Analysis of 500 lake catchments reveals the relationship between crop type, fertilizer and manure inputs and lake nutrient concentrations

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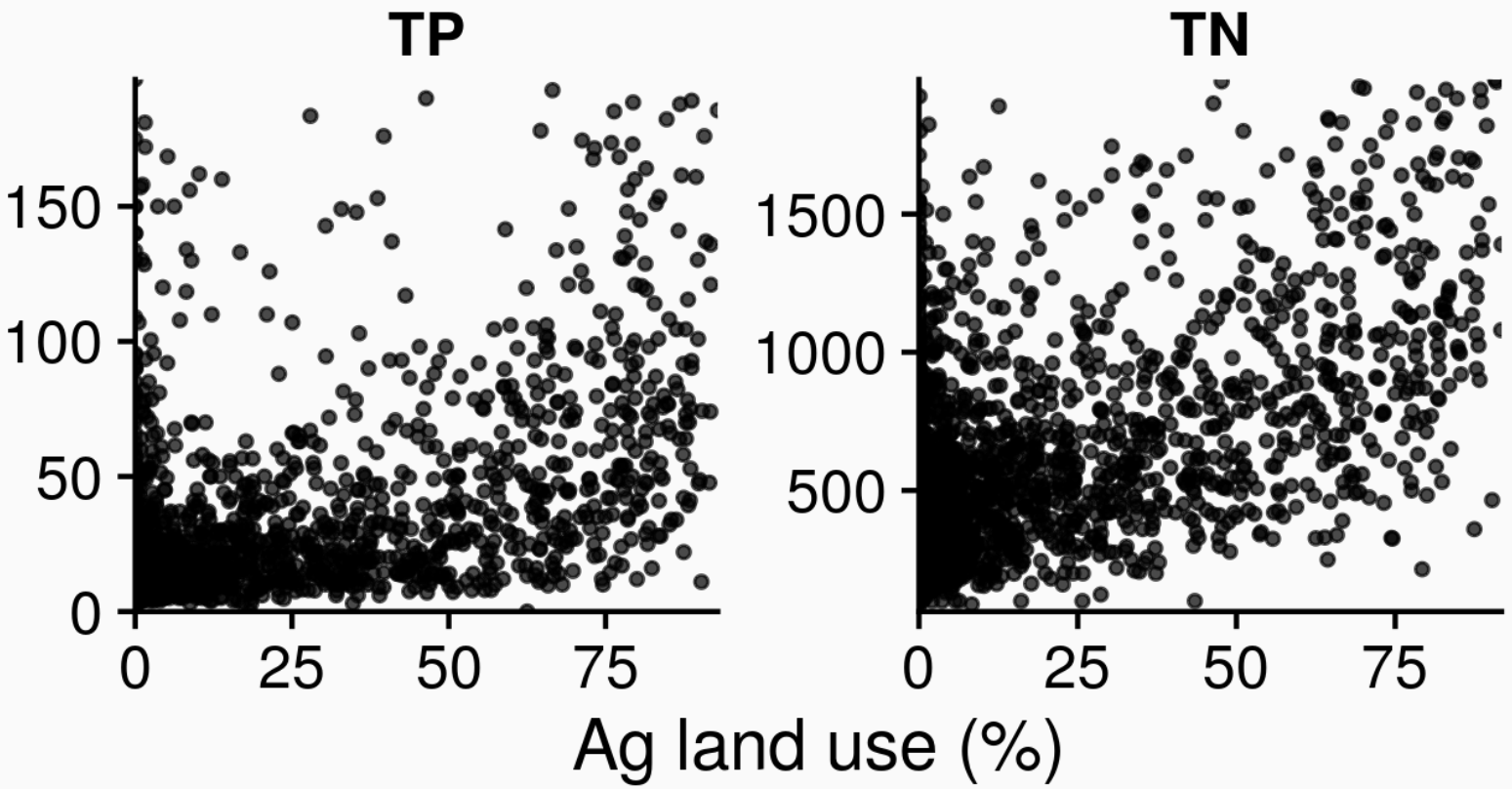
Introduction - Lake nutrients



Introduction - Nutrient predictors

Nutrient inputs - Fertilizer and manure applications

Nutrient transport - Baseflow, soils, precipitation

Land-use cover - Specific crops, etc.

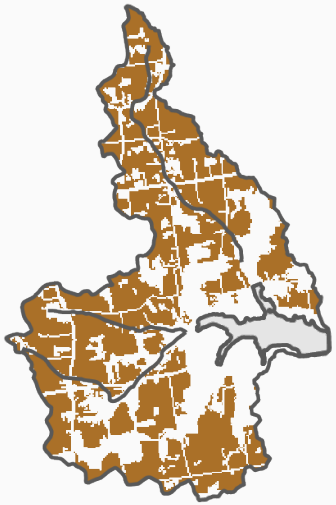
Buffer composition - Land-use cover - Specific crops

Lake characteristics - Depth, area, etc.

