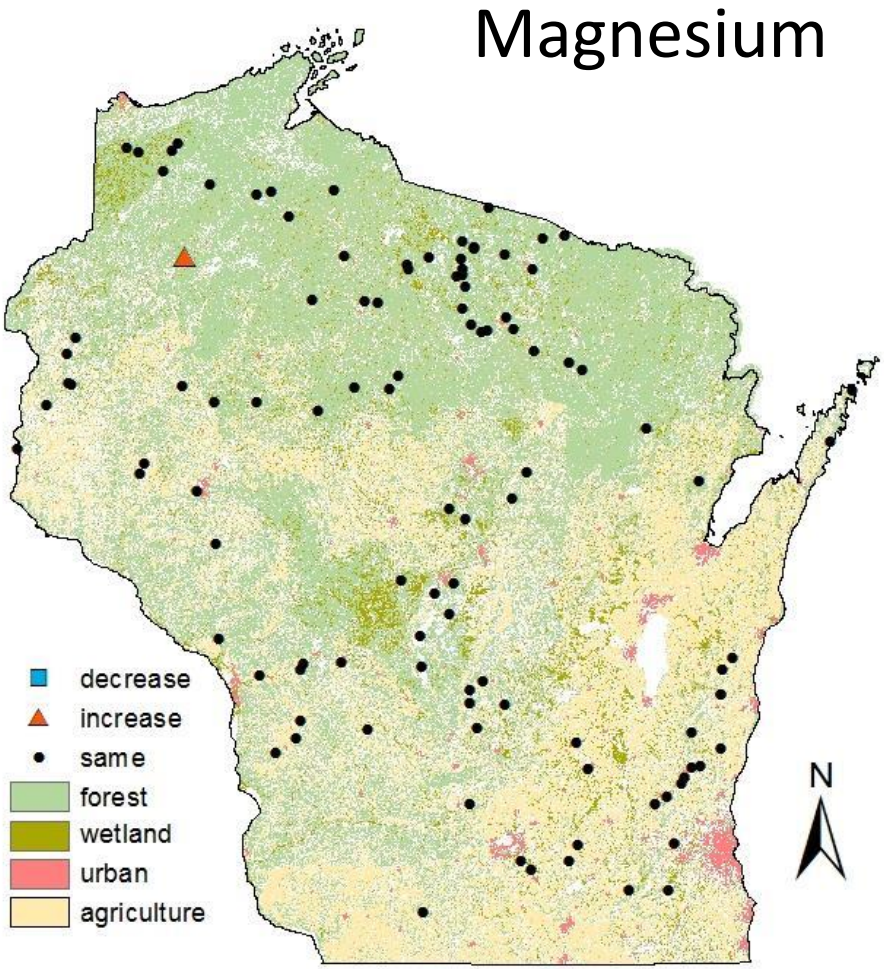

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