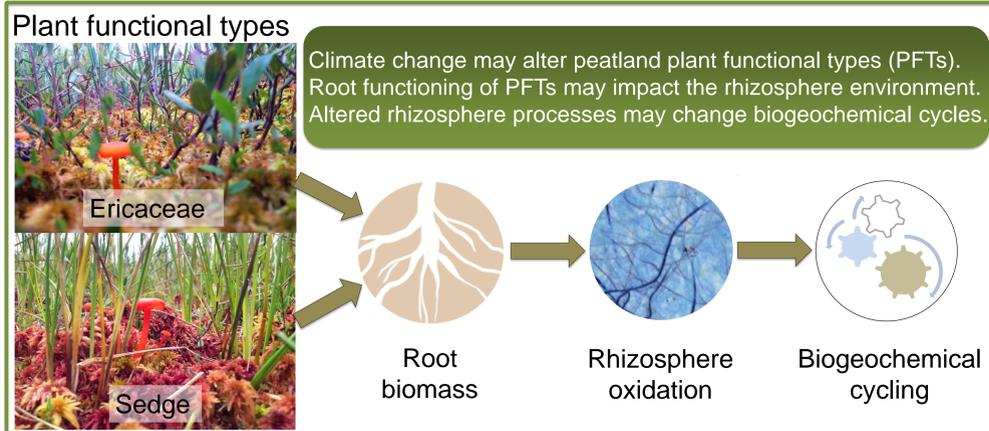


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Background

Dominant peatland plant functional types (PFTs) vary in root traits:

- Ericaceae root activity is restricted to the acrotelm where O₂ is present.
- Sedges are deeply rooted, containing aerenchyma that transport O₂ to sustain roots below the water table.

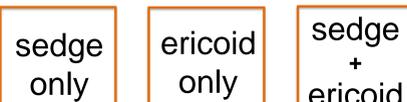
A changing climate may alter PFT dominance (sedge vs. ericoid). Shifts in PFTs may modify preferred C mineralization pathways that regulate CH₄ production.

Sedge abundance can impact methane production either positively or negatively:

1. **Increased CH₄** – Sedges provide labile C from root exudation & turnover, promoting methanogenesis. Aerenchyma provide a pathway for CH₄ flux, bypassing the aerobic zone where methanotrophs oxidize CH₄.
2. **Decreased CH₄** – Radial loss of O₂ from sedge aerenchyma may suppress CH₄ production and stimulate rhizosphere methanotrophy.

Where we work

We are evaluating PFT effects on peat biogeochemistry within three experiments with complimentary designs where vegetation has been manipulated:



PEATcosm experiment

24 mesocosm bins containing 1-m³ of intact peat collected from Meadowlands, MN.

Located at the USFS Forest Sciences Lab in Houghton, MI.

Belowground imaging using a Bartz BTC-100x minirhizotron system for root analyses to ~45-cm depth.



Microcosms

40-cm x 30-cm plexiglass windows with intact peat & sphagnum mosses.

Microcosms were kept outside to receive natural light & precipitation.

Rhizosphere imaging took place in an environmentally controlled growth chamber.



Nestoria peatland

Ombrotrophic bog in Michigan's Upper Peninsula, located 55 miles south of Houghton.

12 1-m² plots replicated within four blocks.

Piezometers installed within plots for collection of porewater at 20-cm & 40-cm depth.



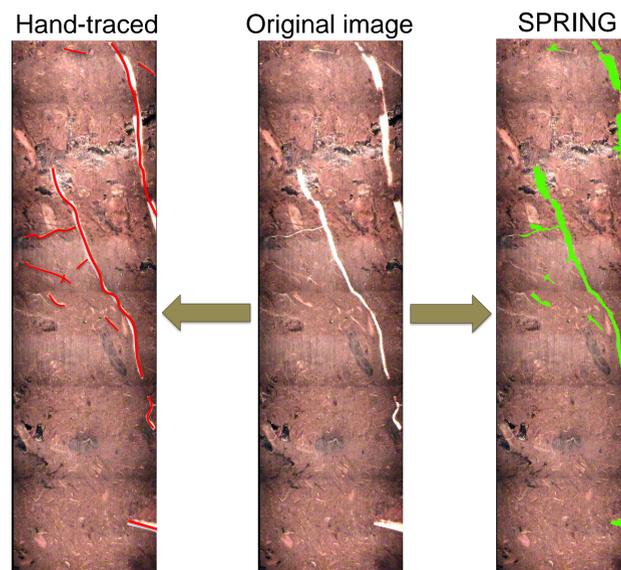
Results

Root biomass

Minirhizotron frames are stitched together for each tube.

Roots are classified either by hand tracing or using an object-oriented image classification algorithm (e.g. SPRING) in GIS software such as ArcMap.

