Prairie Wetlands: Nutrient Sinks or Sources in Spring-Melt?

Emily Cavaliere*[1] and Helen Baulch[1]

Introduction

Nutrients can be washed out of wetlands to downstream environments where they can contribute to water quality problems. Nutrients may also be retained in wetlands.

Prairie wetlands experience dramatic temperature swings and changes in hydrological connectivity as the season shifts from winter to spring.

However, this period remains largely understudied.

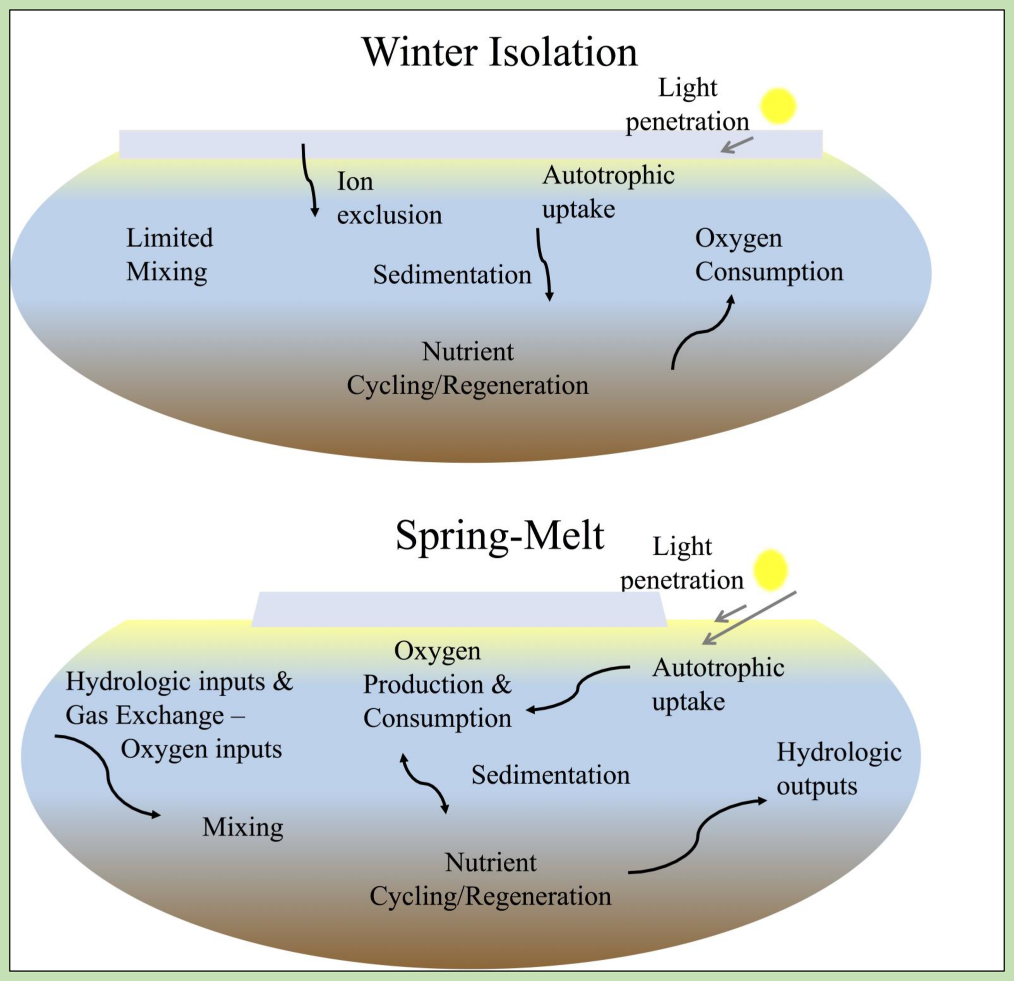

Fig. 1 Wetland ponds experience unique conditions in winter and spring-melt.

Research Questions & Methods

How do the winter and spring-melt conditions impact nutrient concentrations? Are winter and spring-melt periods an important time of nutrient change?

Here we undertook an intensive field campaign at St. Denis National Wildlife Area.