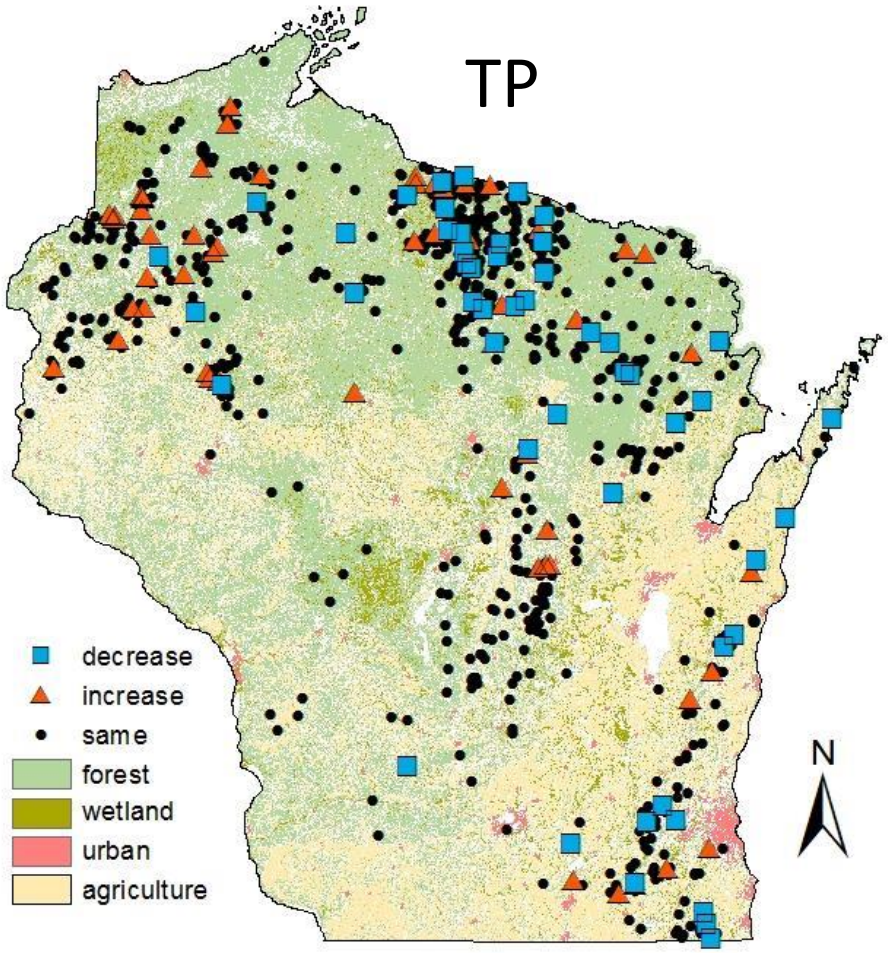
