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Wetland vegetation dynamics in response to beaver activity on Mount Desert Island, Maine.

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Summary

1. Beaver wetlands on Mount Desert Island (MDI), ME include wooded swamps, *Sphagnum* sedge fens, *Sphagnum* shrub fens, and open marshes / sedge meadows.
2. In the presence of beaver flooding, *Sphagnum* shrub fens are more stable than other, "transitional," wetland types due to the formation of a floating mat.
3. Of the transitional types, open marsh / sedge meadow communities are maintained by frequent beaver activity. *Sphagnum* sedge fens form when beaver abandon a wetland for >10 years. White-cedar/tamarack swamps form in the long-term absence of beaver activity.
4. Wetland stability is positively correlated to site size and peat accumulation, but negatively correlated with microtopographic richness.
5. Those wetlands currently inhabited by beaver tend to have higher pH and specific conductivity, and deeper water depths than those with no beaver activity.
6. Stable sites had significantly ($p<0.05$) lower ground- and surface water conductivity than transitional sites. They also had significantly more peat accumulation and lower microtopographic richness. Surprisingly, water pH did not differ significantly between the two types of sites.

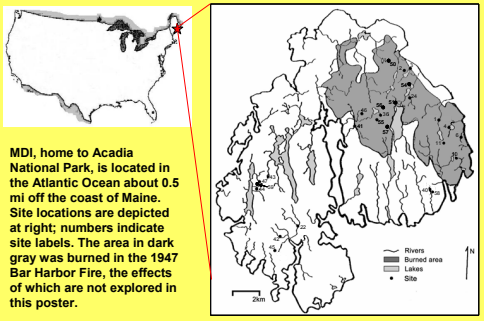
Question

How does beaver activity influence wetland vegetation community dynamics on Mount Desert Island?

Approach

I chose to investigate wetland sites with a wide range of beaver inhabitation histories.

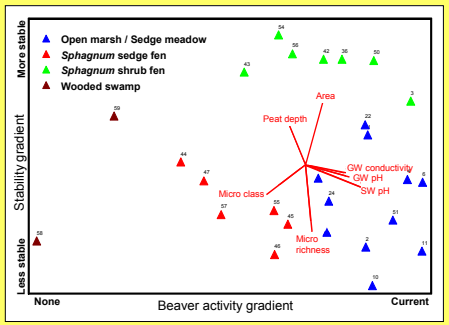
- I characterized wetland vegetation and related it to site history using multivariate analyses.
- I also measured site environmental variables in order to determine the mechanism by which beaver activity affects the vegetation.



MDI, home to Acadia National Park, is located in the Atlantic Ocean about 0.5 mi off the coast of Maine. Site locations are depicted at right; numbers indicate site labels. The area in dark gray was burned in the 1947 Bar Harbor Fire, the effects of which are not explored in this poster.

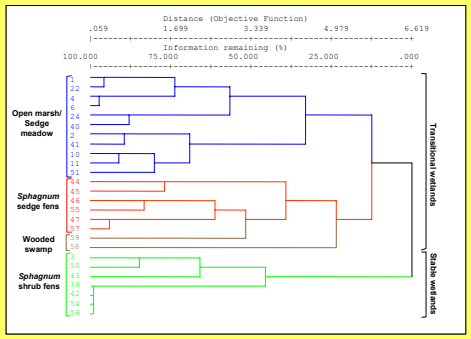
Methods

- I characterized wetland vegetation abundance using visual percent cover in quadrat samples.
- Both groundwater (GW) and surface water (SW) chemistry were measured on a weekly to monthly basis at several locations in each site.
- Peat depth was measured as depth to mineral surface.
- Microtopography was classified in quadrats as combinations of the categories 0 = pool, 1 = flat/hollow, 2 = low hummock, 3 = hummock, 4 = high hummock, and 5 = stump. Microtopographic richness is defined as the # different quadrat combinations in a site / # quadrats in a site. Microtopographic average is defined as the average category score.

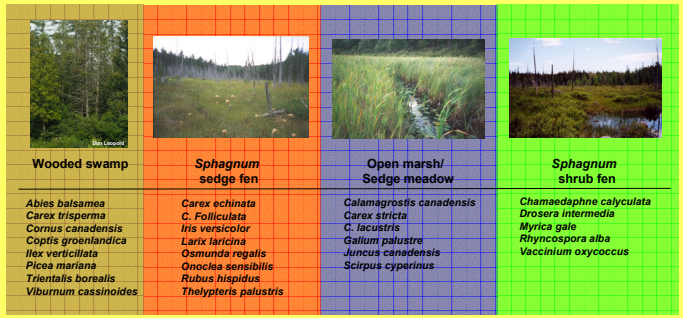


A non-metric multidimensional scaling ordination of sites in species space (2-axis solution) indicates that wetlands fall into four categories based upon vegetation composition and abundance. These categories are open marsh/sedge meadow, *Sphagnum* sedge fen, *Sphagnum* shrub fens, and wooded swamps. Axes correspond to beaver activity and stability gradients.