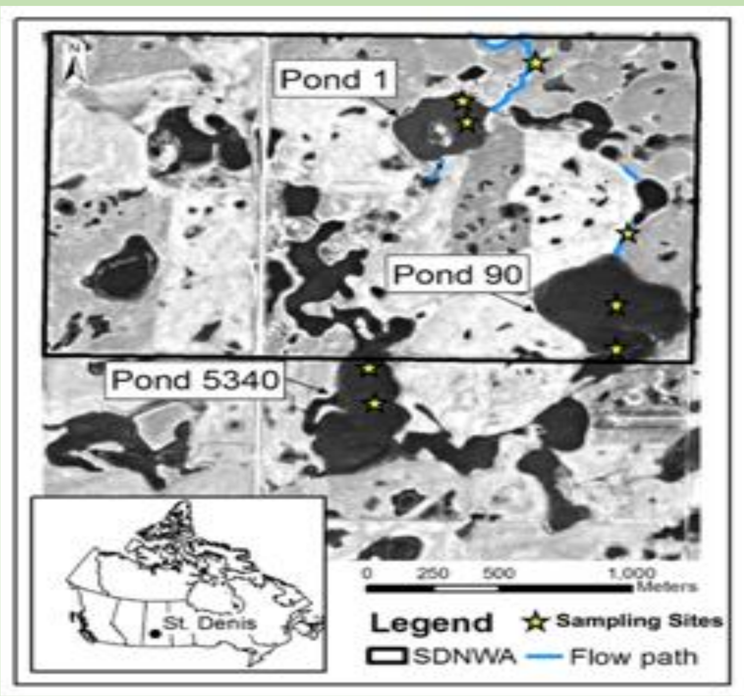

Fig. 2 St. Denis National Wildlife Area

Major Findings

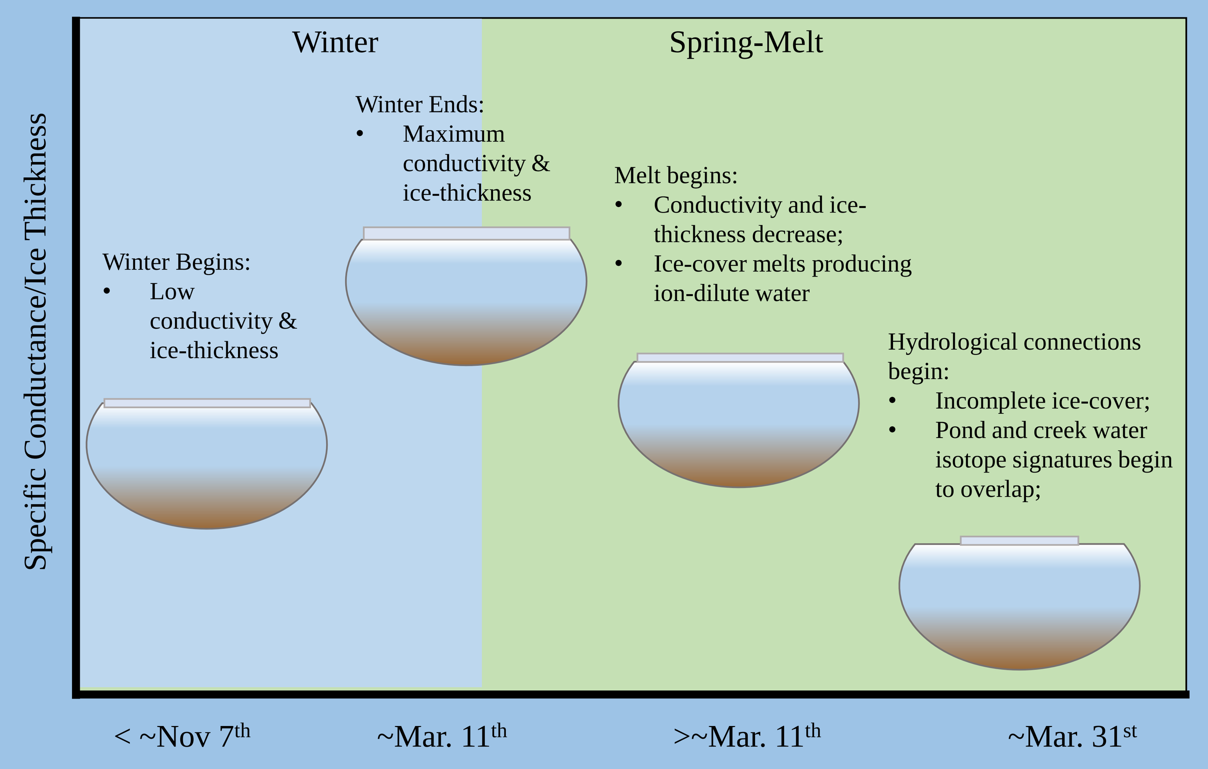

Fig. 3 Time series of photos from St. Denis Pond 5240 over the winter and spring of 2015.