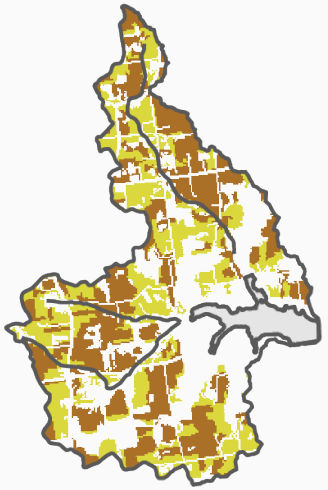
(Collins et al. 2017)

Background - Land-use cover

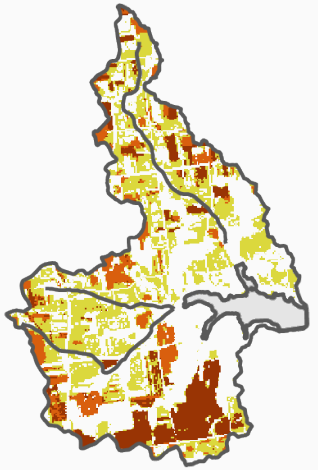
Total Ag



Ag Cover Type



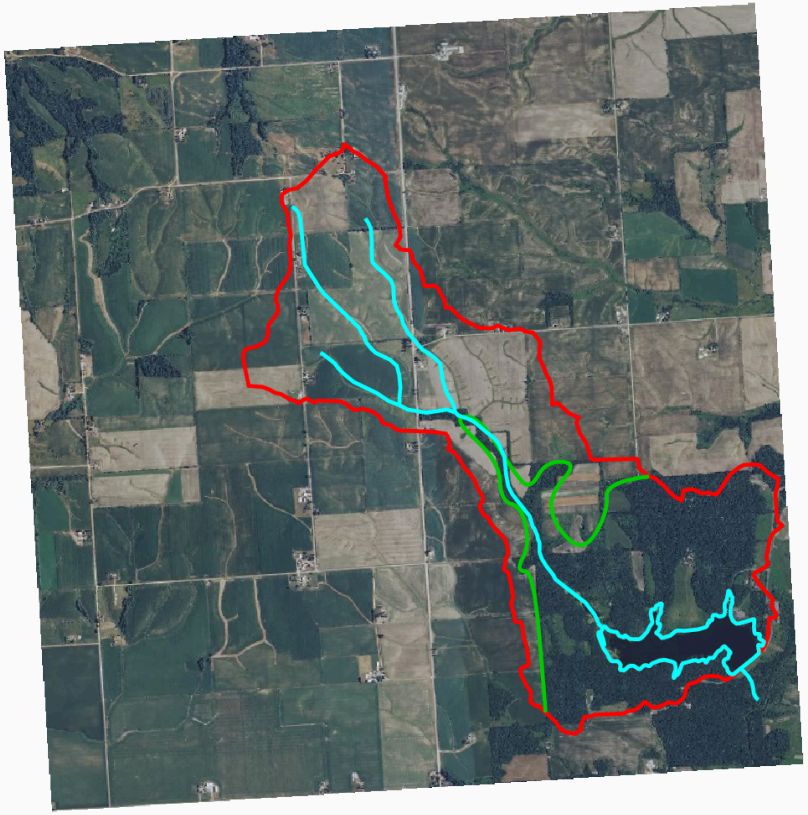
Individual Crops



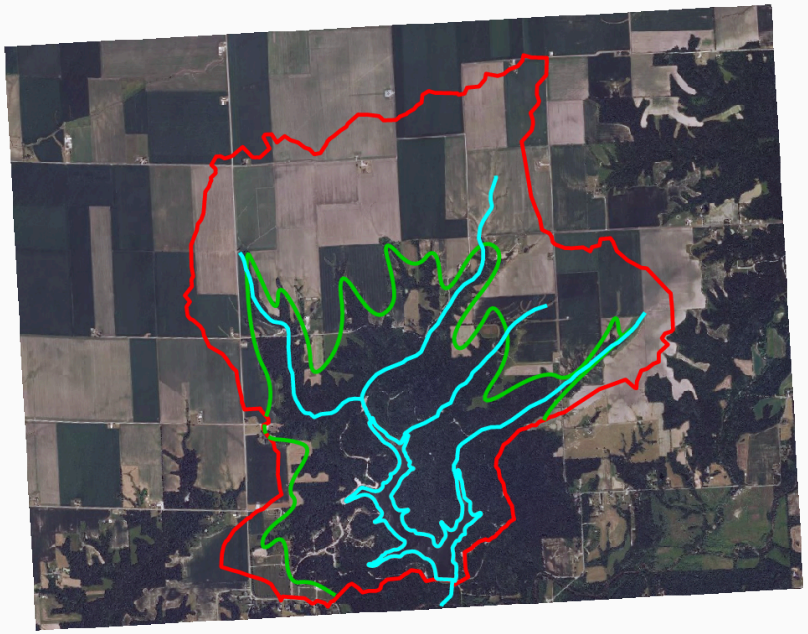
Background - Spatial resolution

Poorly Buffered

Lake Carlton – IL



Argyle Lake – IL