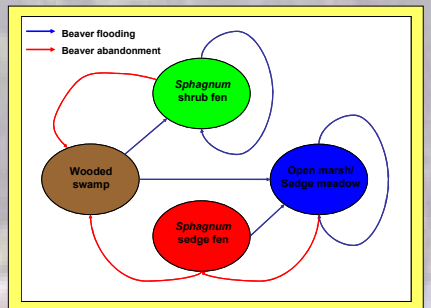
- Beaver activity ranges from current inhabitation (open marshes and meadows) through abandonment (*Sphagnum* sedge fens) to unaffected sites (wooded swamps). Sites with current beaver activity tend to have higher pH and conductivity levels, and lower microtopographic class than abandoned/unaffected sites.
- The stability axis describes a relative gradient from less stable to more stable wetlands. Stability refers to the community's ability to persist during beaver hydrologic modification. Open marsh/meadow, *Sphagnum* sedge fens, and wooded swamps all tend to be less stable, or more transitional, than the *Sphagnum* shrub fens. More stable sites tend to be larger in area and have more peat accumulation, while less stable sites tend to have higher microtopographic richness.



A cluster analysis (flexible-beta method, $\beta = -0.25$) indicates that wetlands can first be differentiated according to relative stability, with the more stable *Sphagnum* shrub fens separating from the remaining transitional wetlands. The next division separates sites within the transitional group into those have been influenced by beaver <10 years ago (open marsh/sedge meadow) and those abandoned by beaver >10 years ago *Sphagnum* sedge fen and wooded swamp).



The species listed above are significant indicators ($p<0.05$) of the different vegetation community types delineated in the ordination and cluster analyses. The best indicators of any community type were *Myrica gale* ($p<0.001$) and *Chamaedaphne calyculata* ($p<0.001$) for the *Sphagnum* shrub fens.



With beaver flooding, wooded swamps can become either *Sphagnum* shrub fens or open marsh/Sedge meadow communities. All wetland types can transition back to wooded swamp in the absence of beaver activity. Open marsh/Sedge meadow communities are maintained by frequent beaver activity. *Sphagnum* shrub fens persist during occasional beaver flooding due to floating mat formation.

Comparisons amongst means (2-sample one-tailed t-Tests) of selected attributes between sites with transitional and stable vegetation indicate that both ground- and surface water specific conductivity are significantly lower in stable *Sphagnum* shrub fen sites than in transitional sites. Peat accumulation was significantly higher in shrub fen sites, but microtopographic richness was lower. Surprisingly, there is no statistical difference in pH between the two types of sites.

Attribute	Transitional sites mean (s.d.), n=19	Stable sites mean (s.d.), n=7	p-value
GW specific conductivity (µS)†	124.29 (80.11)	56.71 (25.66)	**
GW pH	5.55 (0.48)	5.26 (0.51)	ns
SW specific conductivity (µS)†	92.99 (50.99)	47.29 (14.66)	***
SW pH	5.31 (0.45)	4.97 (0.46)	ns
Peat depth (cm)†	81.63 (50.27)	125.15 (25.81)	**
Microtopographic richness	0.28 (0.09)	0.21 (0.08)	*
Microtopographic average†	2.19 (0.43)	1.69 (0.70)	ns
Dominant plant height (m)	0.88 (0.20)	0.77 (0.26)	ns

† Welch Modified Two-Sample t-Test (one-tailed)
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Future directions

More research should also be done in order to determine what differentiates transitional and stable wetland development, and how wetland area, peat depth, and microtopographic richness interact to influence plant communities. In addition, research into how conductivity is linked to *Sphagnum* shrub fen stability is important.

The model presented here is somewhat simplistic. It does not specifically account for differences in frequency and duration of beaver inhabitation, nor does the model explain how variation in landscape-level attributes, such as drainage basin position, influence wetland plant communities. With a more explicit model of wetland dynamics, it may be possible to predict how wetlands will respond to beaver activity. Additional research into how beaver population dynamics and management influence landscape-level wetland diversity is also needed.

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