Modelling and Mapping Bryophyte Distributions in New Brunswick using a Depth-to-Water Index

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BACKGROUND

Wet Areas Mapping

Using digital elevation models (DEMs) derived from airborne Light Detection and Ranging (LiDAR) data, it is possible to map soil wetness at 1m resolution using a cartographic depth-to-water (DTW) index. This index accounts for the least elevation difference between the soil surface and the nearest open-water feature (Figure 1).

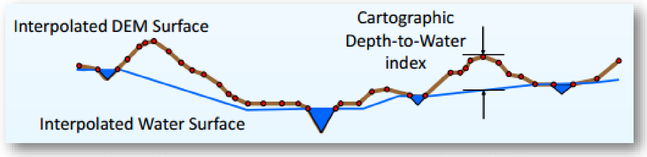


Figure 1: Simplified diagram showing derivation of DTW Index

The DTW index is related to extent of soil wetness and drainage, as drainage varies from very poor to excessively well drained[1].

Bryophytes

Plant species composition is known to vary along environmental gradients. Bryophyte (moss) distributions are related to soil drainage and wetness[2], according to their moisture requirements which may range from hydric to xeric (Figure 2).



Figure 2: Examples of different bryophyte cover types found under varying soil moisture regimes

Research Question

Can wetness related changes in composition and distribution of bryophytes be modelled and mapped using a LiDAR-derived cartographic DTW index?

OBJECTIVES

The objectives of this research are:

- To quantify the relationship between the distributions of common bryophyte species and soil wetness as modelled by way of the DTW index.
- To apply these relationships to map the spatial distribution of the selected bryophyte species across the landscape (from wetlands to uplands).

METHODS

Sampling

- 12 survey locations across NB with available LiDAR coverage were selected (Figure 3).
- Sites stratified by depth-to-water class and predictive gradient transects sampled (from wetland to upland).
- Recorded presence and abundance of species in 1m^2 vegetation plots (N=980).

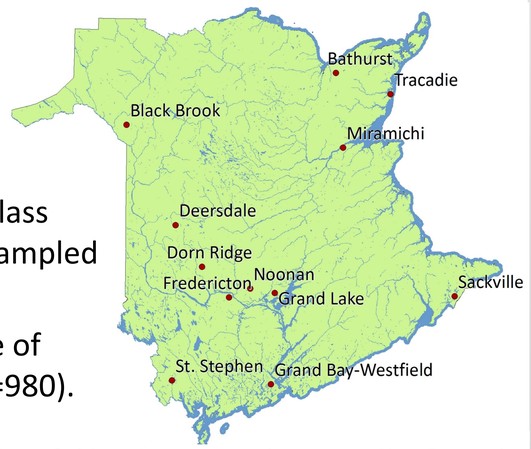


Figure 3: Map of survey locations across New Brunswick

Modelling

- *Occurrence data* (whether or not the species is present) – modelled using hierarchical logistic regression models.
- *Abundance data* (visually estimated % cover when present)
- *Independent variables* (DTW, canopy closure, stand type, slope, etc.)

RESULTS

Presence (Frequency of Occurrence)

When compared, moss species exhibit diverse moisture preferences (Figure 4). The modelled response curves of individual species in relation to depth to the water table show habitat optima of Sphagnum spp. at the wet extreme of the gradient, while the remaining species have a higher probability of occurring at moderate to well-drained sites (Figure 5).

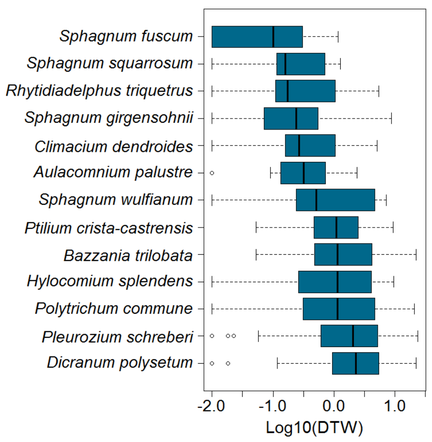


Figure 4: Median, interquartile range, min, and max DTW values for each species.

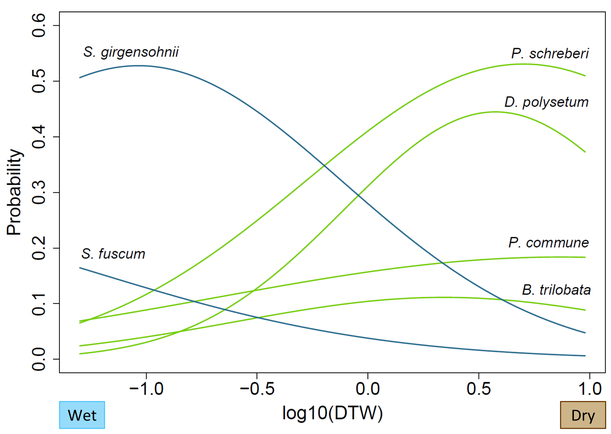


Figure 5: Modelled species response curves over a predictive depth-to-water gradient (log transformed).