Fig. 4 Conceptual diagram of conductivity and isotope signature shifts during the melt period of the 2014/2015 winter.

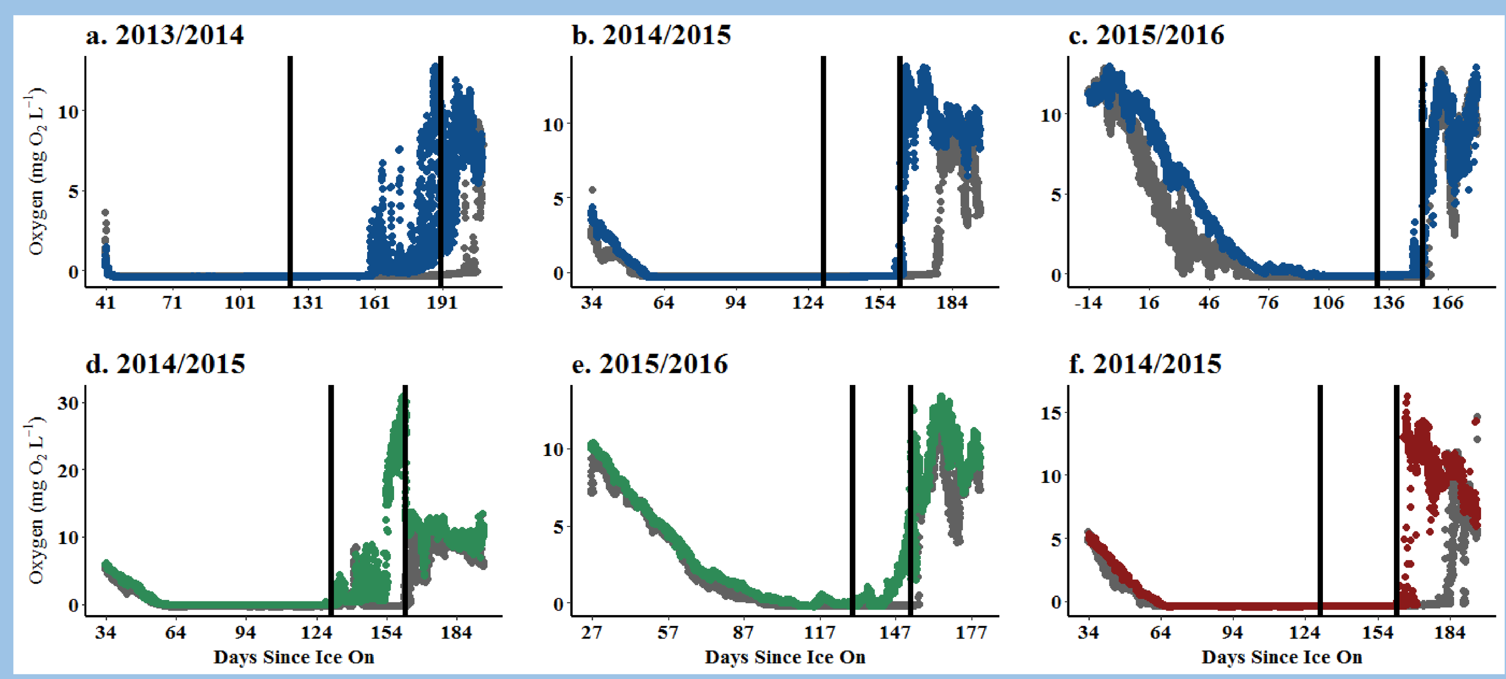

Fig. 5 Time series for measured dissolved oxygen over the three years. The top is either blue (Pond 1), green (Pond 90) or red (Pond 5340) and the bottom sensor is gray.

