

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

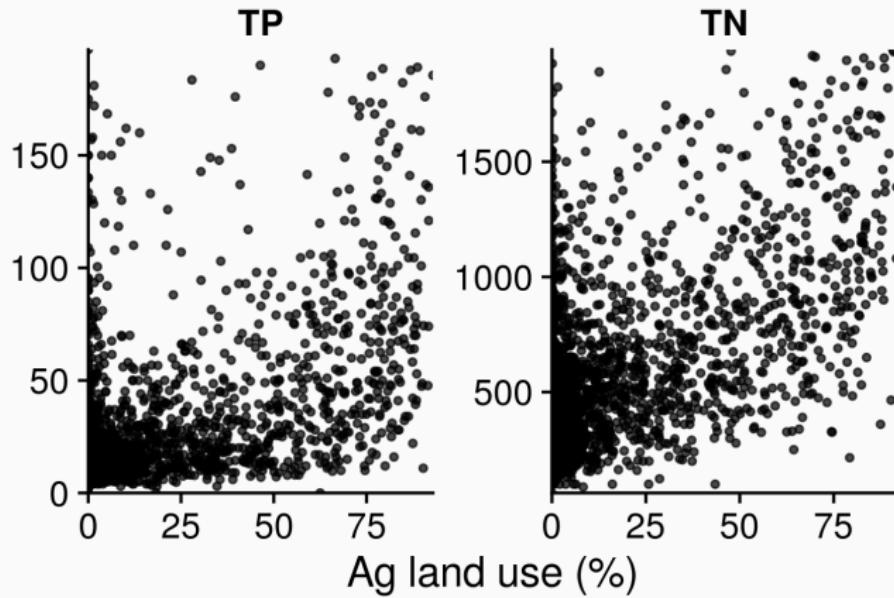
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Introduction

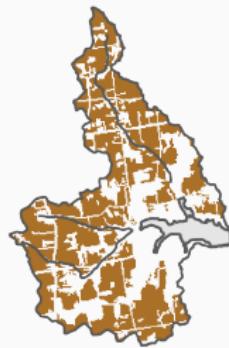
Ag land-use is associated with increased nutrient loading to lakes and higher nutrient concentrations.



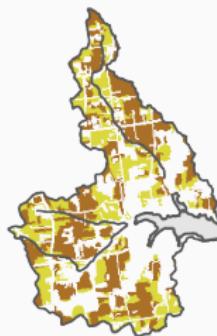
Background

Ag land-use is an aggregated measure that may mask underlying relationships.

