Rates of Nitrogen Transformations in Prairie Wetlands

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The Problem:

⇒ The Prairie Pothole Region (PPR) covers 780,000 km^2 throughout the Canadian prairies and into the upper-midwest United States, and plays a major role in feeding the growing world population (1)

⇒ Nitrogen (N) fertilizers are crucial for quality and quantity of crops, especially under stressed climate conditions

⇒ But, N carried in runoff can have detrimental impacts on water bodies including: surface and subsurface water quality degradation, eutrophication, health hazards, and reduction of biodiversity (2)

⇒ Wetlands are biogeochemical hotspots but, their role in N cycling remains largely understudied

The PPR contains 5 to 60 wetlands per km^2 (1)

Prairie wetlands produce 50-80% of the continents waterfowl (3), but over 71% of wetlands have already been destroyed (1,7)

The dry to semi-arid climate results in evapotranspiration exceeding precipitation (3)

This plays a role in the salinity of wetlands across in the region (4)

Wetlands are classified by their open water and vegetational zones. The hydroperiod, or the duration a wetland holds water, is described by wetland *permanence* classes (6)

Permanence class can range from ephemeral (holds water for days) to permanent (holds water all year round), with size increasing with class

Reduce, Remove, Recycle:

⇒ *Transformation* of N occurs through many biogeochemical processes within wetlands

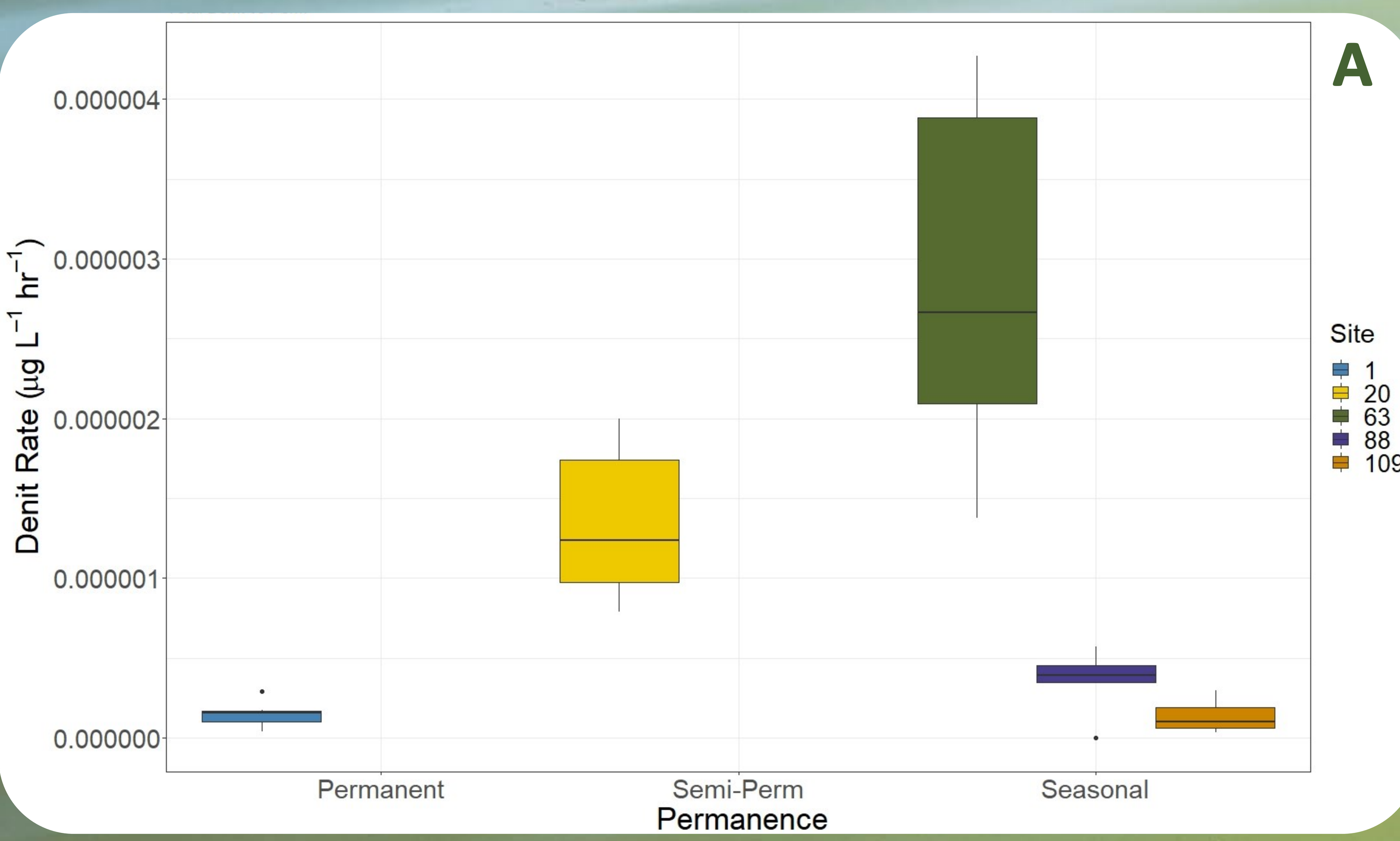
⇒ By exploring the rates of N cycling, along with the physical parameters and characteristics that may influence those rates, we can begin to understand what happens to N in wetlands

