

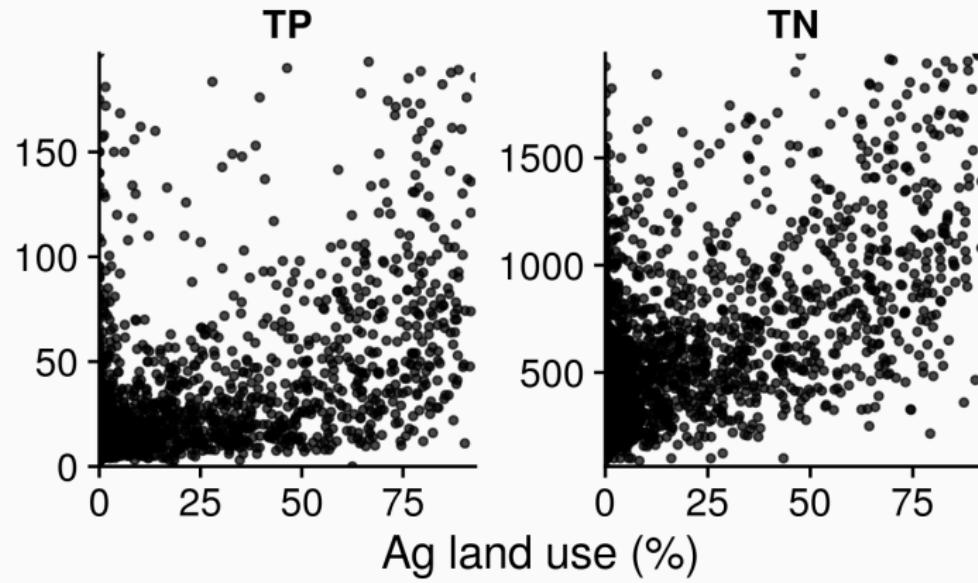
Analysis of 500 lake catchments reveals the relationship between crop type, fertilizer and manure inputs and lake nutrient concentrations

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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.



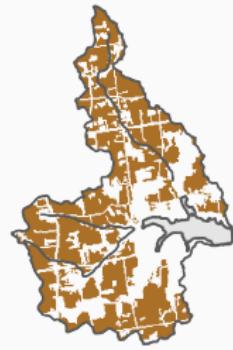
Buffer composition - *Land-use cover*



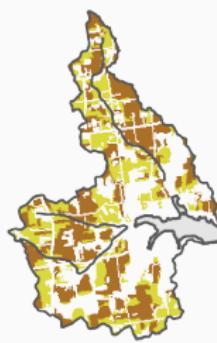
Lake characteristics - Depth, area, etc.