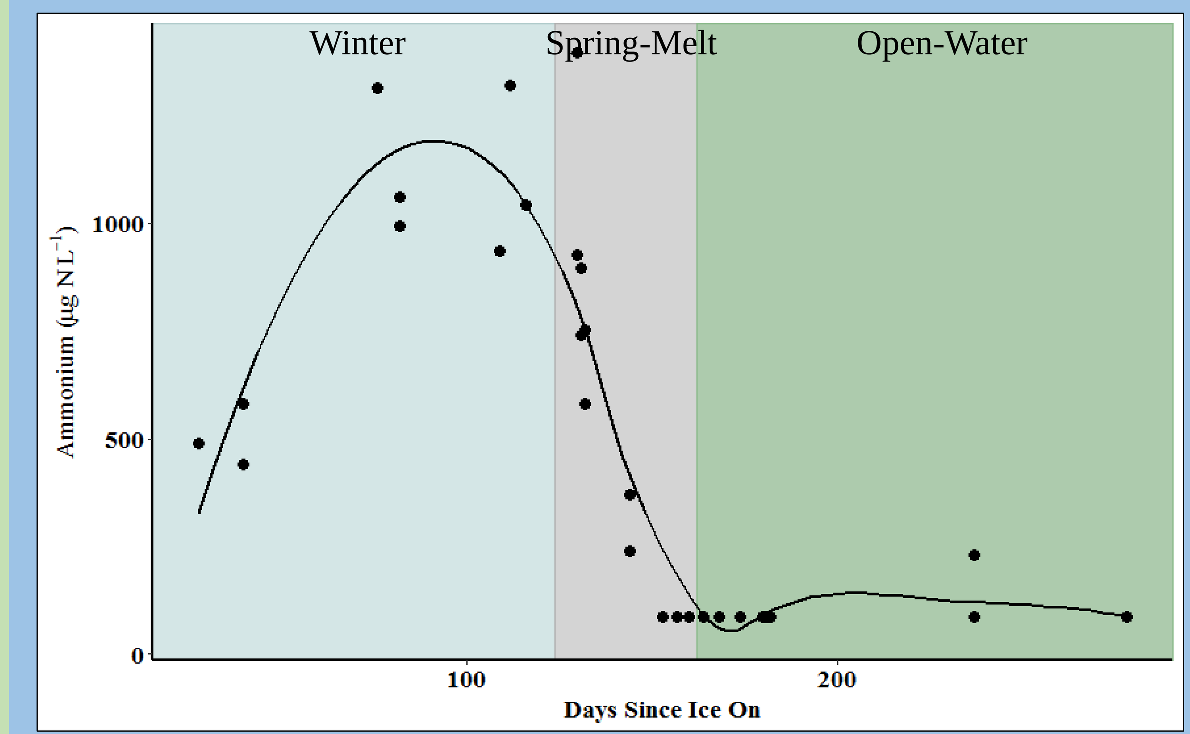

Fig. 6 Ammonium increase in winter and decline in spring-melt

Through winter, we observed the accumulation of ammonium (NH_4^+) and soluble reactive phosphorus (SRP) and concurrent declines in nitrate (NO_3^-) and oxygen concentrations.

The shift from winter to the onset of spring-melt prompts a dramatic physical change that alters oxygen, light, and solute concentrations.

At the onset of melt conditions NH_4^+ and SRP concentrations decline, despite nutrient-rich melt water inputs.

This shift in conditions is associated with the increased availability of light, and oxygen, which appear to cause a 'spring biogeochemical switch.'

Spring melt led to an average 36% decrease in SRP, and 50% decrease in NH_4^+.

At the same time, NH_4^+ uptake by plankton increased 18-fold from winter to melt, and mean NO_3^- uptake during the spring-melt period exceeded that of the open-water period.