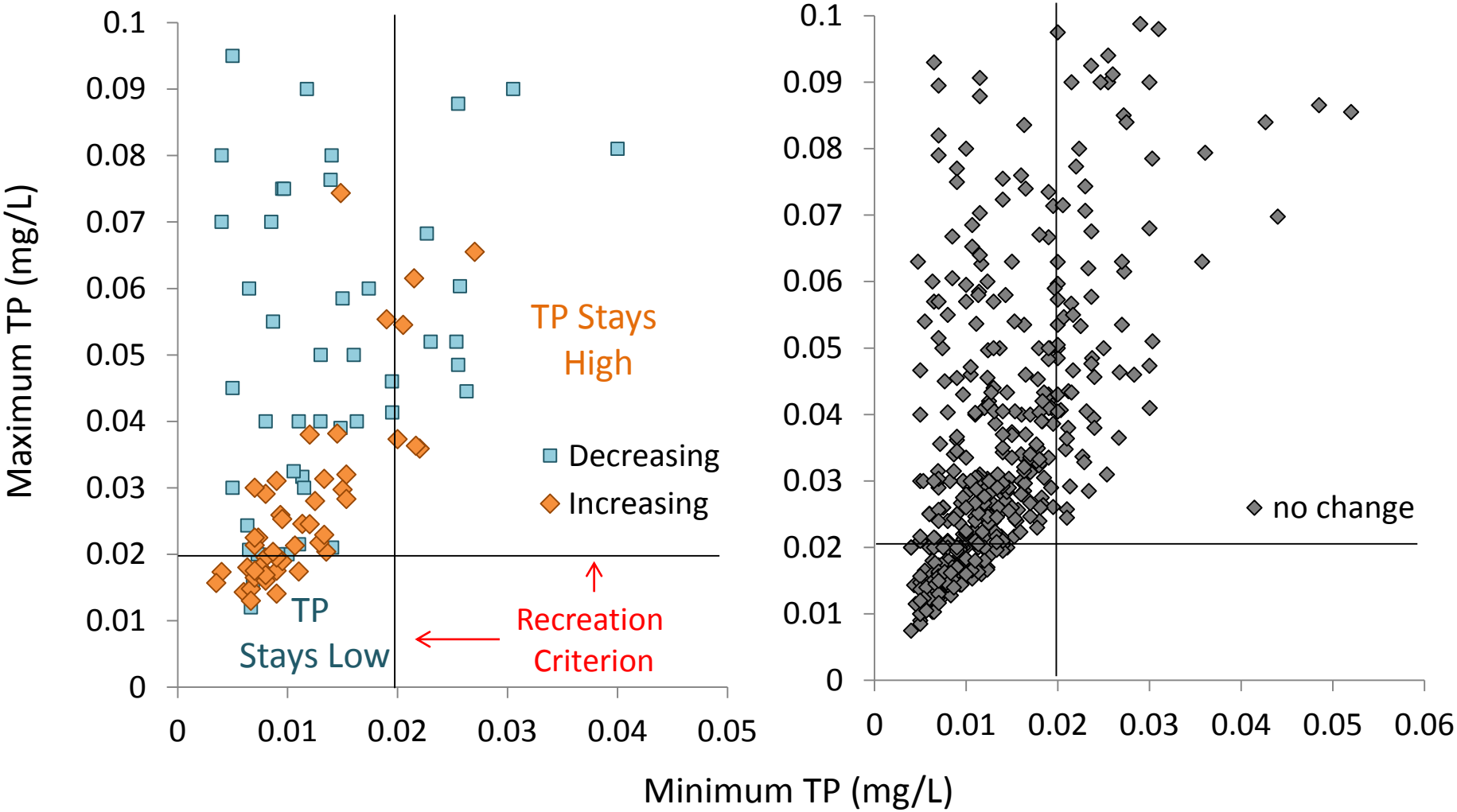
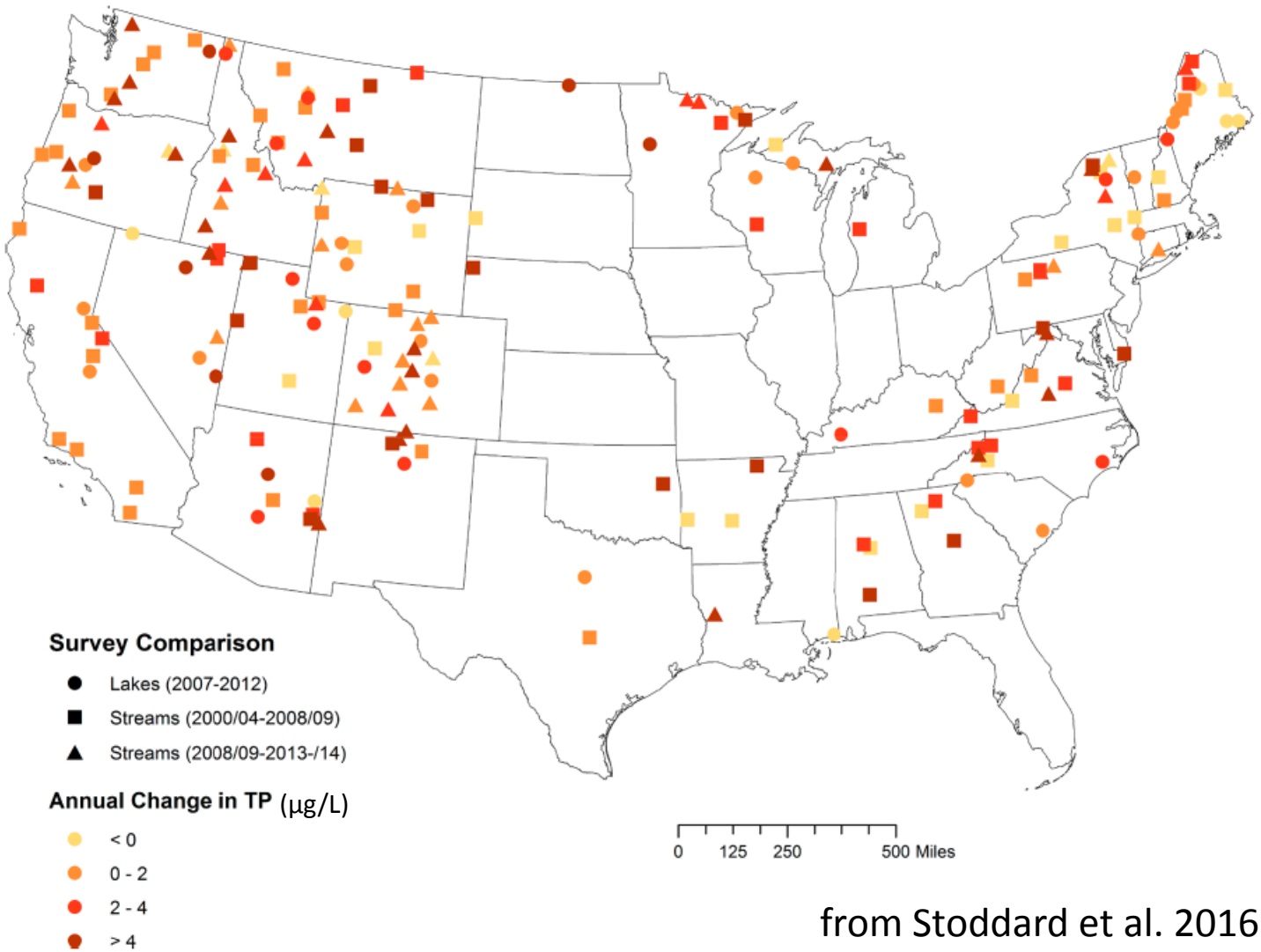