Background - Land-use cover

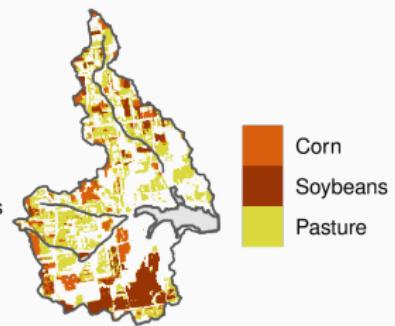
Total Ag



Ag Cover Type



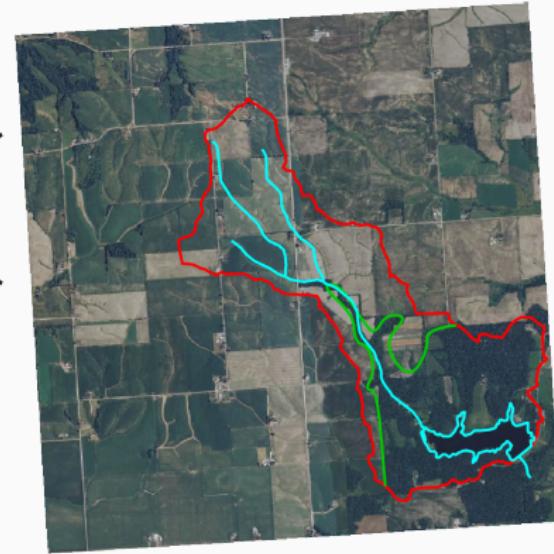
Individual Crops



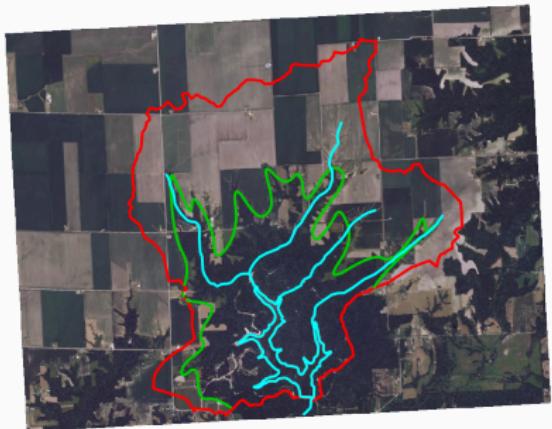
Background - Spatial resolution

Lake Carlton – IL

Poorly Buffered



Argyle Lake – IL



Background - Extent vs resolution

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

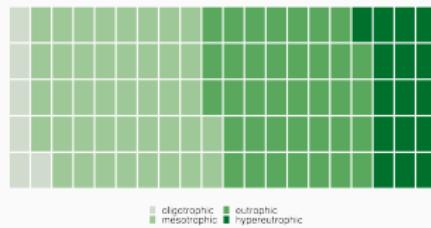
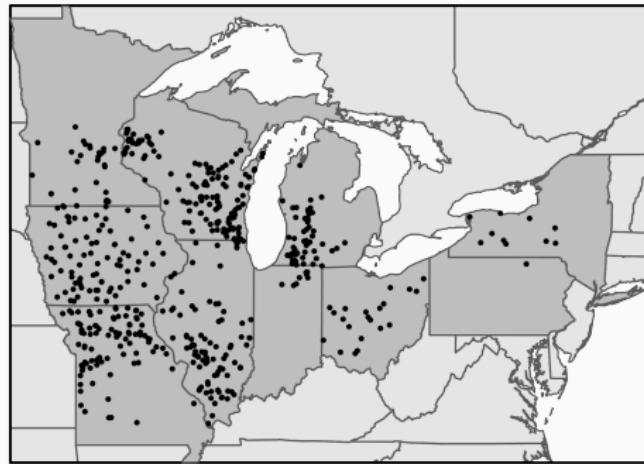
What are some things we've learned from fine scale, granular-data studies?

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 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.