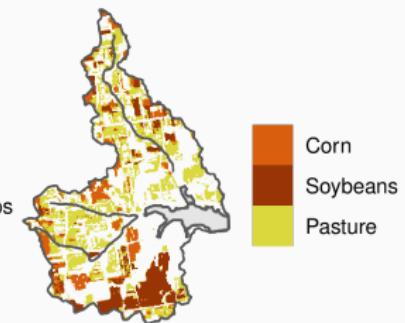
Total Ag



Ag Cover Type



Individual Crops

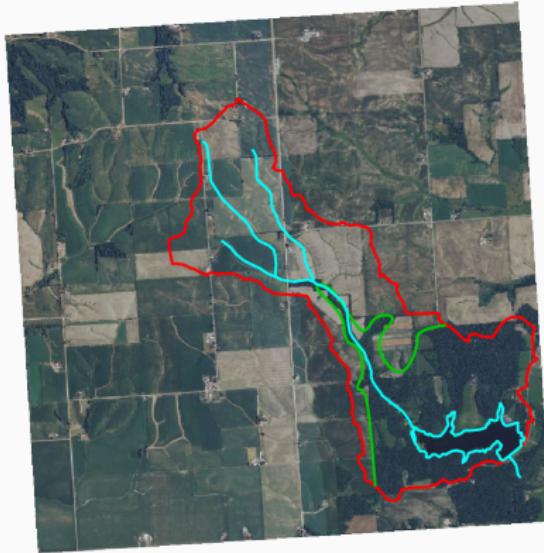


- Corn
- Soybeans
- Pasture

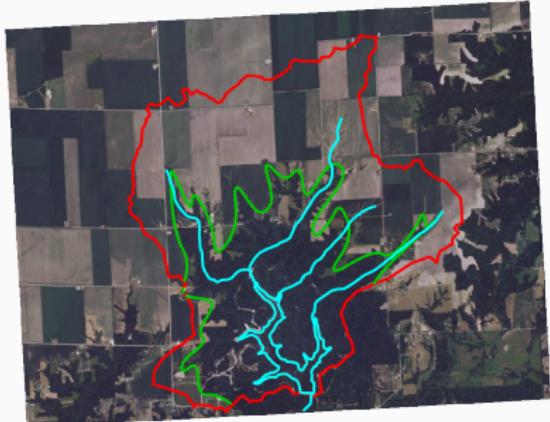
Background

Watershed land-use summaries are spatially coarse measures that may mask underlying relationships.

Lake Carlton – IL



Argyle Lake – IL



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

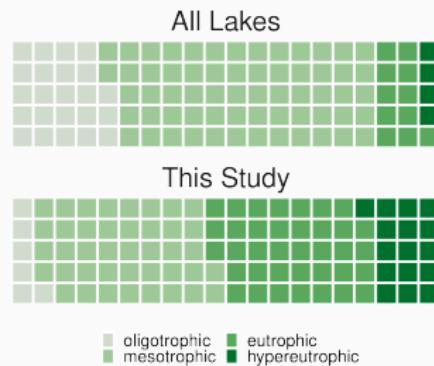
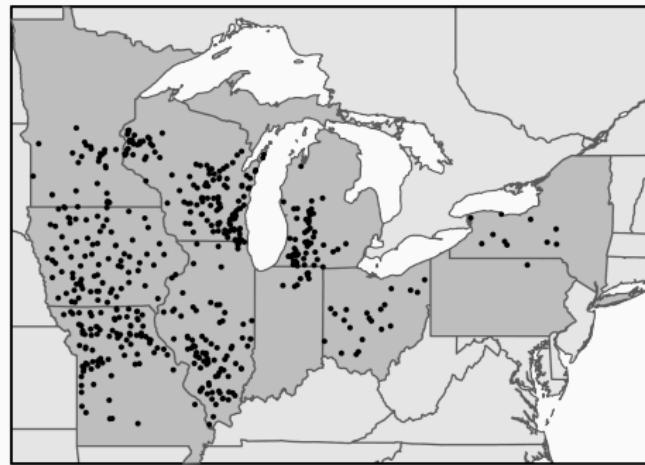
What are some things we've learned from fine scale, granular-data studies?

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 Ag activities and lake water quality vary spatially among hydrologic and climatic regions?**

Methods - 500 lake catchments



Our study lakes have high Ag land use (> 40%).

Our study lakes are more often eutrophic relative to lakes in general.

Methods - Granular Ag data



Nutrient inputs - Fertilizer and manure applications



Nutrient transport - Baseflow, soils, precipitation



Land-use cover - Specific crops, etc.



