

Nitrogen Inputs and Transfer in Northern Peatlands

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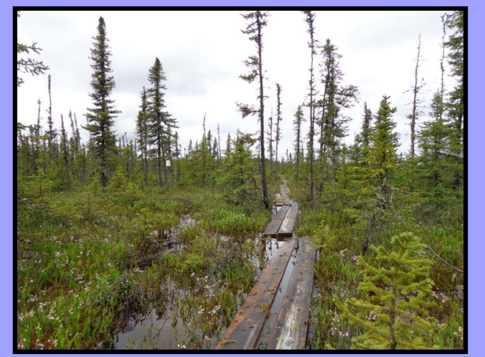
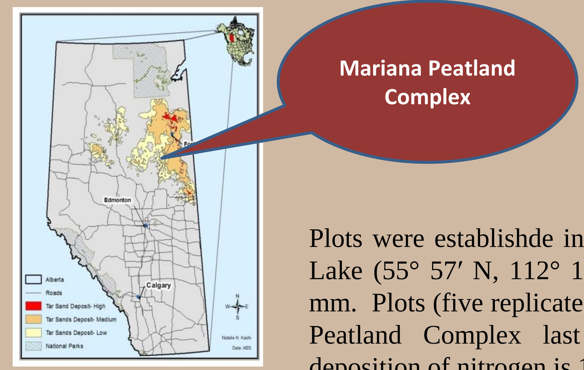


Introduction

- ***Sphagnum*** **mosses are often described as "gatekeepers," intercepting and competing with vascular plants for atmospherically deposited nutrients in ombrotrophic bogs (van Breemen, 1995; Rousk, 2014).**
- **Given relatively high rates of both N sequestration in peatlands and biological N fixation in *Sphagnum* mosses (up to > 30 kg N ha^{-1} yr^{-1} (Vile, 2014)), we investigated the fate of newly fixed N in a pristine bog in Alberta, Canada.**
- **We tracked newly fixed N from $^{15}N_2$ gas biologically fixed in *Sphagnum* mosses into tissues of two native vascular plant species, boreal cranberry (*Vaccinium oxycoccus*) and black spruce (*Picea mariana*).**

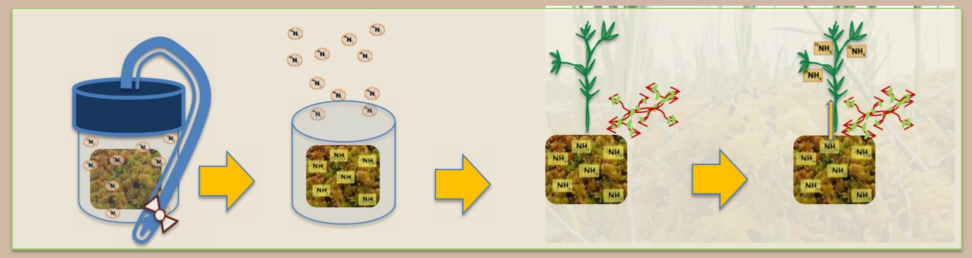
Study Site



Plots were establishde in pristine bog in east central Alberta, Canada; near Mariana Lake (55° 57′ N, 112° 1′ W). Mean annual precipitation in Alberta is less than 450 mm. Plots (five replicates, each 3 X 2 m) were set up in the summer of 2012. Mariana Peatland Complex last burned approximately 60-100 years ago. Background deposition of nitrogen is 1.1 to 2.6 kg N ha^{-1} yr^{-1} (Vile and Wieder, *unpublished data*).