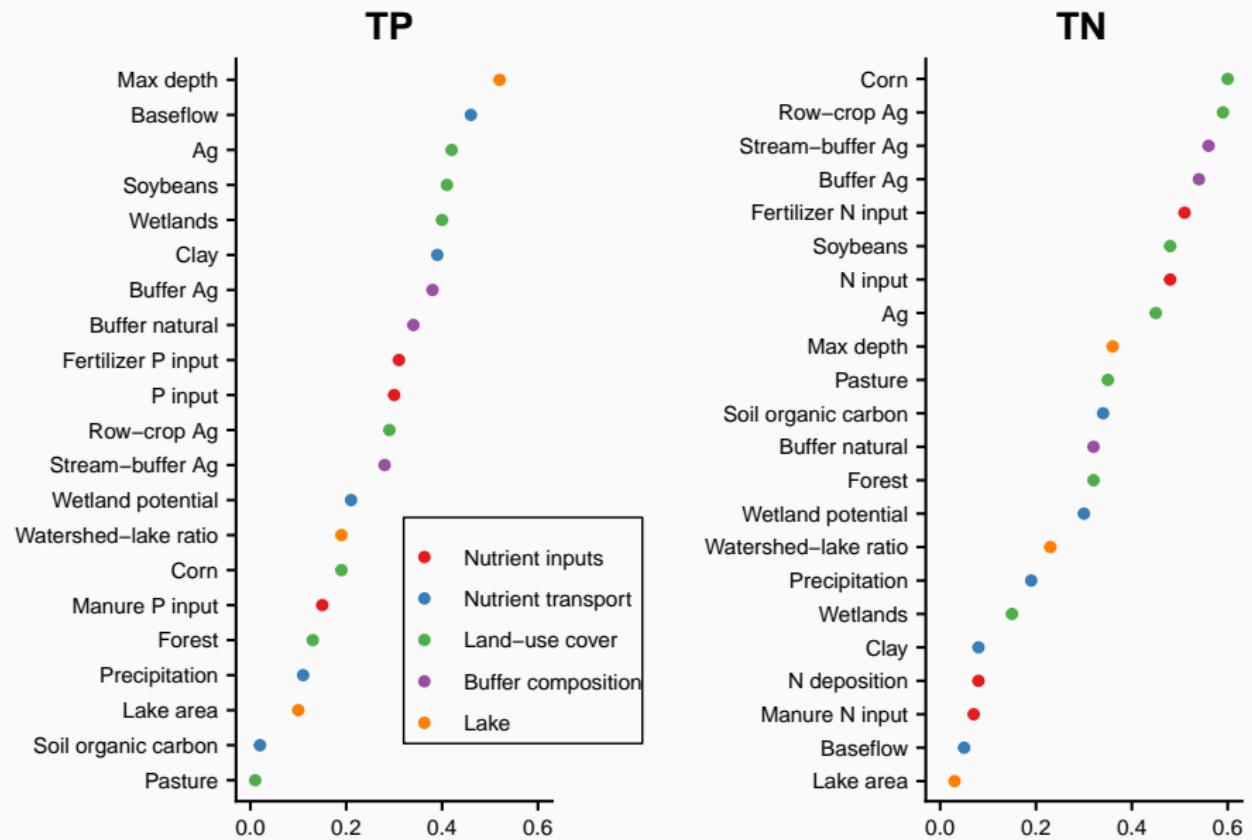


Buffer composition - *Land-use cover*



Lake characteristics - Depth, area, etc.

(Collins et al. 2017)



Methods - Statistical modelling

Build a multivariate model to explain nutrients in lakes that:

1. Tests for spatial variation in nutrient versus land use relationships

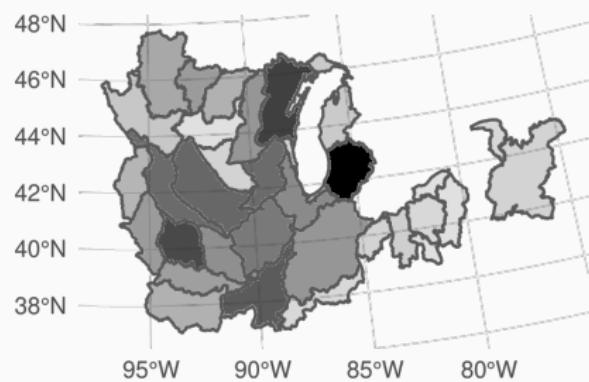
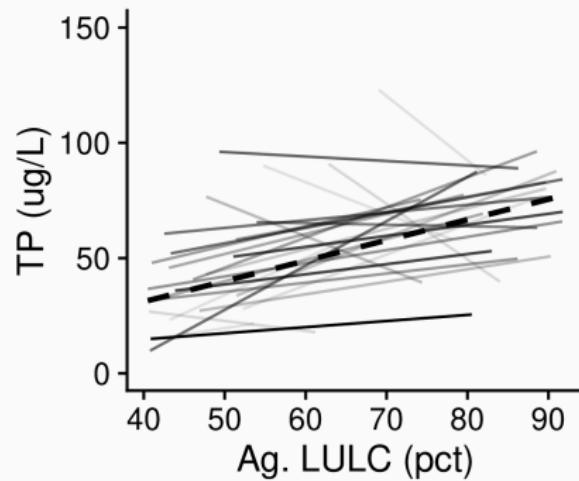
All predictors were treated as global (fixed) effects except for watershed land-use which was treated as spatially varying.

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)

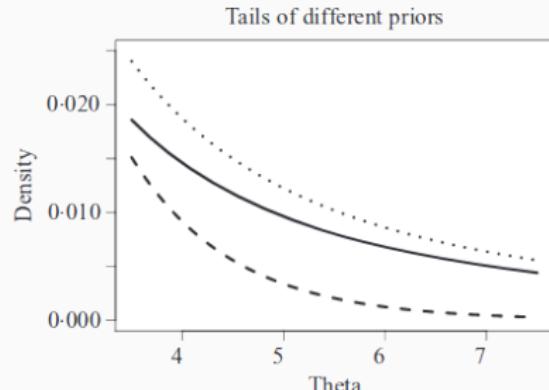
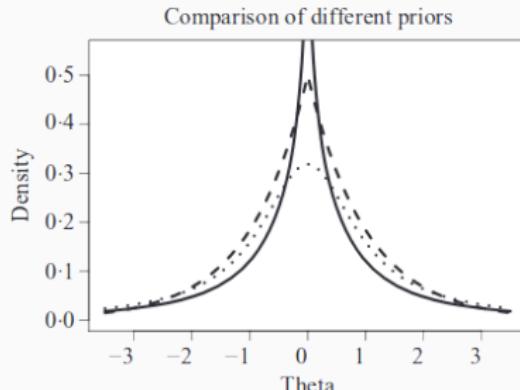