Background - The macroscale

	Fine scale (1 watershed)	Macroscale (many watersheds)
Granular	Many studies	??
Aggregated	Few studies	Some studies

What are some things we've learned from fine scale, granular-data studies?

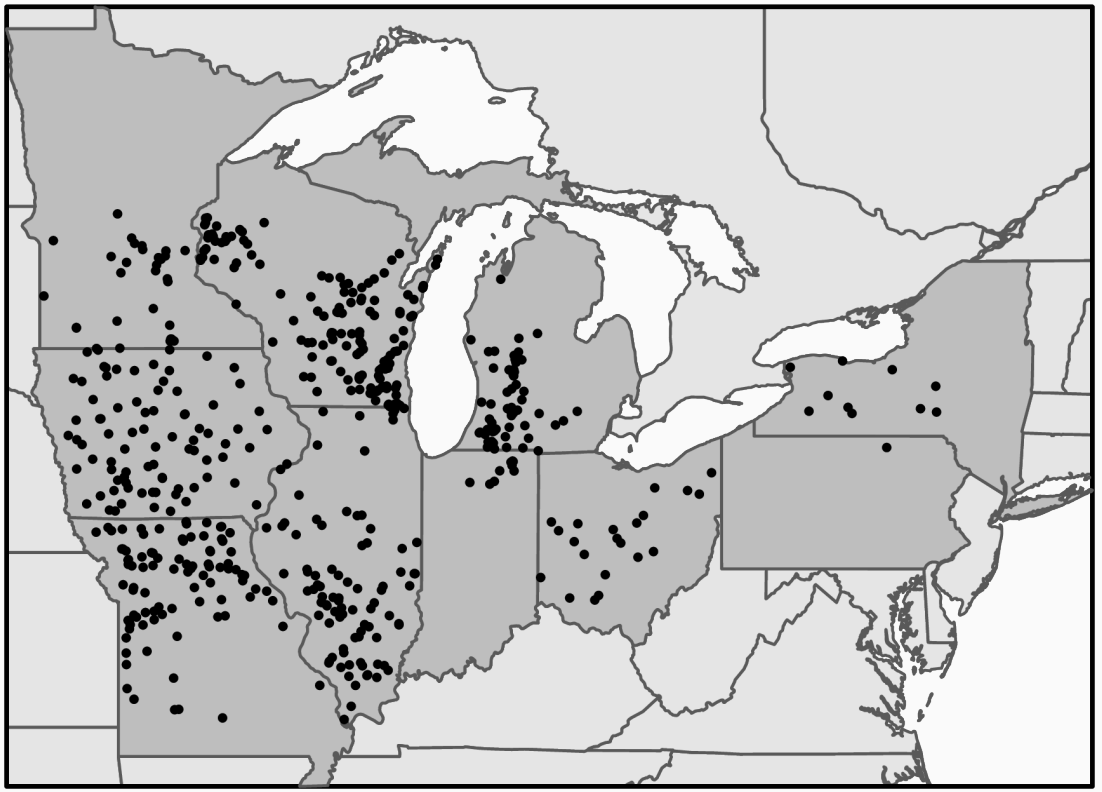
What are some things we've learned from macroscale, aggregated-data studies?