Abundance (% Cover)

Although the relative abundance of mosses is mainly affected by microtopographic features such as substrate and biological factors like competition, there are nevertheless some landscape scale trends of changing abundance by DTW class (from wet to dry) (Figure 6).

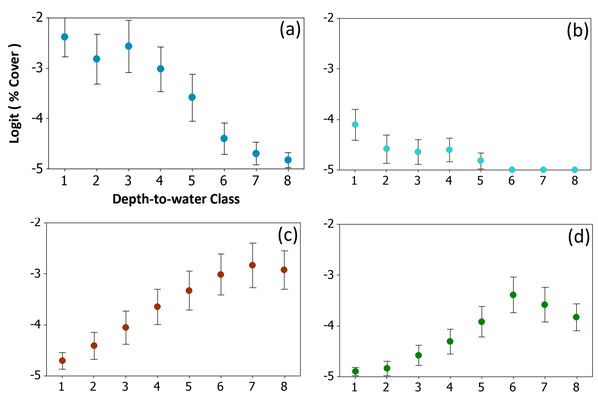


Figure 6: Mean (logit transformed) % Cover by DTW class, with 95% confidence intervals for (a) S. girgensohnii, (b) S. fuscum, (c) P. commune, and (d) D. polysetum.

RESULTS - MAPS

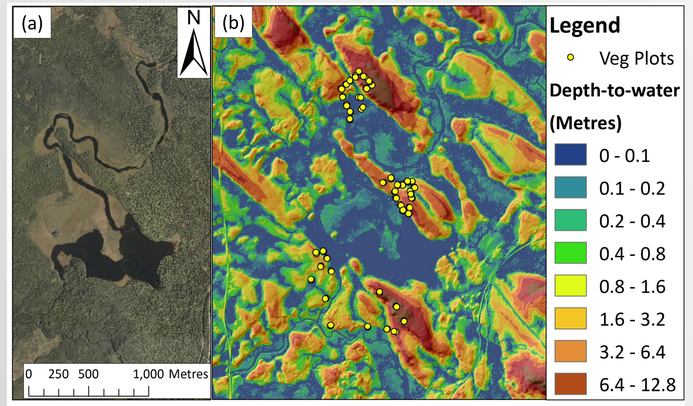


Figure 7: (a) Aerial photo of study site near St. Stephen (b) Wet areas map (1m resolution, 1ha flow initiation) with vegetation plots.

The regression equations from the modelled relationships between species and independent variables can be utilized to create predictive maps in ArcGIS (Figure 8).

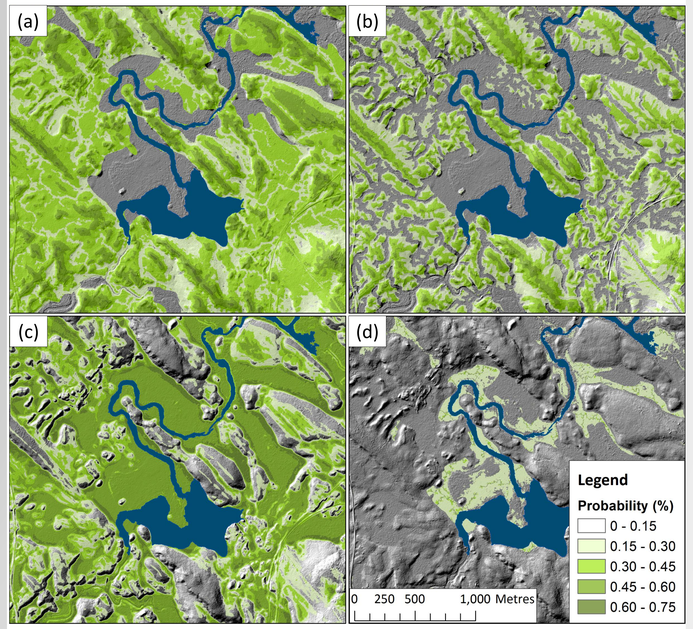


Figure 8: Maps showing probability of occurrence for (a) D. polysetum (b) P. schreberi (c) S. girgensohnii and (d) S. fuscum.

CONCLUSIONS

The observed spatial patterns of bryophytes at a landscape scale reflect changes in soil wetness, as modelled by the DTW index.

This research contributes to knowledge and understanding of how bryophytes are distributed across the landscape, and spatial information of this sort could be valuable for agencies involved in biodiversity conservation, restoration, or related management efforts.

REFERENCES

1. Murphy, P. N. C., Ogilvie, J., Meng, F.-R., White, B., Bhatti, J. S., & Arp, P. a. (2011). Modelling and mapping topographic variations in forest soils at high resolution: A case study. *Ecological Modelling*, *222*(14), 2314–2332.
2. Gillrich, J. J., Bowman, K. C., & US Army Corps of Engineers. (2010). The Use of Bryophytes as Indicators of Hydric Soils and Wetland Hydrology during Wetland Delineations in the United States.