Monitoring Nutrient Enrichment Impacts in Wetlands with PRS Probes

H. Deng[1], E. Bremer[1], L. J. Sheppard[2], K. M. Hoffman[3], B. Starzomski[3], T. Moore[4], and M. Wang[4]

[1] Western Ag Innovations, Inc.; [2] Centre for Ecology and Hydrology, Penicuik; [3] University of Victoria, Victoria; [4] McGill University, Montreal

Key words: PRS probe, Wetland, Nutrient enrichment,

Introduction

Wetland ecosystems are sensitive to nutrient enrichment due to naturally low nutrient levels, limitations to plant uptake and high mobility.

Ion exchange membranes, such as Plant Root Simulator (PRS™) probes, are useful for measuring soil nutrient bioavailability in situ with minimal disturbance.

Three recent studies that utilized PRS probes are presented to highlight the impact of nutrient enrichment in wetland system.

N enrichment in an ombrotrophic bog with different N forms

PRS-probes were used to measure the impact of 11 years of dry ammonia deposition (circa 6 g N m^{-2} yr^{-1}) with similar deposition doses as oxidised N (Sodium nitrate) or reduced N (Ammonium chloride), to an ombrotrophic bog, Whim, in southern Scotland.

Dry ammonia deposition has completely transformed the vegetation, whereas wet deposited N has only caused dramatic vegetation changes as oxidised N in the presence of additional PK.

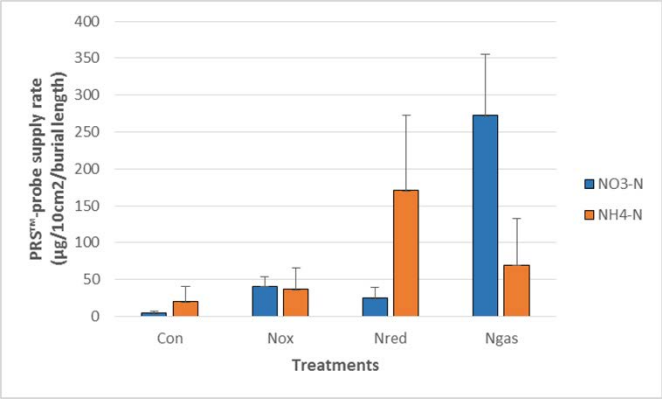

Figure 1. N measured in treatment treated with $NaNO_3$ (Nox), NH_4Cl (Nred) and Ammonia (Ngas) as PRS™-probe supply rate

Dry ammonia deposition has led to a significant increase in NO_3^--N supply rate. While large change in NH_4^+-N was also observed in plots with wet application of NH_4Cl (Figure 1). This maybe attribute to the vegetation changes induced by the deposition of different N forms.

Effect of nutrient enrichment in open blanket bogs

PRS probes were used to understand the impact of nutrient enrichment in minerotrophic bogs (Figure 2) on the central coast of British Columbia as part of a three-year NPK addition experiment where changes to soil microbial and plant communities were examined.

Figure 2. PRS probes installed in a minerotrophic bog.

Four nutrient treatments were applied: unamended control, N-enriched (8 urea/m^2), P-enriched (100 g triple superphosphate /m^2), and K-enriched (18 g muriate of potash/m^2). Two pairs of PRS-probes were installed in four replicates of each treatment from June 23 till September 10, 2013.

PRS-probes detected a large impact of nutrient enrichment for N, P and K: measurements varied by two orders of magnitude between treatments (Figure 3).

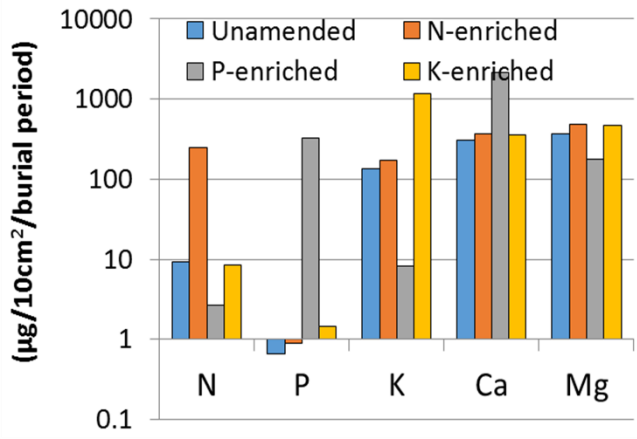

Figure 3. Effect of nutrient enrichment on PRS-probe N, P, K, Ca and Mg supply rates (logarithmic scale).

Long-term fertilization experiment at Mer Bleue Bog

PRS probes were used to understand the N, P, K availability in Mer Bleue, a boreal peatland ecosystem as affected by long-term fertilization and to interpret the nutrient uptake by shrubs and mosses.

Treatment applied were 2 controls (C1 and C2), N (NH_4NO_3)addition rate of 1.6, 3.2 and 6.4 g N m^{-2} yr^{-1} (5N, 10N and 20N), N addition with 5 g P m^{-2} yr^{-1} and 6.3 g K m^{-2} yr^{-1} as KH_2PO_4 (5NPK, 10NPK and 20NPK) and P, K only (PK).

The PRS probes were buried for 4 weeks in the beginning, mid and end of the growing season in 2012. Fertilization was conducted biweekly from the beginning of May to the end of August.

