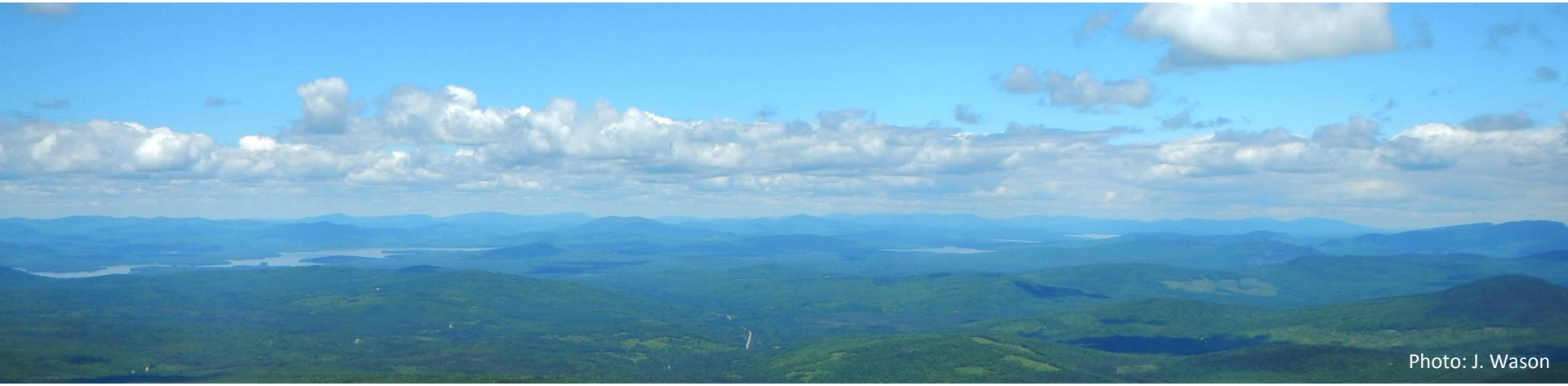
Patterns of acidic deposition, soil acidification, and forest understory plant biodiversity in the Adirondack Mountains