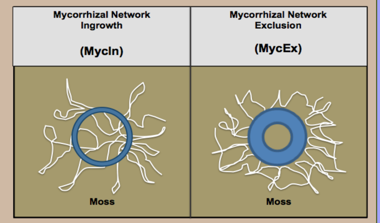
Methods

- ***Sphagnum*** **moss cores were collected from 2nd year water control and nitrogen addition plots (20 kg N ha^{-1} yr^{-1} in the form of NH_4NO_3 applied twice monthly by backpack weed sprayer) at the Mariana Peatland Complex for $^{15}N_2$ labeling.**



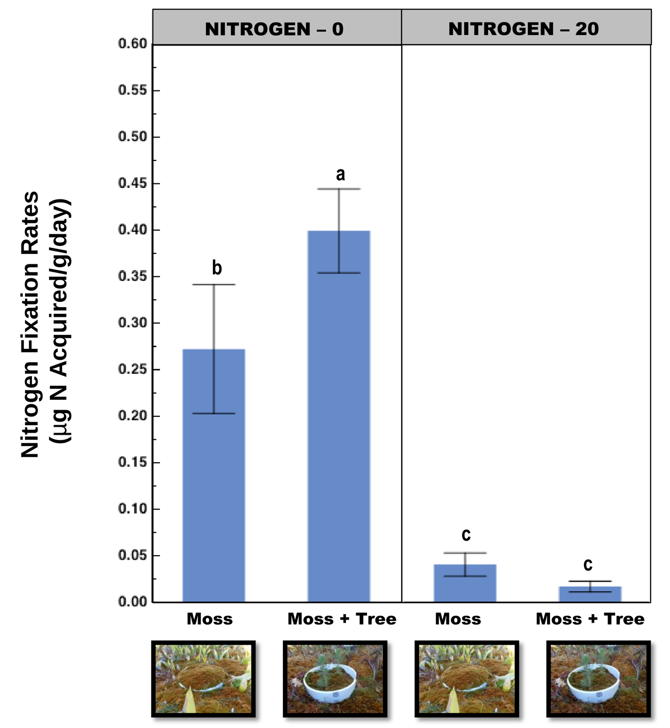
- ***Sphagnum*** **cores were placed in 500 ml canning jars with airtight lids containing a port for gas sampling. 30 ml of air was evacuated from the headspace and replaced with an equal volume of 98% pure $^{15}N_2$ gas. Mosses were then incubated outdoors under partial shade at the Meanook Research Station in Athabasca, Canada for 40 hours *in-vitro* in mid-July 2013.**

- **^{15}N-labeled moss cores were then returned to the field where Black Spruce (*Picea mariana*) and Cranberry (*Vaccinium oxycoccus*) were planted in the live labeled mosses and grown *in-situ* for one and two months each.**
- **Half of these cores were placed in mesh bags to allow in–growth of peatland biota including mycorrhizal networks (MycIn). The other labeled cores were excluded from the mycorrhizal network (MycEx) with 1 µm nylon filter fabric (Versapor ©, Pall Corporation).**

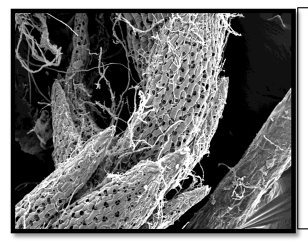


- **Additional *Picea mariana* and *Vaccinium oxycoccus* were planted ~12 cm outside (Out) of the labeled moss to investigate transfer out from the cores.**
- **Upon harvest all samples were immediately dried for analysis of ^{15}N concentrations in roots and leaves (separately) of *Picea mariana* and *Vaccinium oxycoccus* and in the top 2 cm of *Sphagnum* mosses.**