Methods - Statistical modelling

Build a multivariate model to explain nutrients in lakes
that:

2. Allows for interpretation of variable importance

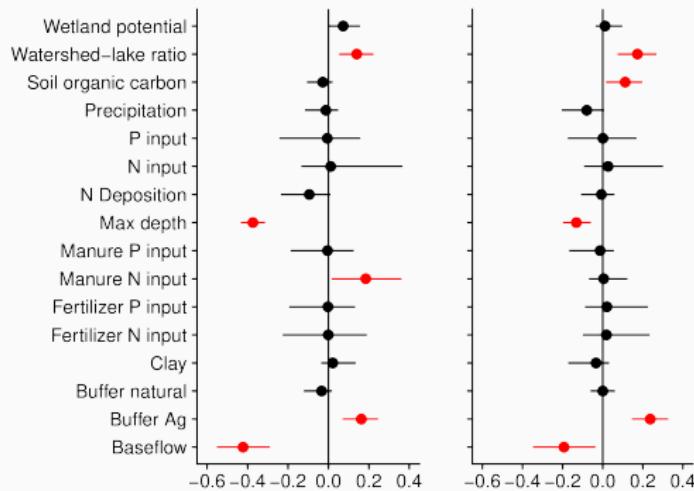
Fit model in a Bayesian framework where predictor coefficients are given "horseshoe" priors. (Carvalho, Polson, and Scott 2010)



Results - Fixed effects

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

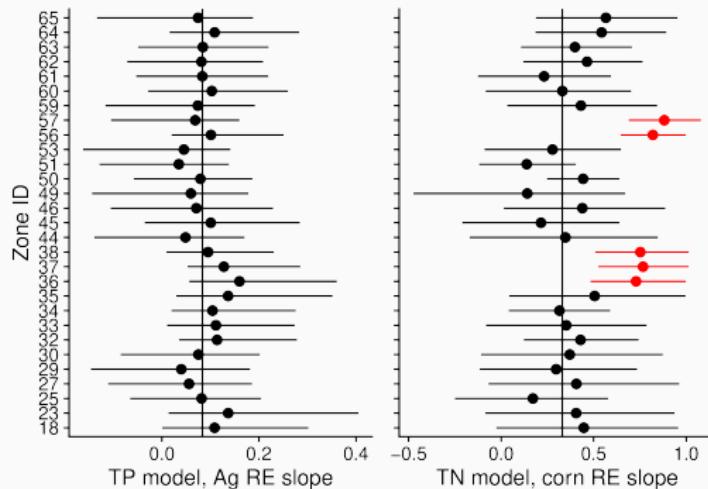
Buffer Ag land had a stronger influence on predicted TN concentrations relative to TP.



Results - Random effects

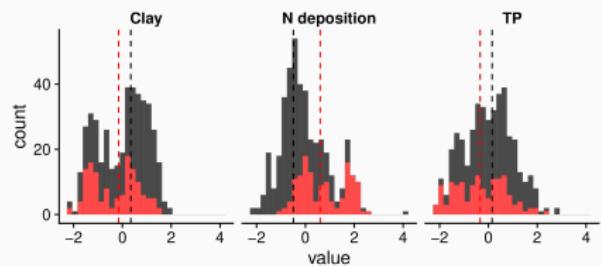
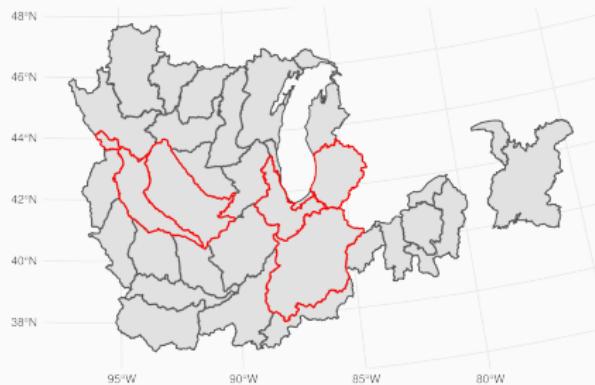
No evidence for spatial variation in the relationship between watershed Ag land use and TP.

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



Results - TN Model

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



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).
- Carvalho, Carlos M., Nicholas G. Polson, and James G. Scott. 2010. "The Horseshoe Estimator for Sparse Signals." *Biometrika* 97 (2): 465-80.
- 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>.