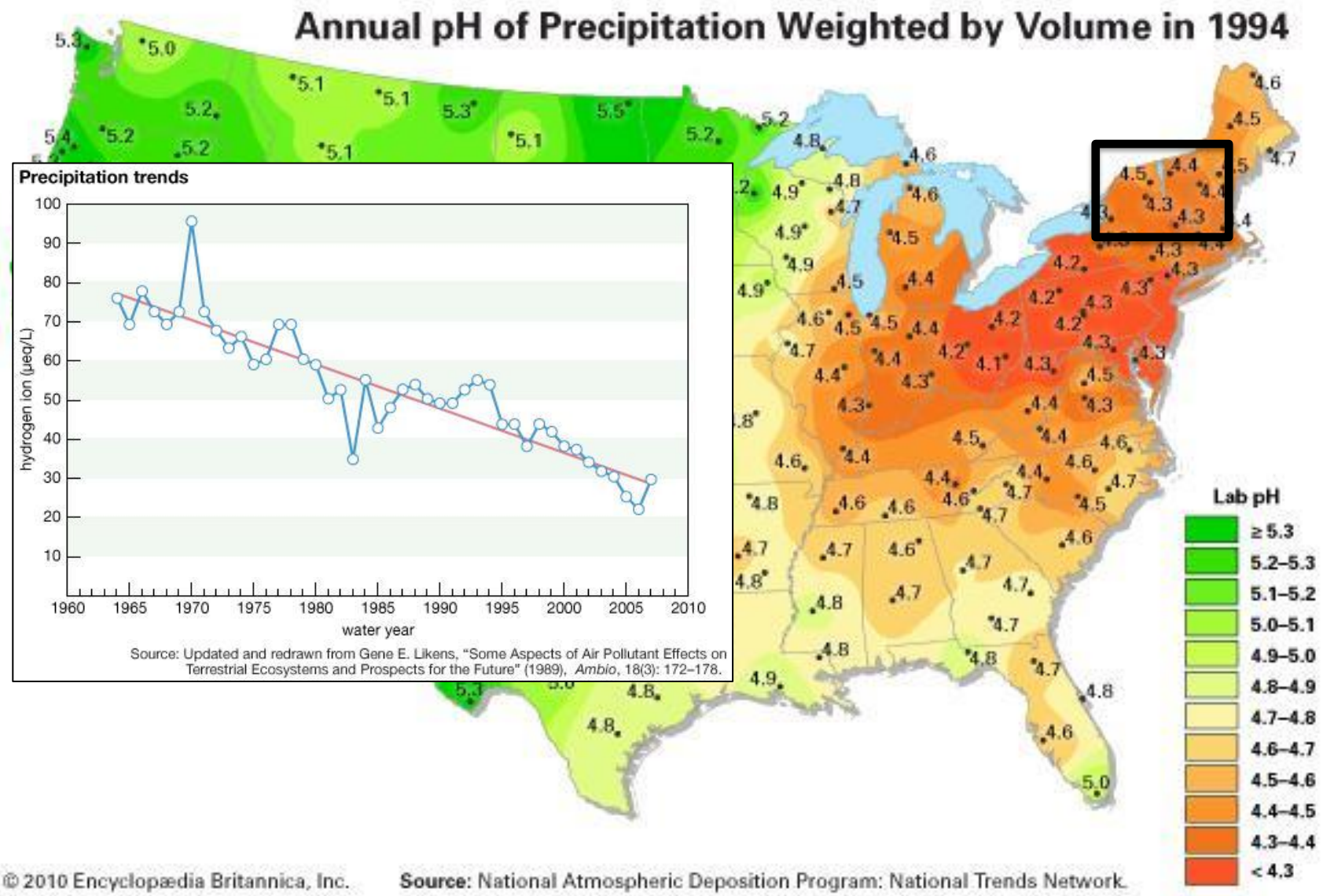


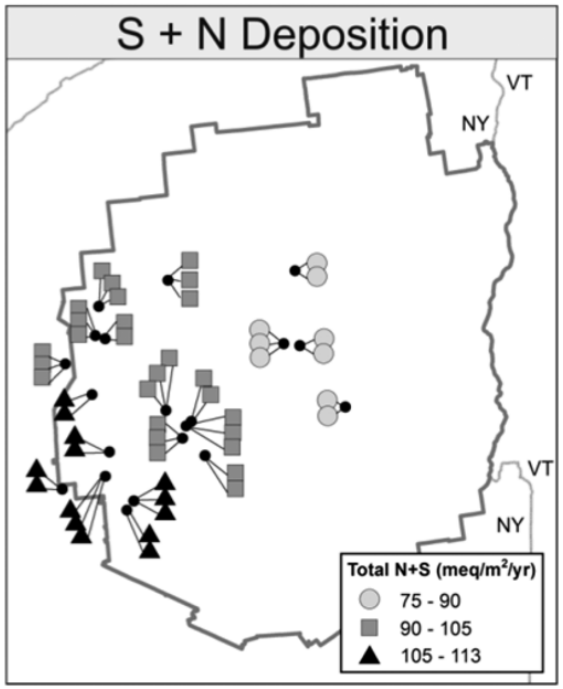
M. Dovciak, M. Whalen, T. McDonnell, G. Lawrence, and T. Sullivan

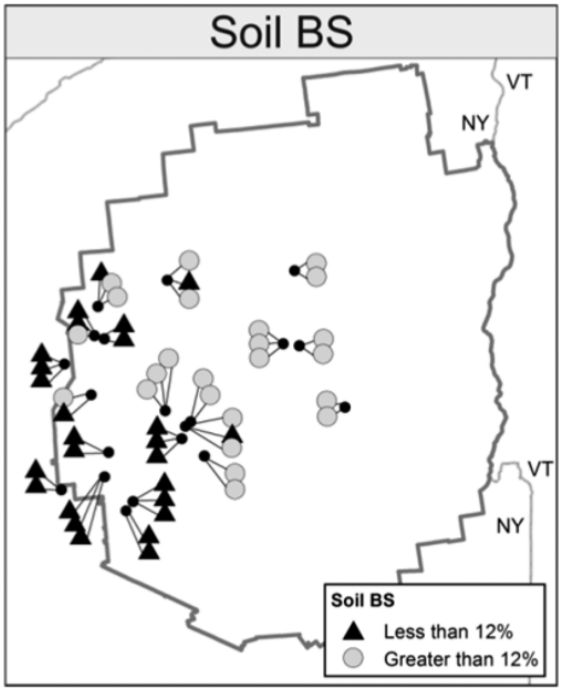
SUNY ESF – USGS – E&S Environmental Chemistry