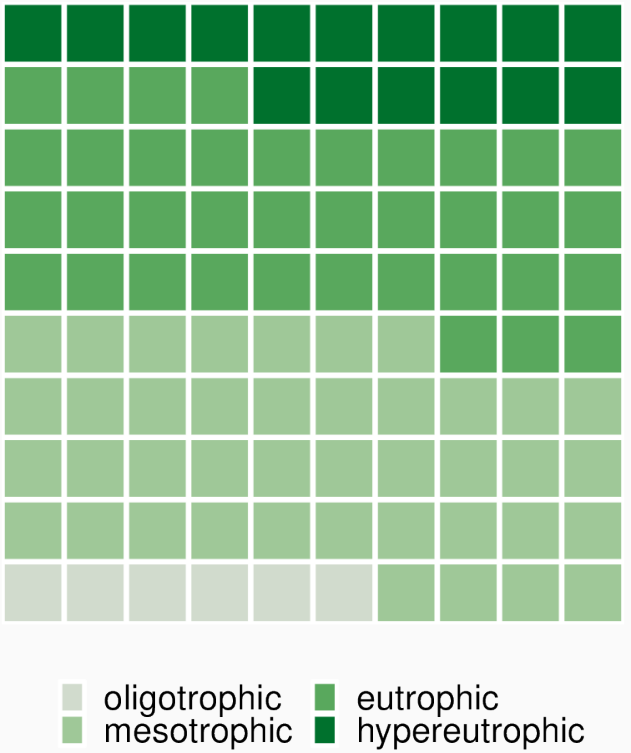
Research Question(s)

1. **Are more granular measures of Ag activity related to lake water quality (TN, TP) across hundreds of lakes and their watersheds?**

2. **Do relationships between watershed land use and lake water quality vary spatially among hydrologic and climatic regions?**

Methods - 500 lake catchments…





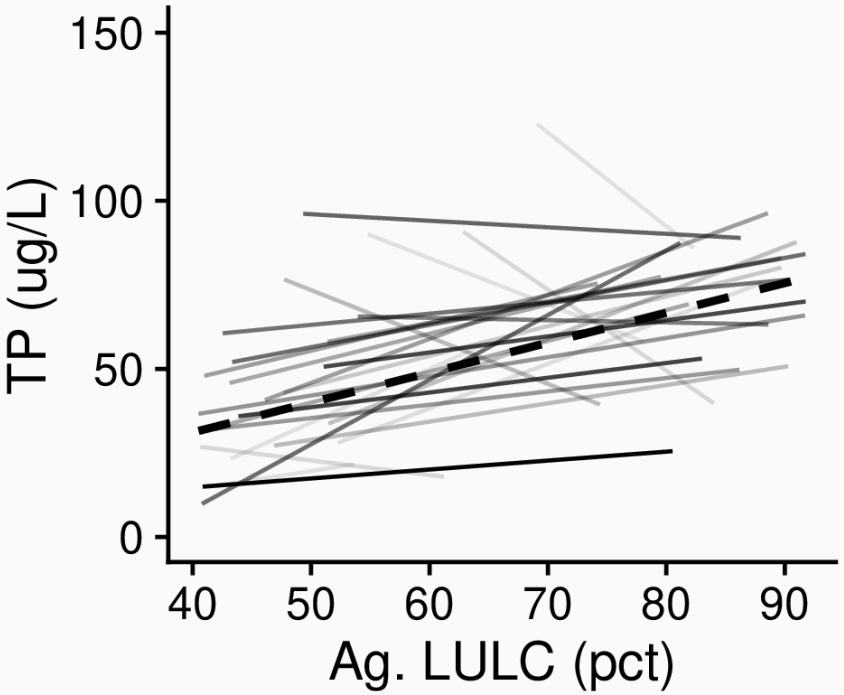
Methods - Regression Modelling

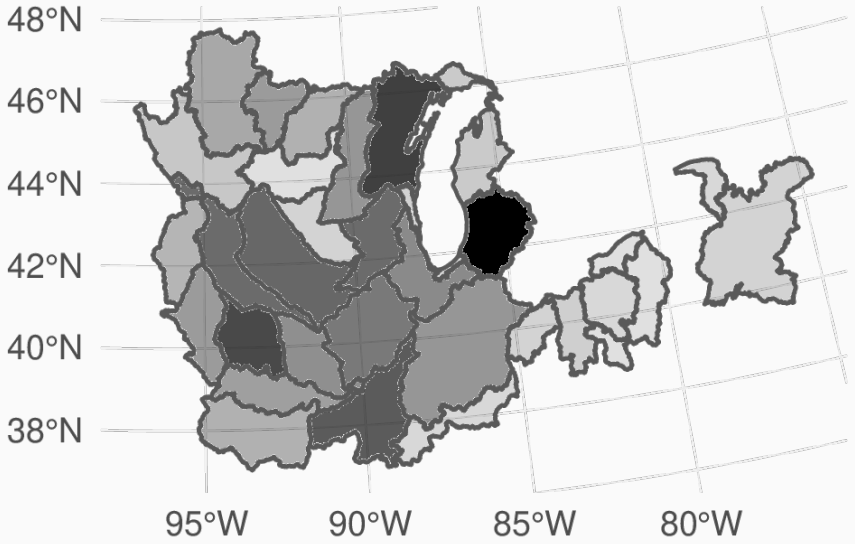
Model type: Hierarchical Bayesian
Predictands: TP, TN
Global predictors: 12 Granular Ag variables
3 Lake and watershed characteristics
Variable selection: None (*horseshoe* shrinkage)
Regional predictors: 7 Watershed land-use variables
Model selection: Cross-validation on watershed land-use