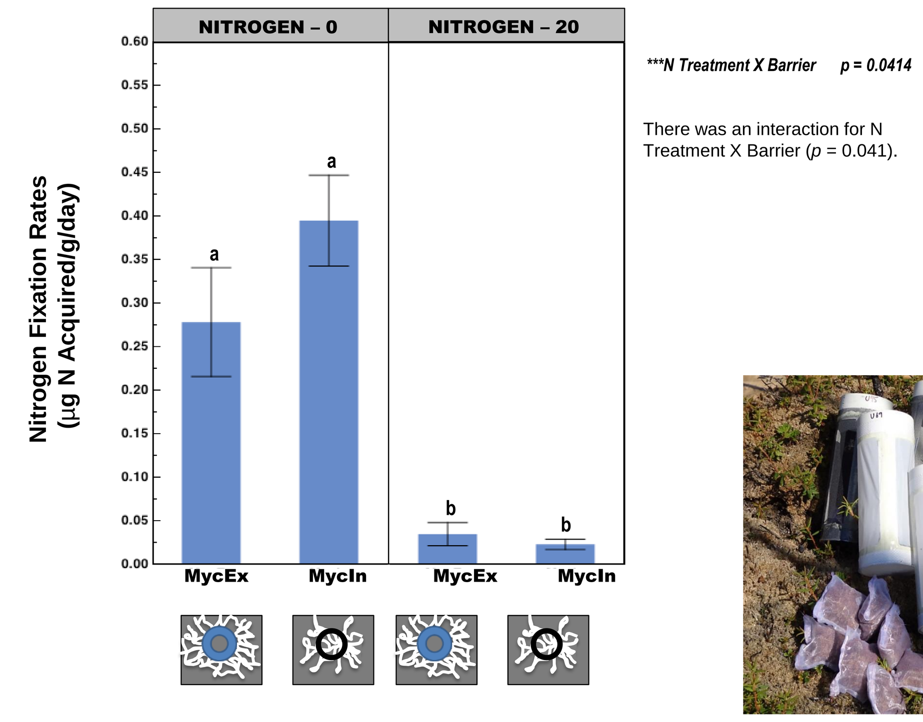
Stimulation of Biological Nitrogen Fixation by Black Spruce Seedlings