Are lakes getting better or worse?



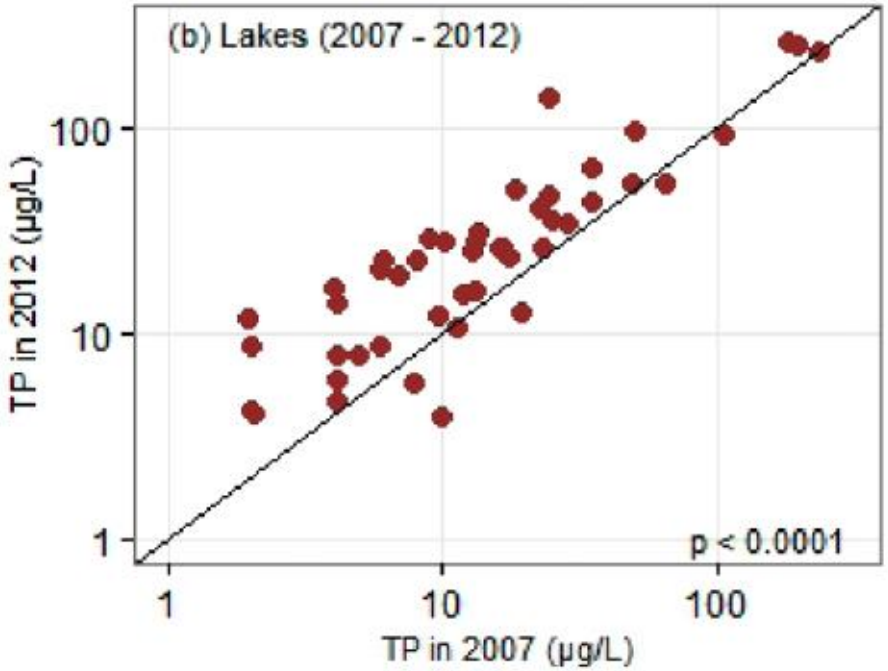
National Aquatic Resource Surveys: Minimally Disturbed Lakes and Streams are Getting Worse