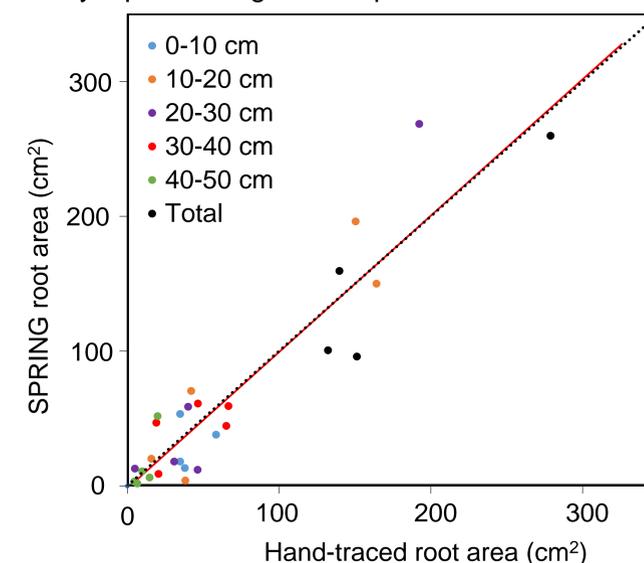
We tested the accuracy of SPRING-generated classification vs. hand-traced images:



SPRING-generated root classification is strongly correlated with hand-traced results ($P < 0.0001$, $R^2 = 0.87$)

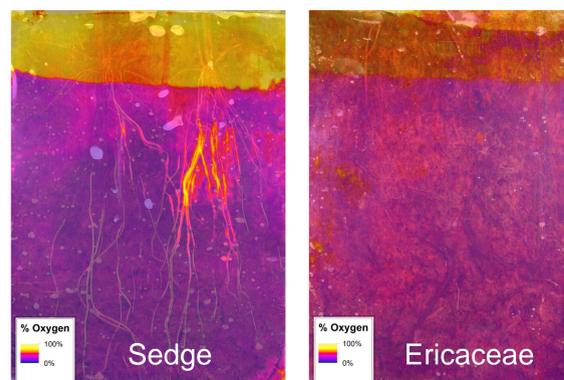
Regression (red line) was similar to 1:1 line (dashed line): slope=1.015 (95% CI: 0.86, 1.17)

These results suggest semi-automated approaches provide accurate root classification with large reduction in analyst processing time required.



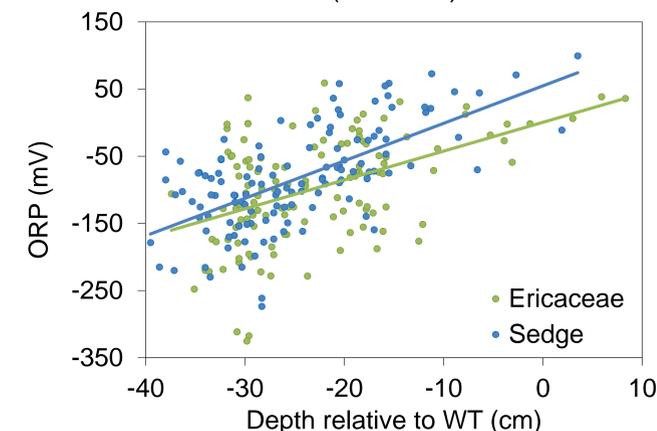
Rhizosphere processes

Planar optodes allow for visualize of peat [O₂]:



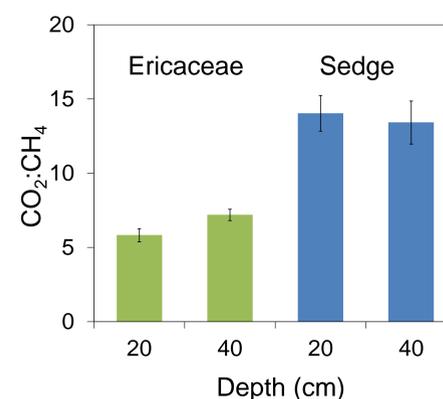
Microcosms show fine-scale spatial patterns of [O₂] around sedge roots, but not roots of ericaceae.

Higher oxidation-reduction potential (ORP) in sedge bins relative to Ericaceae ($P = 0.001$) at PEATcosm



Biogeochemical cycling

Porewater dissolved gas concentrations differ between PFTs at Nestoria from 20- & 40-cm peat depths at 3 sample dates (6/23, 8/5, 10/5).



- Lower [CH₄] in sedge plots ($P < 0.0001$).
- Higher CO₂:CH₄ in sedges ($P < 0.0001$).

Lower methane fluxes in sedges vs. Ericaceae ($P < 0.01$) in the PEATcosm study.