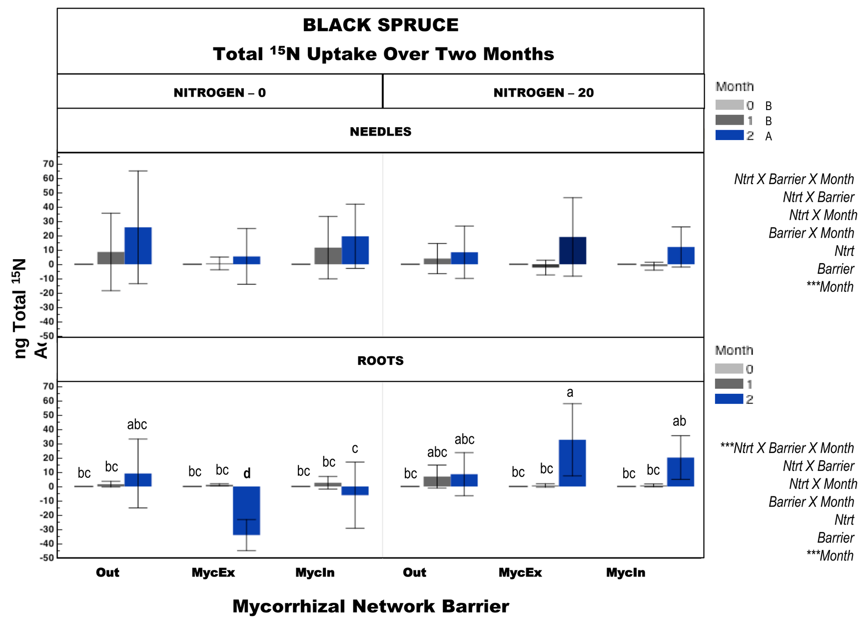


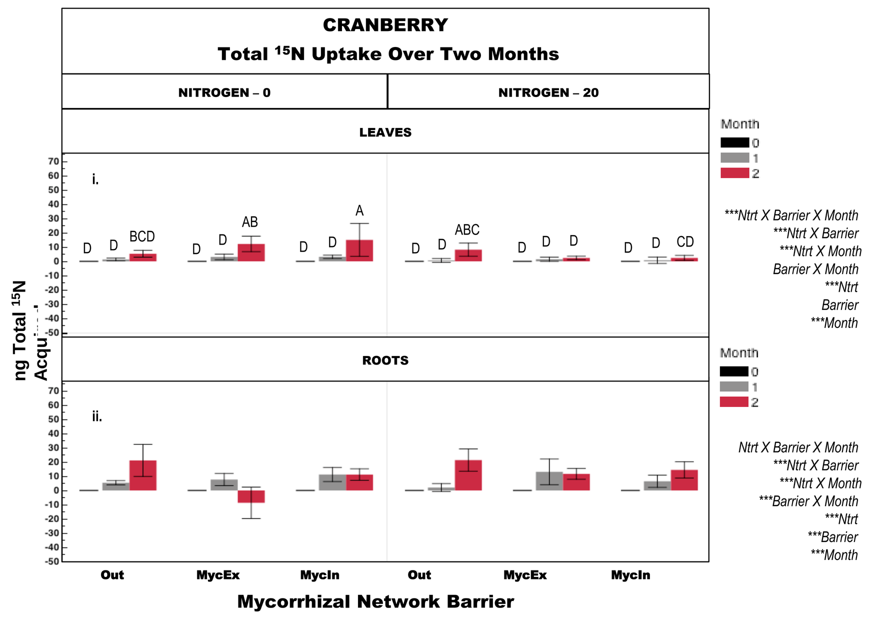



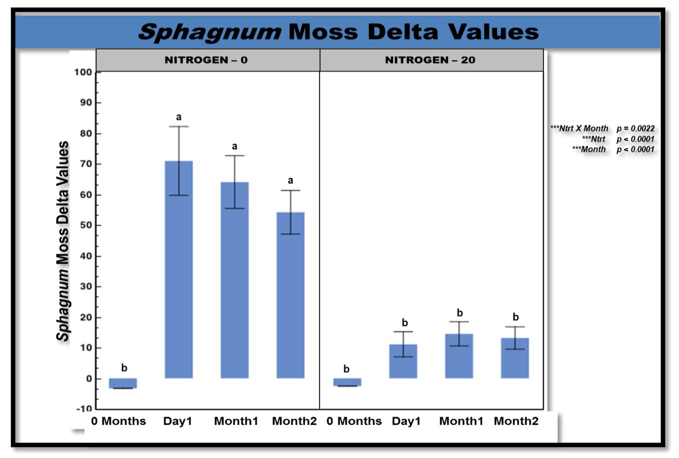
Black Spruce seedlings stimulated biological N fixation (estimated from acetylene reduction assay) when grown in *Sphagnum* mosses over two year N fertilization experiment.