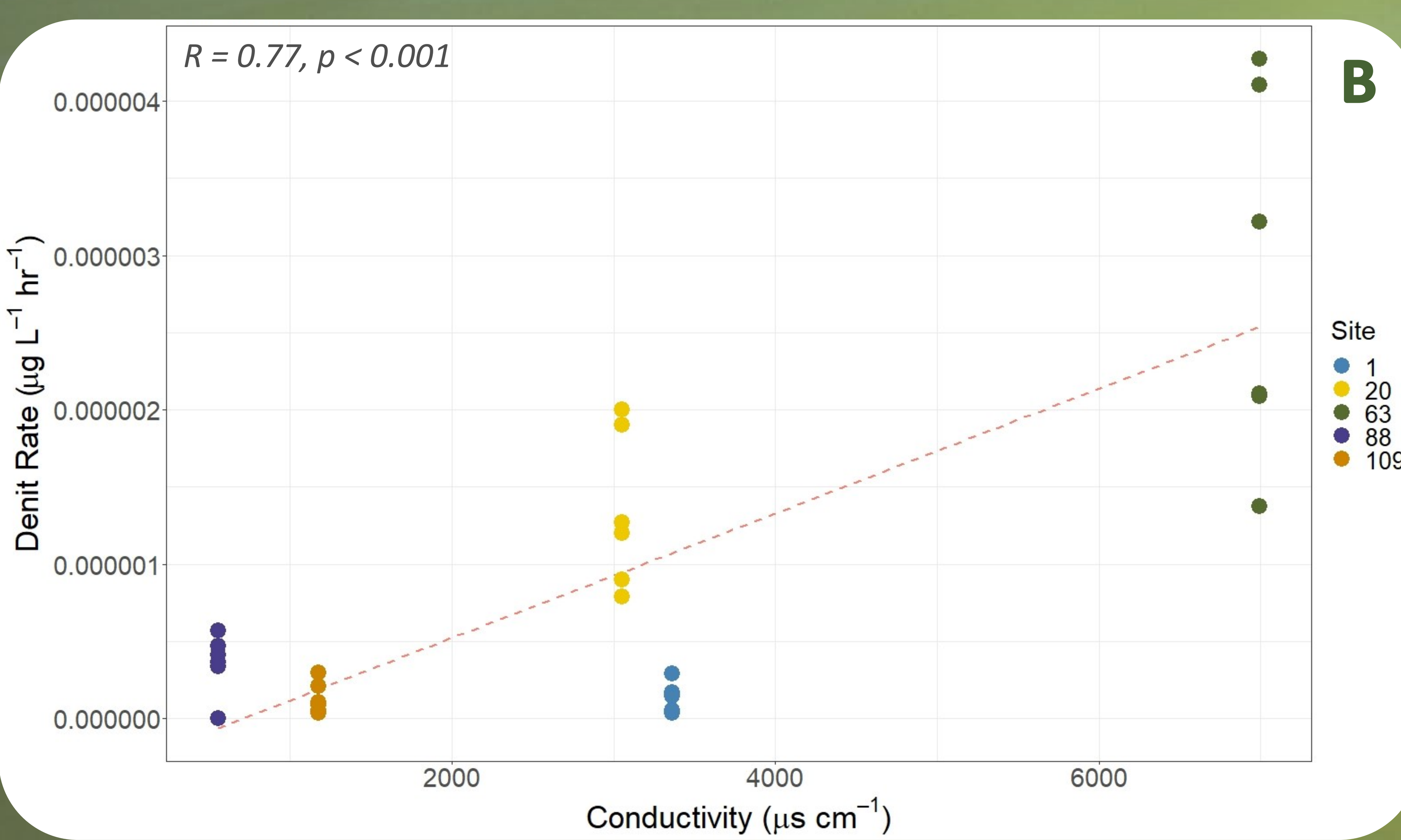
⇒ In this study, we quantified the rates of seasonal N uptake by algae and N removal through denitrification across different pond permanence classes

⇒ By investigating these processes we can begin to answer the fundamental, but complex question:

How can we balance food production with the preservation of our ecosystem services?