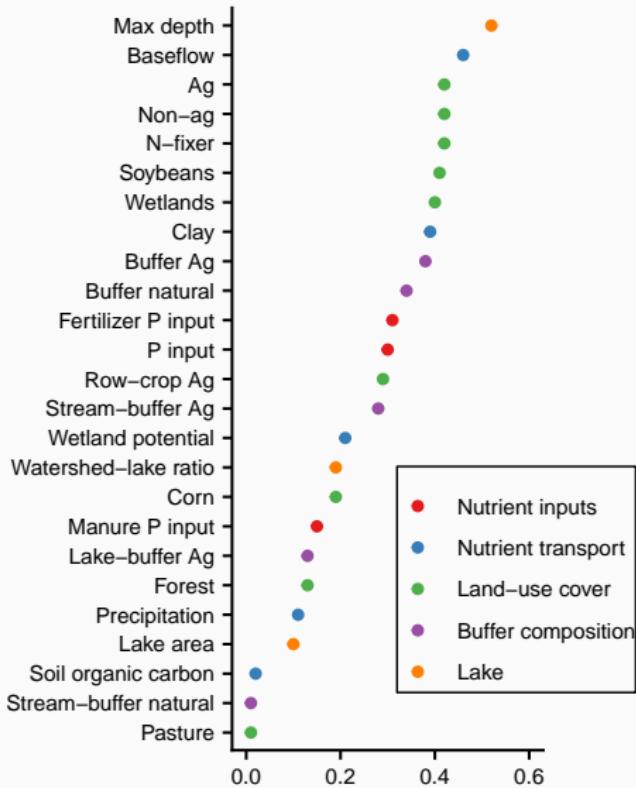
Buffer composition - *Land-use cover*



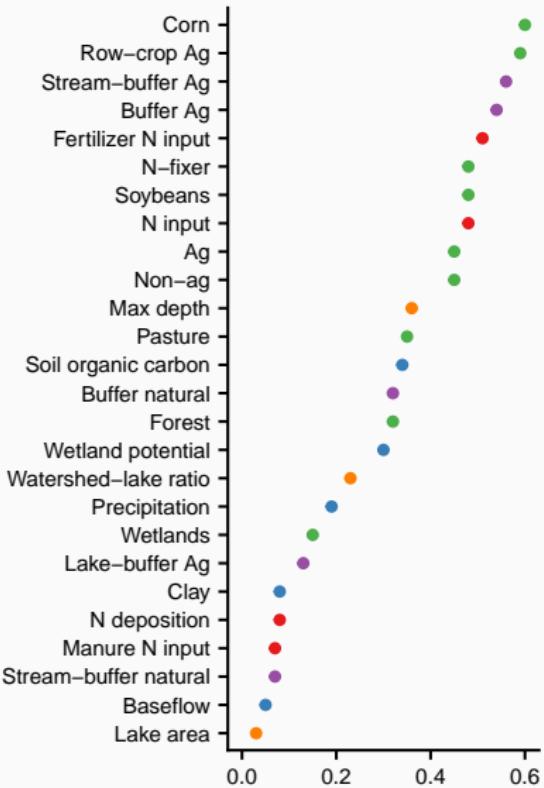
Lake characteristics - Depth, area, etc.

(Collins et al. 2017)

TP



TN



Methods - Statistical modelling

Build a multivariate model to explain nutrients in lakes
that is:

1. Informative - Allows for interpretation of variable importance

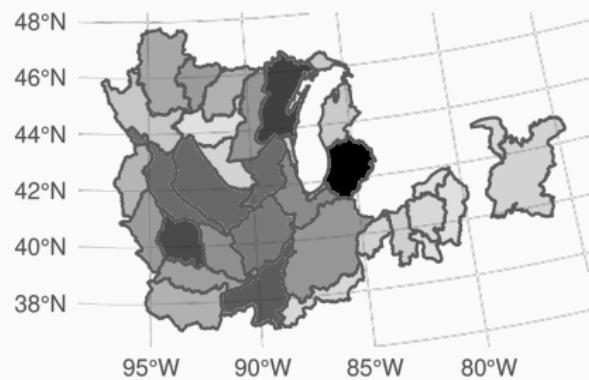
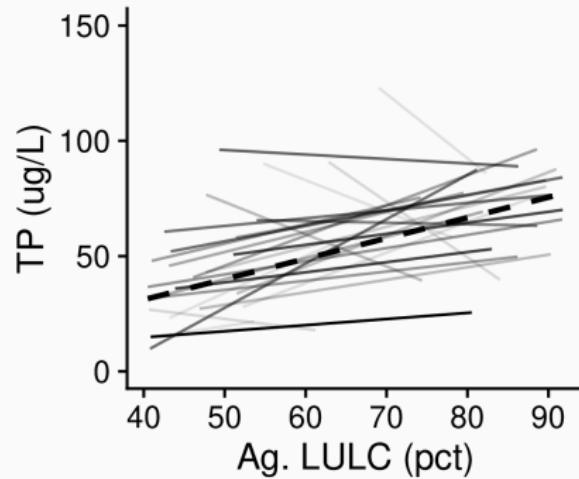
All predictors were treated as global (fixed) effects except for watershed land-use which was treated as spatially varying.