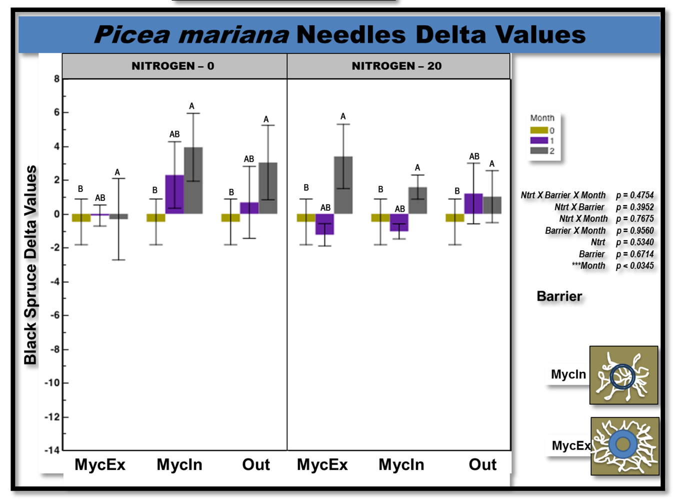

^{15}N Transfer from *Sphagnum* moss to native Vascular Plants

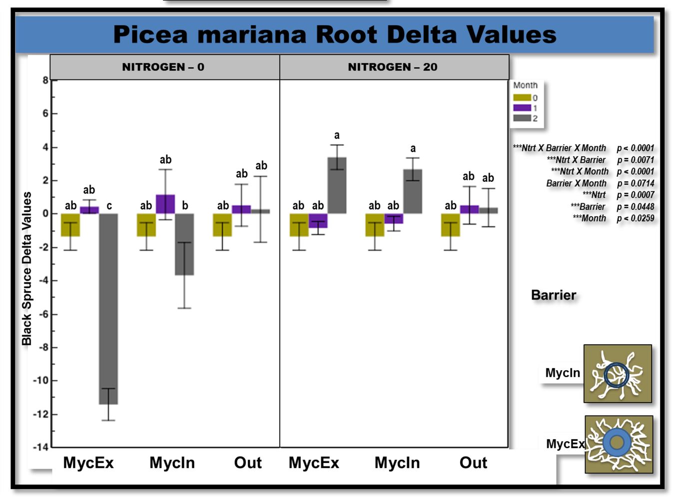


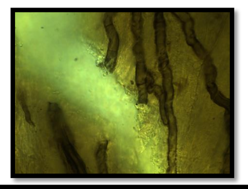


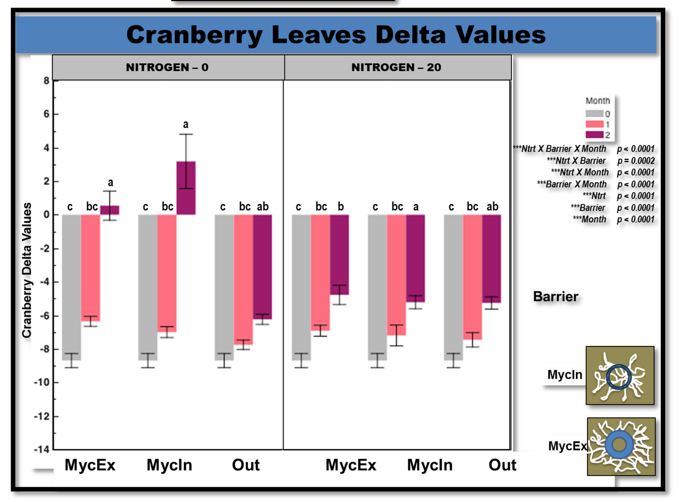


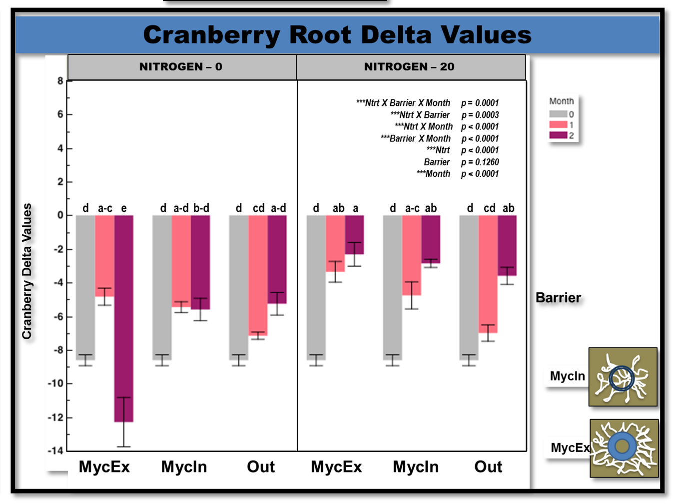










Conclusions

- **Results support our two main hypotheses:**
  - **1) Biological N_2 fixation, occurring in *Sphagnum* mosses, represents a source of N in boreal bog vascular plants**
  - **2) Passive $^{15}N_2$ labeling is a useful tool to investigate ecosystem level N cycles in an environment where biological N_2 fixation is a significant input.**
- **Diazotrophs provide the largest input of new N to these peatlands and similar to mosses, vascular plants also benefit from this N_2 fixation. While mosses retained the majority of ^{15}N label, vascular plants appear to have accessed majority of label early on in the experiment.**
- **Biological N_2 fixation offers a way to label tissues with an environmentally appropriate N form and concentration. Labeling with $^{15}N_2$ provides natural levels and forms of N (rather than excess added mineral or organic N) that can be traced through the ecosystem with ecologically meaningful results.**
- **New understandings of the dynamics of N inputs into peatlands will help us to further understand the processes that lead to soil C sequestration or mineralization as peatlands wax and wane with changing climatological trends.**

References

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