Fertilization had large effects on nutrient supply rates at Mer Bleue, especially for P and K addition (Figure 4).

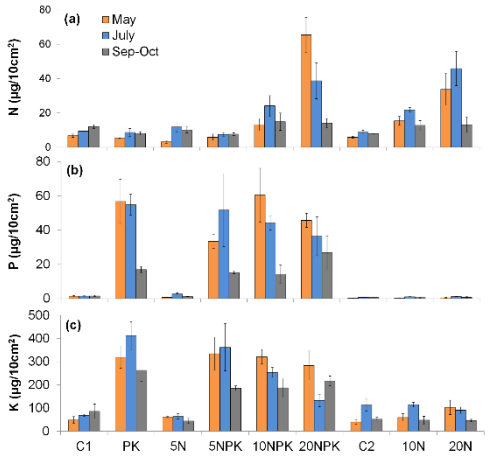

Figure 4. The seasonal pattern of nitrogen (a), phosphorus (b) and potassium (c) availability (μg/10cm^2/4 weeks) measured by PRS^{TM} probes in response to long-term fertilization (see background for treatment descriptions).

The nutrient enrichment effect detected was relatively large due to the continuous fertilization from May to August. The availability of N generally returned to the same level as controls, but P and K availabilities in P and K fertilized plots remained higher than the controls one and a half months after the last fertilization.

Conclusions

PRS probes can accurately measure the nutrient enrichment effect in wetland systems, taking into account various factors affect the nutrient supply. Using PRS probes to investigate impacts on temporal and spatial patterns would be useful.

Monitoring nutrient enrichment impacts in wetlands with PRS probes

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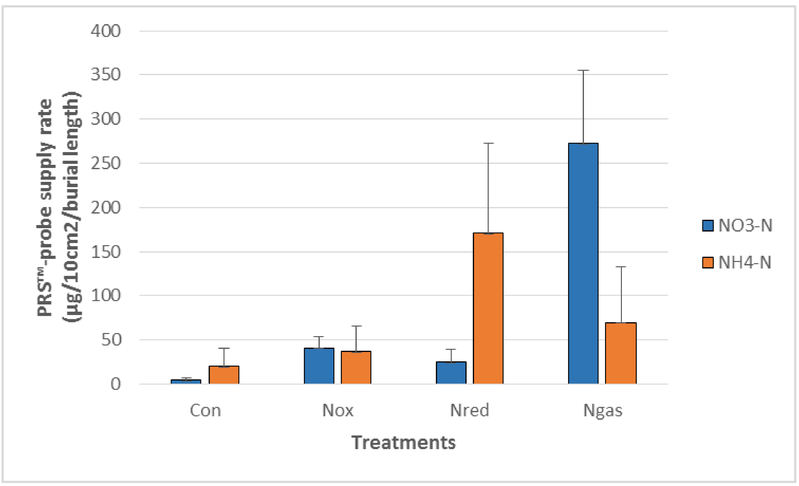

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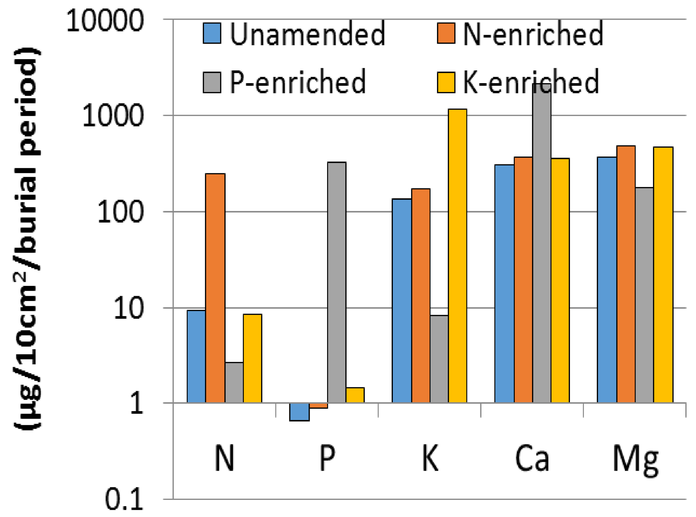

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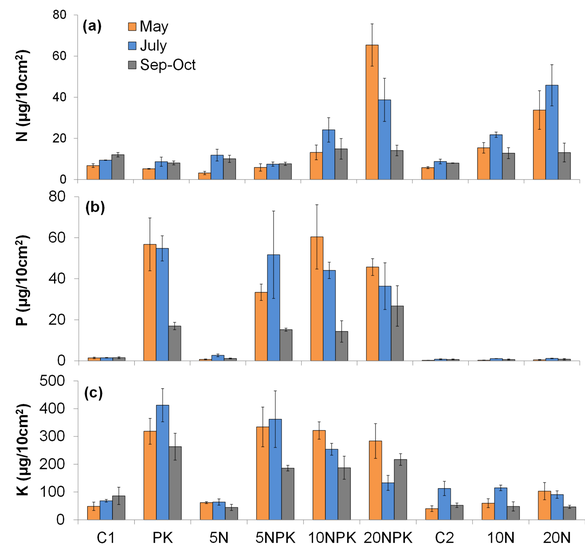

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Conclusions

- Nutrient enrichment in these wetland systems had a large impact on nutrient supply rates measured with PRS probes. These effects were greater than observed in most studies.
- Further studies would be useful to investigate impacts on temporal and spatial patterns.