Productivity and $\delta^{13}C$ in *Sphagnum* mosses across climatic and nitrogen deposition gradients

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Research Objectives:

- To determine whether *Sphagnum* productivity varies between regions that differ in climate and N deposition.
- To explore the relationships among productivity, microhabitat characteristics and $\delta^{13}C$ values.

Introduction:

Sphagnum mosses are important producers in peatland systems, yet we understand little about the mechanisms that underlie differences in their productivity. Meta-analyses using studies from north temperate, boreal and Arctic locations indicate strong associations between long-term climate and light availability with productivity[1]. Unfortunately, these results rely on different species, various methodologies and historical climate patterns. Consequently, it is difficult to draw robust conclusions or to address how recent changes like increased N deposition affect *Sphagnum* growth and productivity. Also, the relationship between environmental factors and carbon stable isotope ratios ($\delta^{13}C$) in *Sphagnum*, which may be used as a proxy for paleoclimate, habitat and/or microhabitat characteristics, remains unclear.

The Global *Sphagnum* Productivity (GSP) Project, a consortium of over 35 research groups across the northern temperate to subarctic regions, seeks to refine our understanding of *Sphagnum* productivity and its relationships to environmental drivers. This effort focuses on two peat-forming species (*S. magellanicum* and *S. fuscum*) over two growing seasons (2013-14). The GSP Project is organized by Gustaf Granath (McMaster University, Canada) and Håkan Rydin (Uppsala University, Sweden). We report on part of this work by comparing growth, productivity, $\delta^{13}C$ and microhabitat characteristics between field sites in New York and Maine that differ in climate and N distribution.

Acknowledgements

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Field Sites

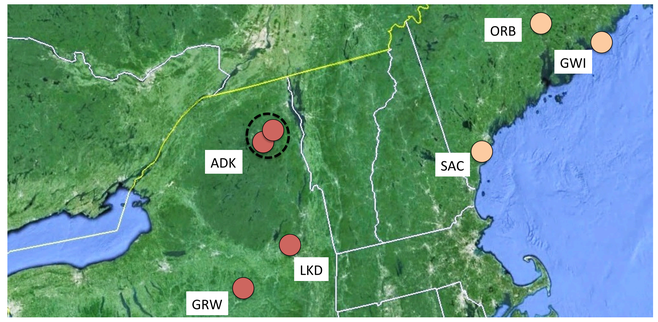

Fig 1. Distribution of sites containing *S. fuscum* and *S. magellanicum*. Each of the ADK sites includes only one species.

Site	Precipitation (cm/season)[2]	Temperature (C, avg)[2]	N Deposition (kg/ha/yr)[3]
GRW	88	17	4.3
LKD	58	16	3.8
ADK	76	13	3.8
SAC	37	16	3.6
GWI	88	15	2.5
ORB	68	15	2.1

Table 1. Climate and N deposition for New York (top 3) and Maine (bottom 3) sites. May-Oct 2013 values except for N, which is annual avg. from 2010-12.

Field Sampling

- Productivity measured using vertical growth and bulk density (normally n=4 plots per species per site).
- Brush wires (n=3) installed at each plot early in growing season 2013. Growth increment was measured at end of growing season and bulk density obtained from 10 cm cores.
- Microhabitat characteristics measured: height above water table, vegetation cover.

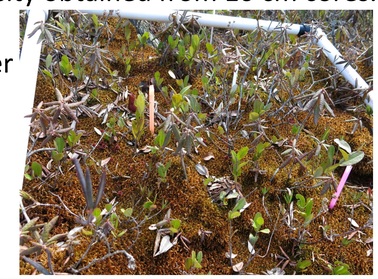

Fig 2. *S. fuscum* hummock with three brush wires installed. Straws allow for easy relocation.

Laboratory Analyses

- Productivity calculated as $g/m^2/yr$.
- $\delta^{13}C$ of plant tissue measured following grinding on a Thermo Delta Advantage ratio mass spectrometer.

Productivity

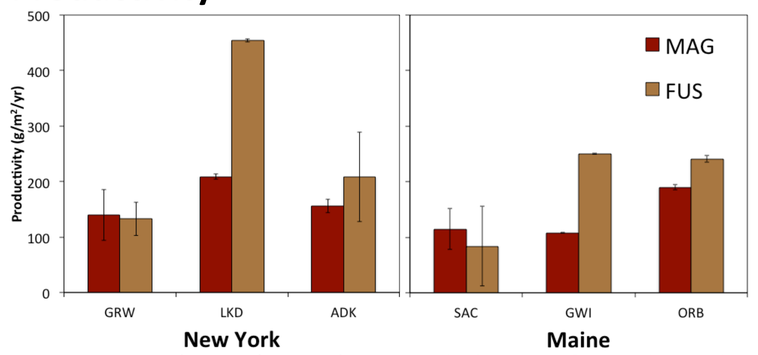

Fig 3. ANOVA indicates that productivity is higher in *S. fuscum* ($p=0.02$) and it differs significantly among sites within regions ($p<0.01$). There is no main effect of region nor a species x region interaction. Using regression analyses, productivity is not significantly associated with measured site characteristics.

$\delta^{13}C$ of Plant Tissue

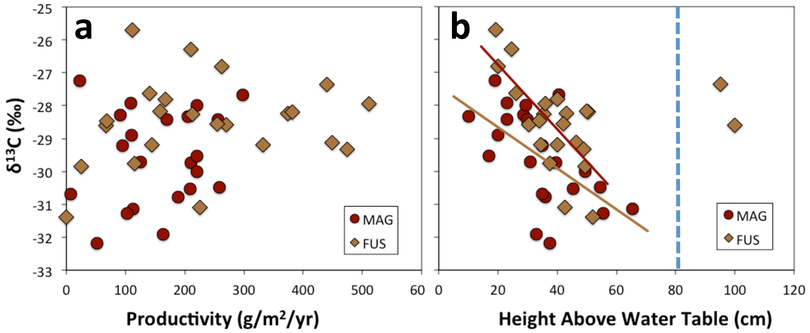

Fig 4. The $\delta^{13}C$ ratio of plant tissue shows no relationship with productivity in either species (a), but shows a strong association with position relative to the water table below 80 cm (b, $p<0.01$ and $R^2>0.35$ for each line, points above 80 cm excluded). Outliers for *S. fuscum* indicate different photosynthetic conditions for plants in very high hummocks, likely indicating microsites with low rates of evaporation.

Summary

- Within similar latitudes, regional variation in climate and N deposition does not affect *Sphagnum* productivity as much as site variation within regions; climate, but not N, was also more variable within regions.
- Microsite variation along hummock-hollow gradients affects $\delta^{13}C$ ratios of *Sphagnum* tissue more than environmental or physiological factors that control productivity.

Footnotes
[1]Gunnarson 2005. J. of Bryol. 27: 269; Loisel et al. 2012. Biogeosciences 9:2737
[2]National Climate Data Center
[3]National Atmospheric Deposition Program