Model selection by leave-one-out cross validation to arrive at the “best” watershed land use predictor.

Methods - Regression Modelling

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

(Burcher, Valett, and Benfield 2007)



Methods - Statistical modelling

Build a multivariate model to explain nutrients in lakes
that is:

2. Reliable - Provides an estimate of parameter uncertainty

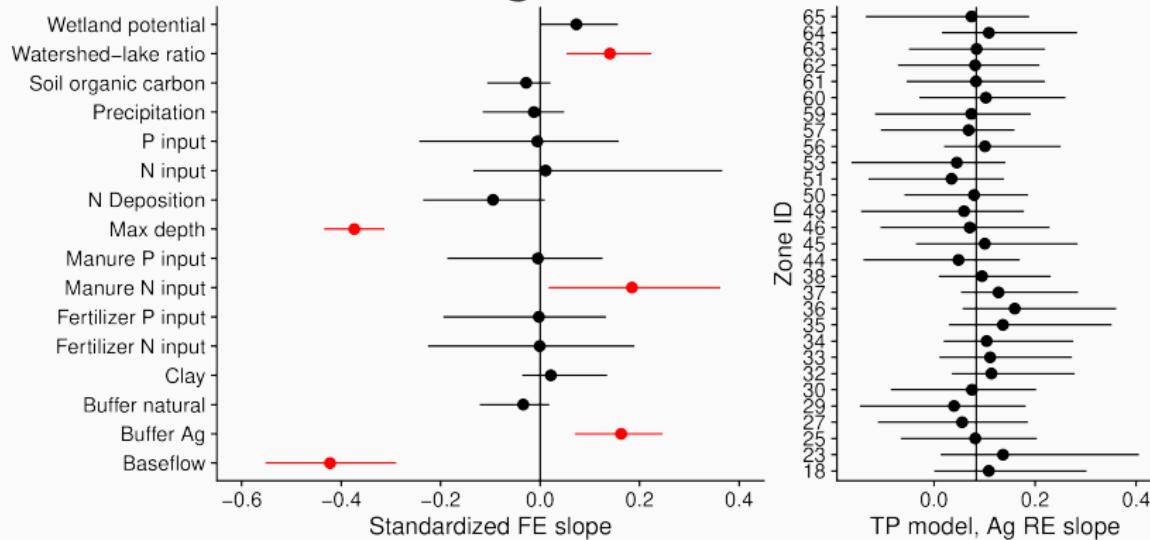
Fit model in a Bayesian framework where predictor coefficients are given “horseshoe” priors.

[Image of a horseshoe prior?]

Results - TP Model

Several fixed effect coefficients like Baseflow and Max depth had a strong influence on predicted TP concentrations.