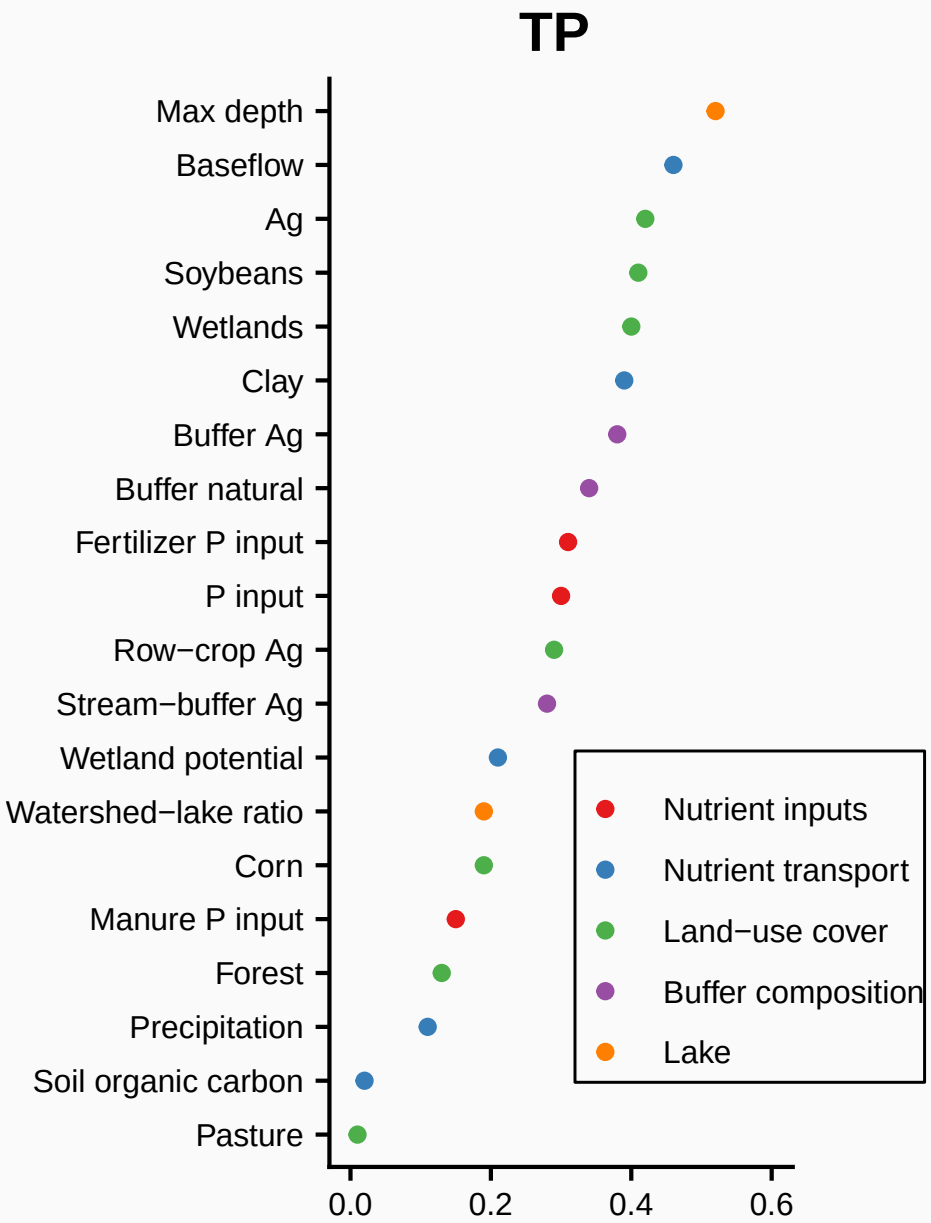
Methods - Regionally varying predictors

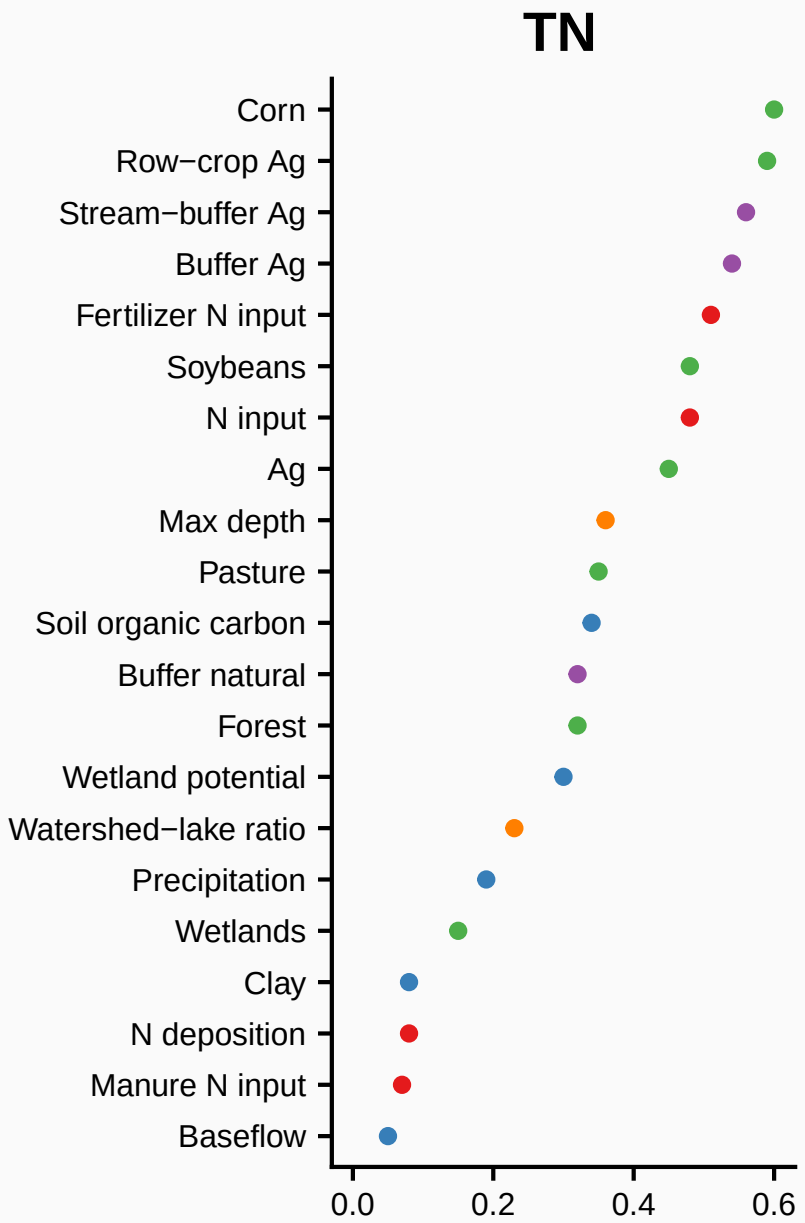
Watershed land use is a proxy for many different specific activities which are likely to be regionally variable.

(Burcher, Valett, and Benfield 2007)