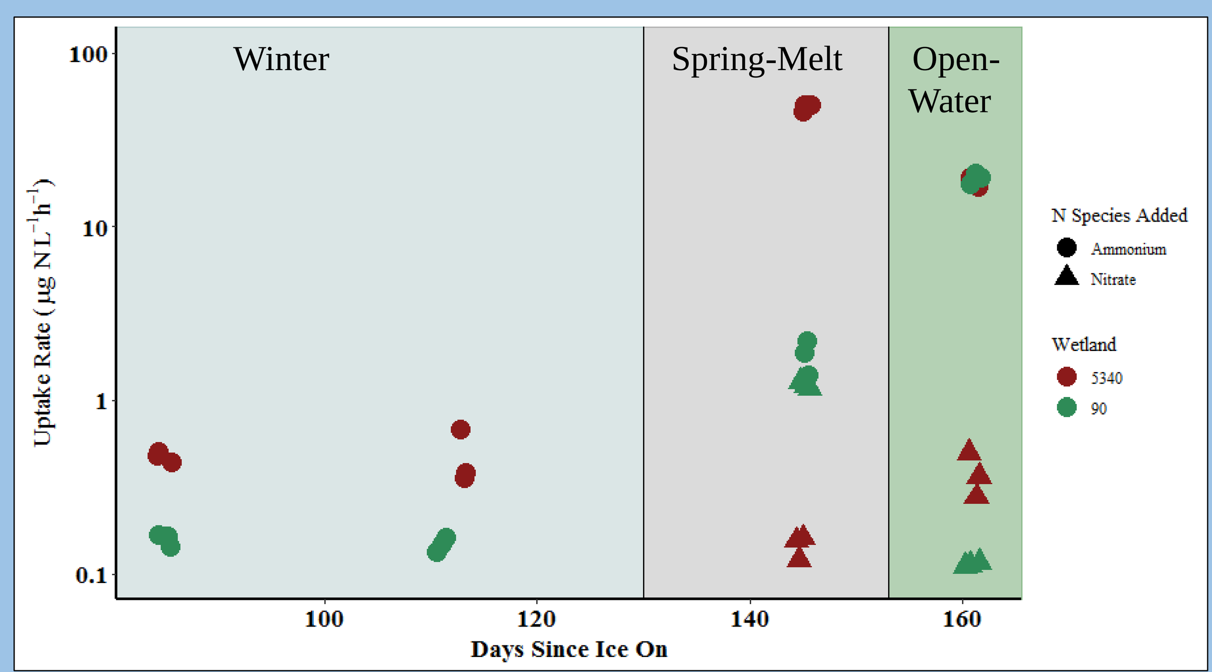

Fig. 7 Uptake rates in the winter, spring-melt and open-water seasons.

*emily.cavaliere@gmail.com [1]GIWS/GWF, University of Saskatchewan

Conclusions

The spring-melt period results in rapid changes in both nutrient concentrations and the rates of nitrogen uptake.

These wetland ponds act as a hot spot for nutrient transformations despite their small size.

These changes happen at a time when these ponds are mostly likely to be hydrologically connected – when snow is melting.

We conclude that the spring-melt period may help buffer some of the nutrient impacts to downstream ecosystems.

Future Work

More work is required to understand the fate of nutrients accumulated within biomass during spring bloom.

My future work will include modelling efforts to understand how pond numbers, size, depth and residence time affect nutrient cycling, and nutrient export.

With this we aim to better understand the potential effects of wetland drainage and consolidation.

Acknowledgements

The authors would like to acknowledge support of NSERC (Discovery Grant to HMB), Environment Canada Science Horizons Program, the Global Institute for Water Security and Canada Excellence Research Chair Funding, the School of Environment and Sustainability, the University of Saskatchewan, and the Teacher-Scholar Doctoral Fellowship for funding this project. For their support and advice, we would like to thank Drs. Rebecca North, Angela Bedard-Haughn, John-Mark Davies, and Cherie Westbrook. Further, we would like to acknowledge the following individuals for their extensive technical assistance, particularly those that aided in field work that took place in the extreme cold of Saskatchewan winter: Bruce Johnson, Dell Bayne, Jay Bauer, Britni Brenna, Cameron Hoggarth, Erin Hillis, Heather Wilson, Victor Sit, Kim Gilmour, Navjot Kaur, Rosa Brannen, Dr. Michael Kehoe, Dr. Chris Spence, Alyse Kambeitz, Katya Dobrovolskkava, Katy Nugent, Jeremy Kiss, Dr. Colin Whitfield, Sherry Olauson, Kate Wilson, Michelle Martel-Andre, Raea Gooding, Noel Galuschik, Zachary Keesey and all members of the Saskwatche Lab.

University of Saskatchewan School of Environment and Sustainability
NSERC CRSNG