Presented at the Adirondack Research Forum, March 2, 2016

Legacy of acidic deposition in northeastern US







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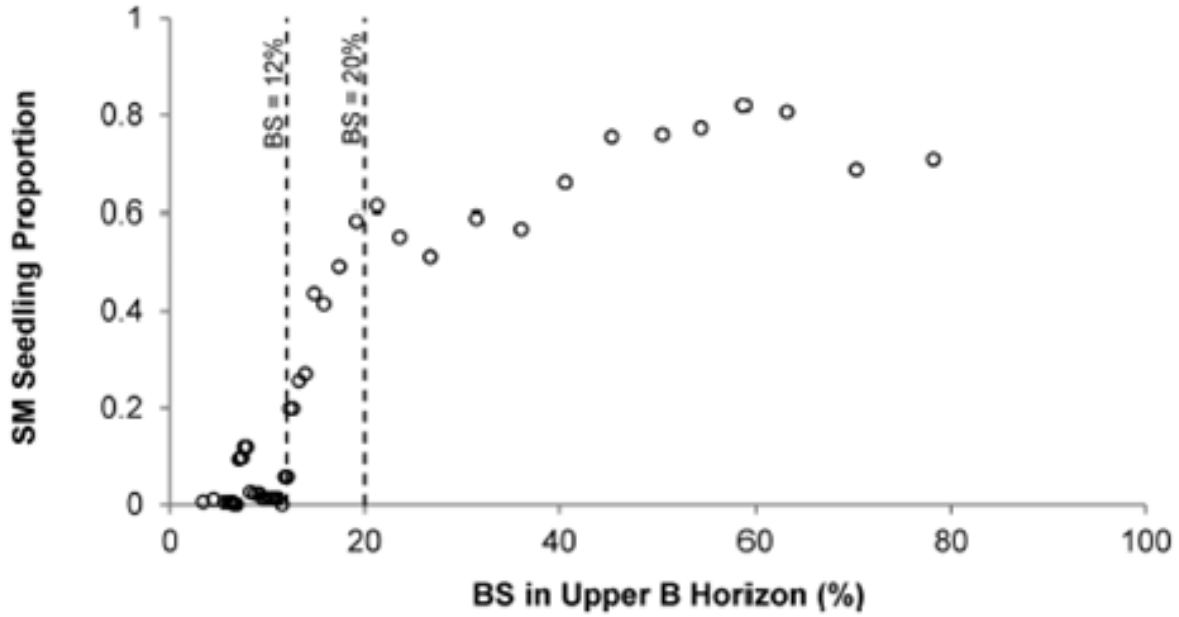
Effects of Acidic Deposition and Soil Acidification on Sugar Maple Trees in the Adirondack Mountains, New York

T. J. Sullivan,*[,†] G. B. Lawrence,[‡] S. W. Bailey,[§] T. C. McDonnell,[†] C. M. Beier,[∥] K. C. Weathers,[⊥] G. T. McPherson,[†] and D. A. Bishop[∥]



Questions and Hypotheses

- How has acidic deposition and soil acidification affected patterns of forest understory plant diversity and composition in the Adirondack Park? (on the previously studied sugar maple plots)

  - ❑ H1: Acidic deposition & soil acidification affect community composition (species shifts over acidity gradients, indicator species)