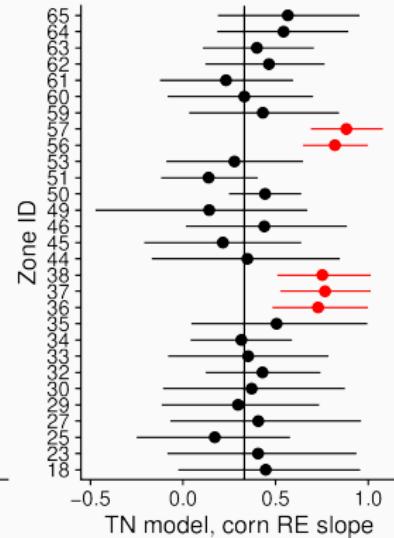
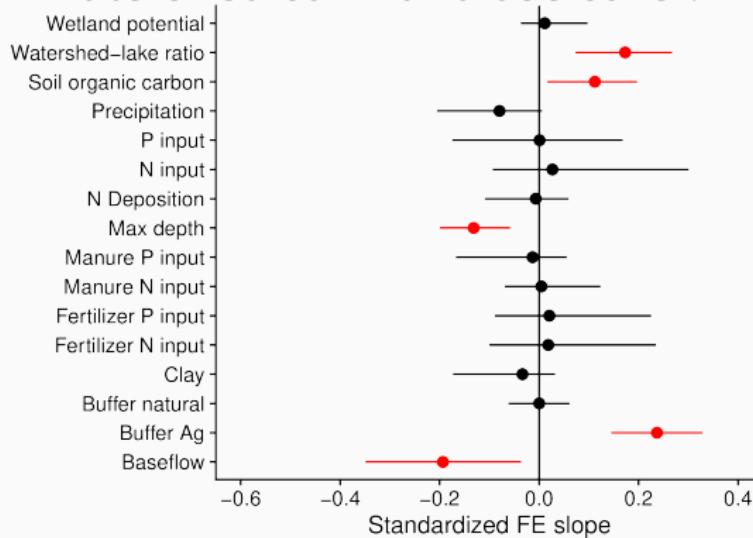
No evidence for spatial variation in the relationship between watershed Ag land use and TP.



Results - TN Model

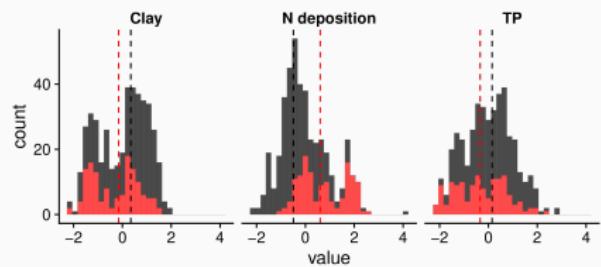
Few fixed effect coefficients had a strong influence on predicted TN concentrations.

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



Results - TN Model

Regions that are Ag sensitive appear to have lower soil clay content, higher N deposition, and lower TP concentrations.



Discussion

Lake TN in highlighted regions may be more sensitive to Ag because:

Fields in these regions have more direct drainage due to higher prevalence of wetland soils.

Lakes in these regions are P limited so excess TN accumulates in the water column (Filstrup and Downing 2017)

Lakes in these regions are less hypereutrophic (Wagner et al. 2011)

Lakes in these regions are affected by an interaction among multiple land use types.

Conclusions

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

Both lake TP and lake TN were related to granular measures of Ag activity.

Lake TN concentration was related to watershed corn cover and riparian buffer composition.

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

The relationship between lake TN and land-use cover was spatially variable.

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](https://doi.org/10.1890/0012-9658(2007)88[228:TLCRCL]2.0.CO;2).
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- Filstrup, Christopher T., and John A. Downing. 2017. "Relationship of Chlorophyll to Phosphorus and Nitrogen in Nutrient-Rich Lakes." *Inland Waters* 7 (4): 385-400. <https://doi.org/10.1080/20442041.2017.1375176>.
- Wagner, Tyler, Patricia A. Soranno, Katherine E. Webster, and Kendra Spence Cheruvellil. 2011. "Landscape Drivers of Regional Variation in the Relationship Between Total Phosphorus and Chlorophyll in Lakes: Relationship Between Total Phosphorus and Chlorophyll." *Freshwater Biology* 56 (9): 1811-24.
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