Denitrification

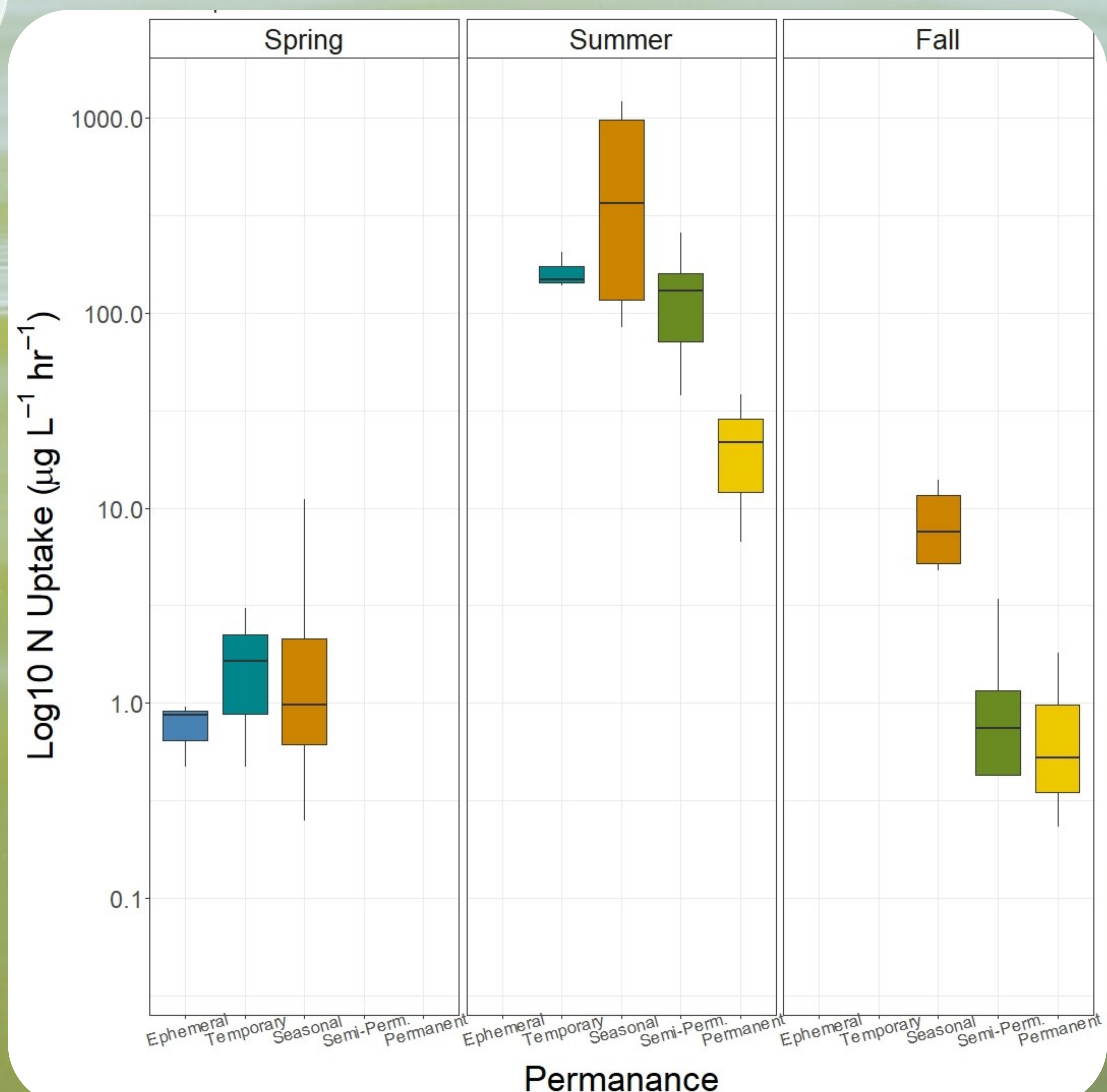




Denitrification: A) A boxplot displaying denitrification across pond permanence class, with rates reaching 4.27 x 10^{-6} ug N L^{-1} hr^{-1} and illustrating a similar, but more diverse denitrification potential in seasonal and semi-permanent wetlands.

B) A scatterplot displaying rate of denitrification across pond conductivity, showing the strong relationship with conductivity and denitrification activity.

Algal Uptake



Algal Uptake: A boxplot displaying the N uptake rate (NO_3^-, NH_4^+, and urea) across pond permanence during different seasons. The highest rates of N occurred during summer in the seasonal and semi-permanent wetlands, with rates reaching 3400 µg N L^{-1} hr^{-1}, pointing to the importance of shorter-lived wetlands for N reduction.

Conclusion & Next Steps:

⇒ Both denitrification and algal uptake were found to be higher in seasonal or semi-permanent wetlands. Paradoxically, these wetlands feature a short hydroperiod and are the most threatened by drainage and land modification

⇒ These results illuminate the need for further research into wetland N cycling, including exploration into other processes, such as our additional research into DNRA, especially when considering consolidated drainage and related policies

⇒ By developing an integrative understanding of a broad suite of processes, we can begin to understand the capacity at which wetland ponds may recycle, release, or retain N and contribute to the resilience of the PPR

Application

This research can further be used:

⇒ For more informed and sustainable decisions made by producers, managers, agencies, and government personnel

⇒ To guide the prediction of N cycling dynamics in wetlands of different permanence, and provide improved nutrient budgets across the prairies

⇒ To supply information for future integrative modelling exercises and programs to contribute to a better understanding of wetland biogeochemistry

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References: [1] National Wetlands Working Group (1997), [2] Saunders and Kalff (2001), [3] Batt et al. (1989), [4] Biswas et al. (2012), [5] LaBaugh et al. (2018), [6] Doherty et al. (2013), [7] Montgomery et al. (2018)