  - ❑ H2: Acid deposition and soil acidification lower biological diversity





Previous Data

ENVIRONMENTAL Science & Technology

Article

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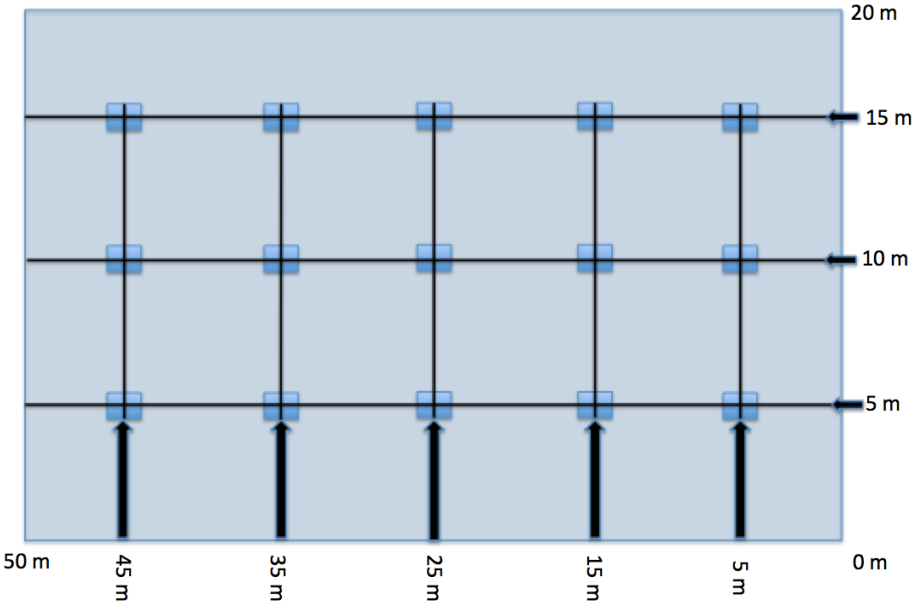
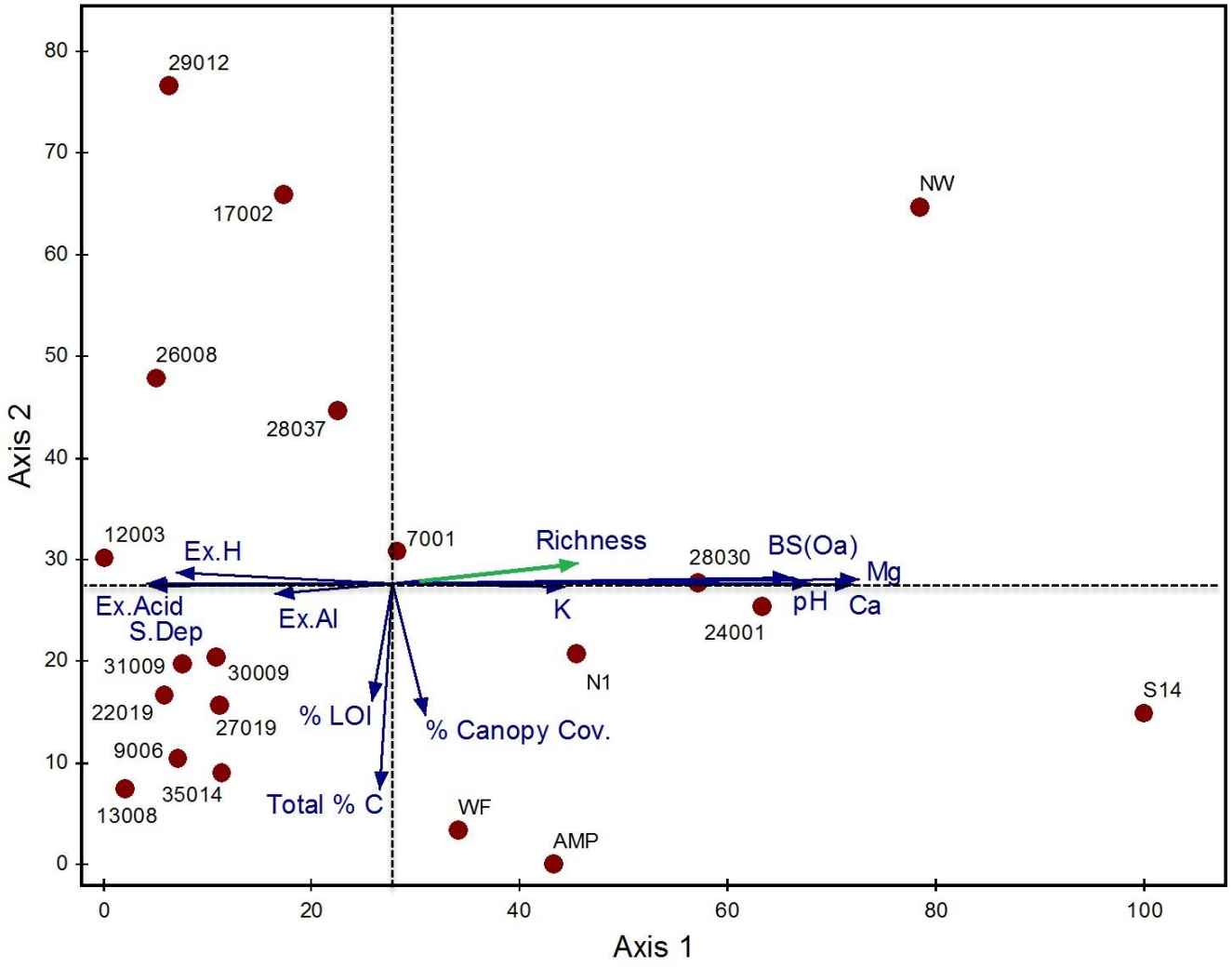
- Soil chemistry (e.g., pH, BS, Ca, Mg, Exch. Al)
- Acid deposition (S, N)
- Topographic moisture indices
- Canopy cover (photographs)