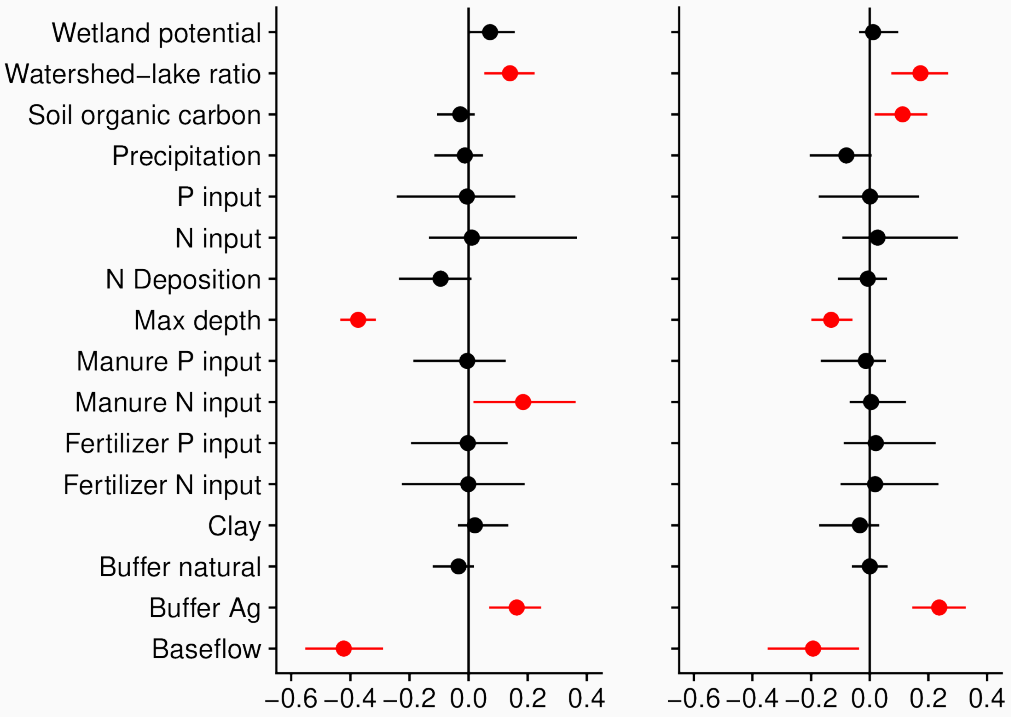

TP
Max depth
Baseflow
Ag
Soybeans
Wetlands
Clay
Buffer Ag
Buffer natural
Fertilizer P input
P input
Row−crop Ag
Stream−buffer Ag
Wetland potential
Watershed−lake ratio
Corn
Manure P input
Forest
Precipitation
Soil organic carbon
Pasture
0.0
0.2
0.4
0.6
Nutrient inputs
Nutrient transport
Land−use cover
Buffer composition
Lake


TN
Corn
Row−crop Ag
Stream−buffer Ag
Buffer Ag
Fertilizer N input
Soybeans
N input
Ag
Max depth
Pasture
Soil organic carbon
Buffer natural
Forest
Wetland potential
Watershed−lake ratio
Precipitation
Wetlands
Clay
N deposition
Manure N input
Baseflow
0.0
0.2
0.4
0.6

Results - Fixed effects

Baseflow and Max depth had a strong influence on predicted TP concentrations.

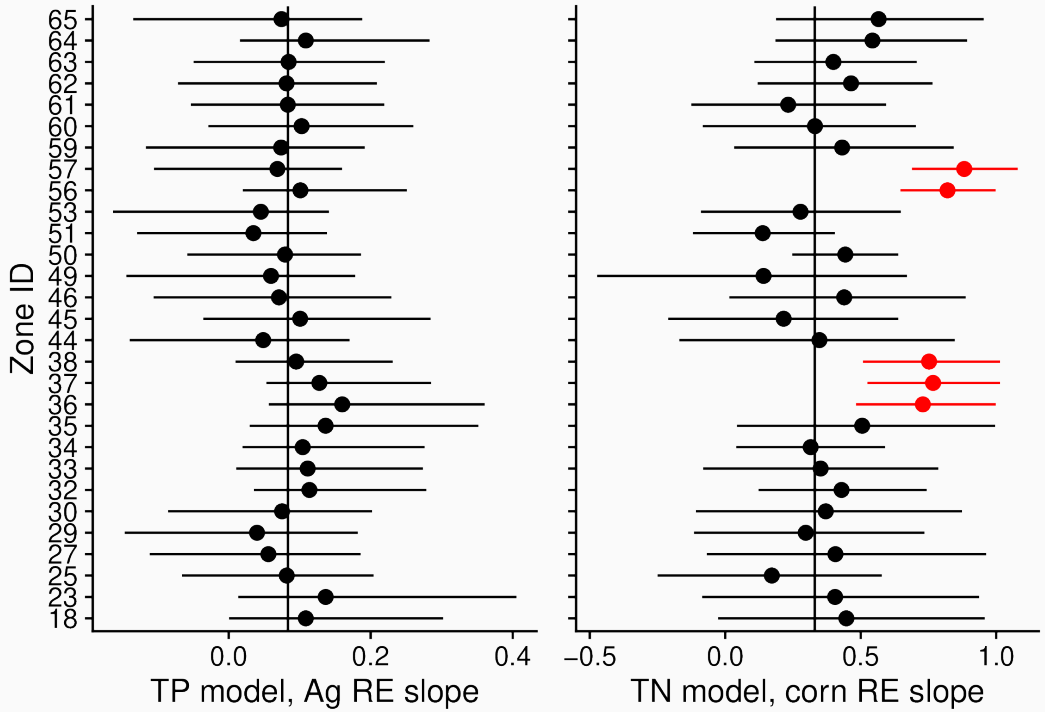
Buffer Ag land had a stronger influence on predicted TN concentrations relative to TP.