from Stoddard et al. 2016 Env Sci & Tech

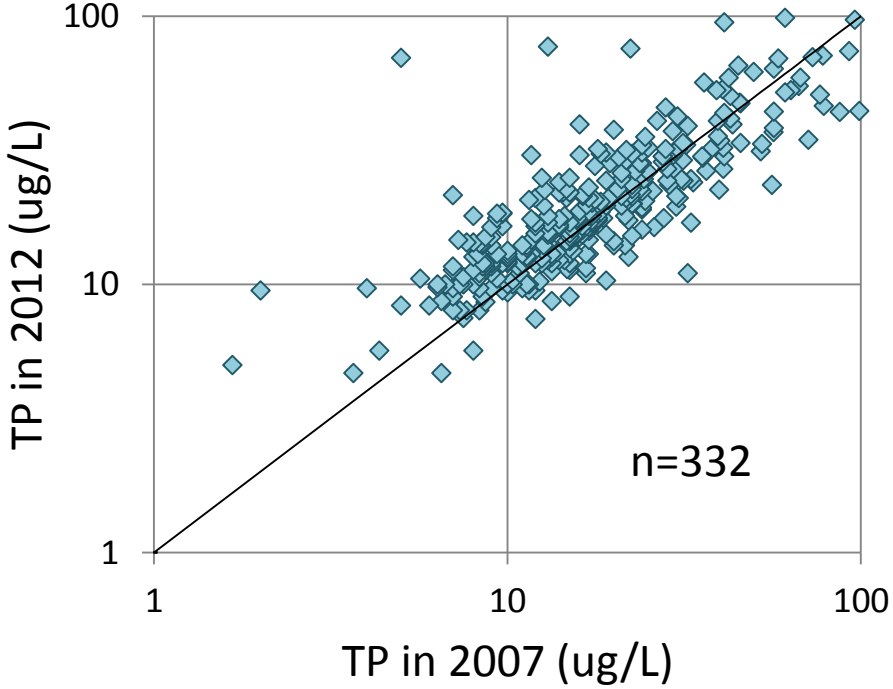
National vs. Wisconsin Trends

National Reference Lakes



Median annual TP increase: 1.6 ug/L/year

All Wisconsin Lakes



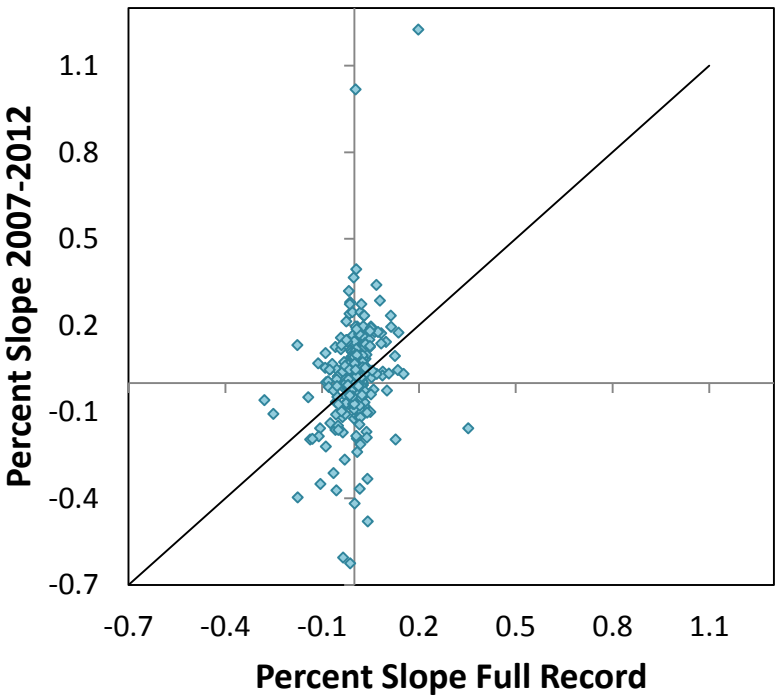
0.27 ug/L/year

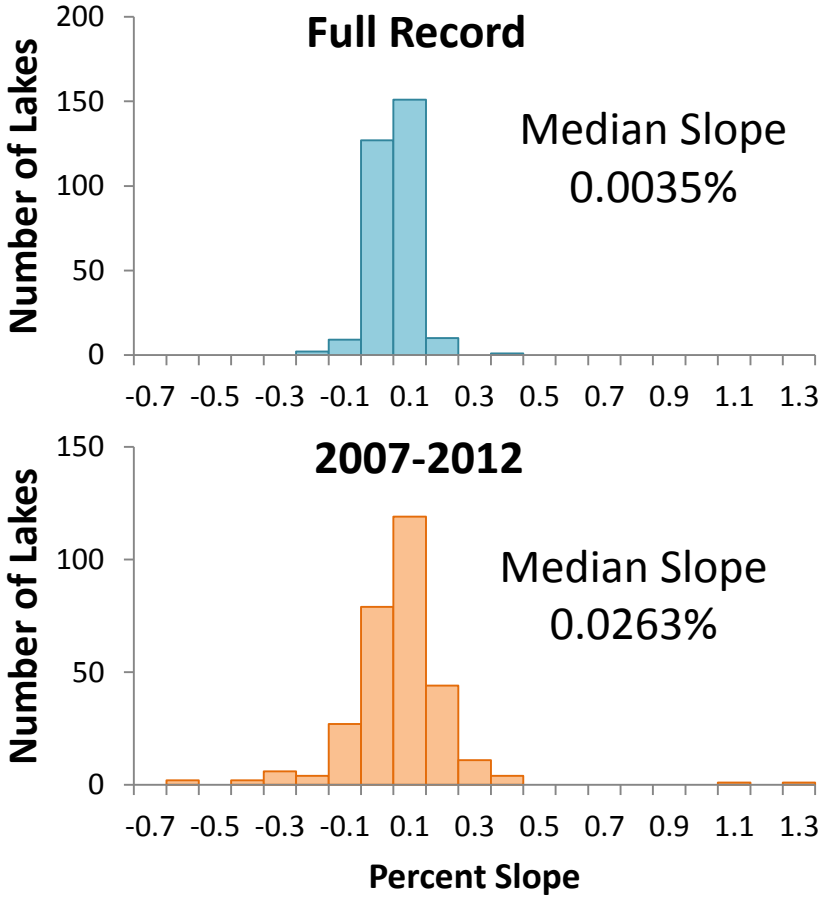
from Stoddard et al. 2016 Env Sci & Tech

Trends in Total Phosphorus from 2007-2012 vs. Full Record

Full Record

Years of Data:	4 - 31
Start Year:	1973 - 2007
End Year:	2012 - 2015





Paired T-Test ($p<0.02$)

Summary of Trends

- Most lakes have not changed over time spans of 3 – 43 years, but a small percent of lakes have significantly increasing or decreasing trends.
- Lack of spatial pattern suggests local watershed processes are important drivers
- Median slope
  - Calcium, Magnesium

  0 NO2+NO3

  + TP, TKN, Alkalinity, Color


Thanks to Department of Natural Resources lake biologists, summer staff, and citizen volunteers!