Results - Regionally varying effects

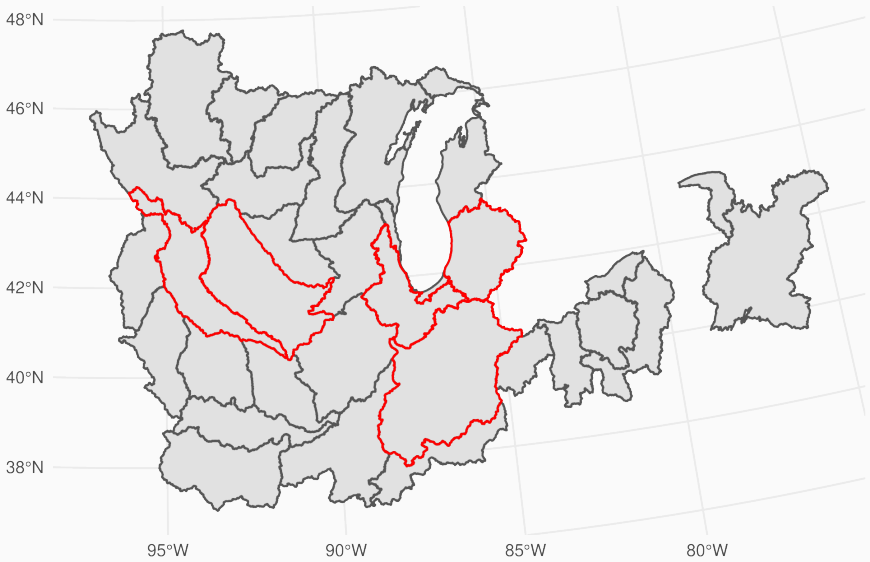
No evidence for spatial variation in the relationship between watershed Ag land use and TP.

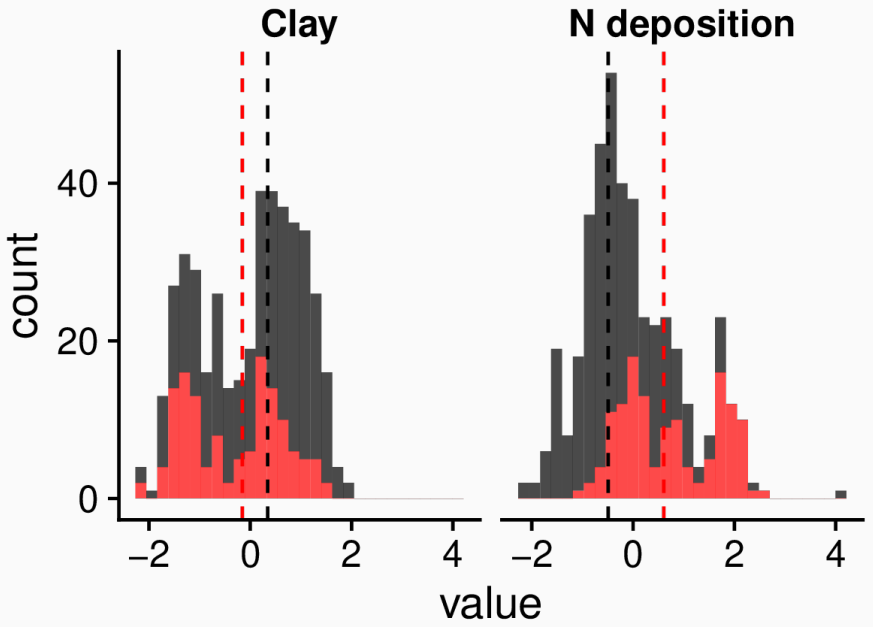
Several regions appear to be more sensitive to watershed corn land use cover.



Results - TN Model

Ag sensitive regions have lower soil clay content and higher N deposition rates.





Conclusions

1. Are more granular measures of Ag activity related to lake water quality (TN, TP) across hundreds of lakes and their watersheds?

Yes, both lake TP and lake TN were related to granular measures of Ag activity.

But, specific crop land use and riparian buffer composition was more influential in the lake TN models.

2. Do relationships between Ag activities and lake water quality vary spatially among hydrologic and climatic regions?

Yes, in the case of lake TN concentrations.

Methods - Data

Inputs - Fertilizer and manure applications
Land use - Ag, Pasture, Row crop, Corn, Soybeans, N-fixers, Small grains
Transport - Baseflow, Soil characteristics, Precipitation
Buffers - See *Land use*
Lake - Max depth, Area, etc.

References

Burcher, C. L., H. M. Valett, and E. F. Benfield. 2007. “THE LAND-COVER CASCADE: RELATIONSHIPS COUPLING LAND AND WATER.” *Ecology* 88 (1): 228–42. https://doi.org/10.1890/0012-9658(2007)88[228:TLCRCL]2.0.CO;2.

Collins, Sarah M., Samantha K. Oliver, Jean-Francois Lapierre, Emily H. Stanley, John R. Jones, Tyler Wagner, and Patricia A. Soranno. 2017. “Lake Nutrient Stoichiometry Is Less Predictable Than Nutrient Concentrations at Regional and Sub-Continental Scales.” *Ecological Applications* 27 (5): 1529–40. https://doi.org/10.1002/eap.1545.