Methods

- Survey of % species cover
- Time search for rare species
- NMS ordination and Indicator Species Analysis in PC-ORD
- Simple linear regression in SAS



NMS Ordination of Watersheds Based on Species Frequency



Vector overlay represents associations of environmental variables (r > 0.4) with at least one ordination axis

Stress: 11.33

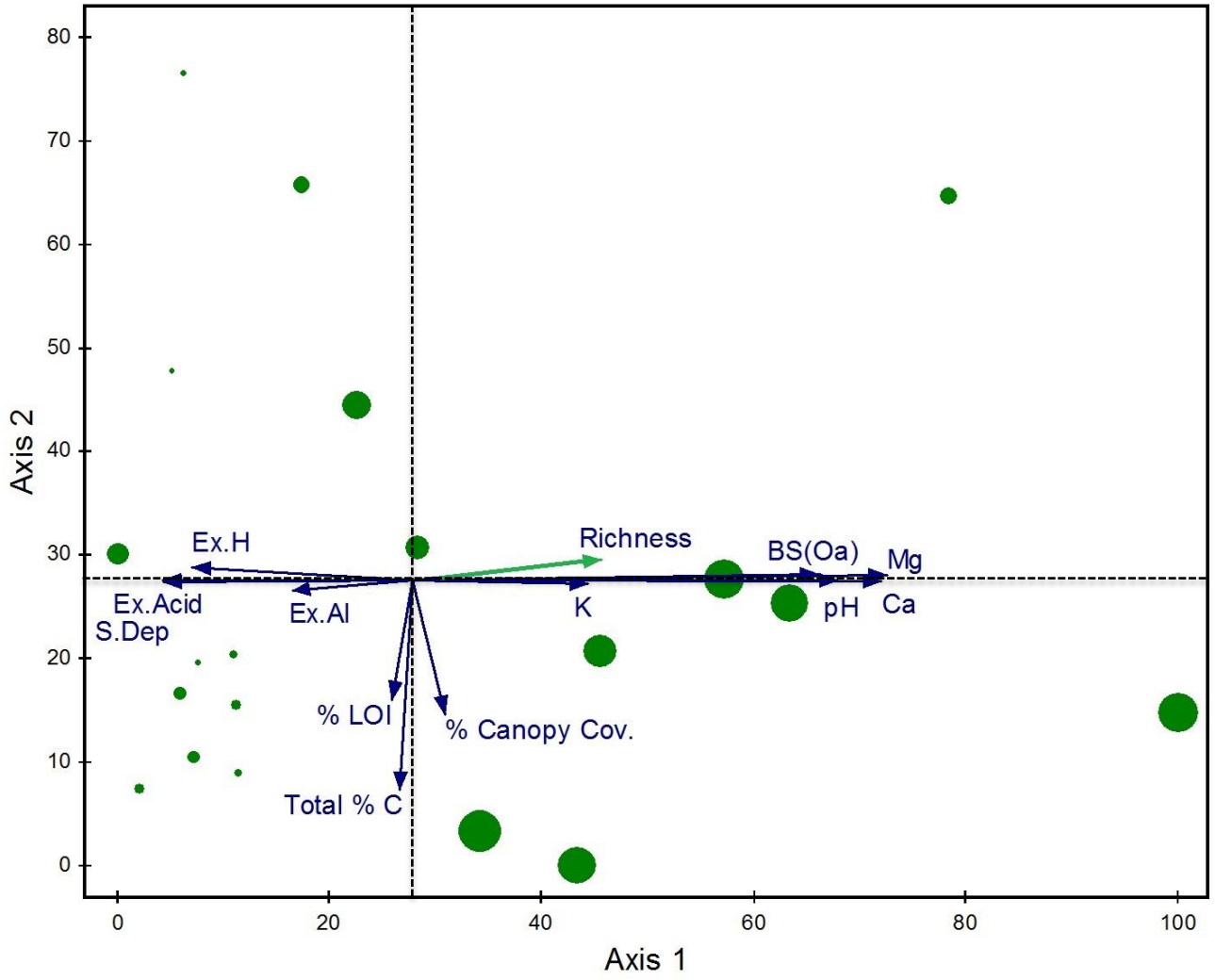
- **P-value: 0.004**

Variance Explained by:

- **Axis 1: 63.5%**
- **Axis 2: 27.7%**

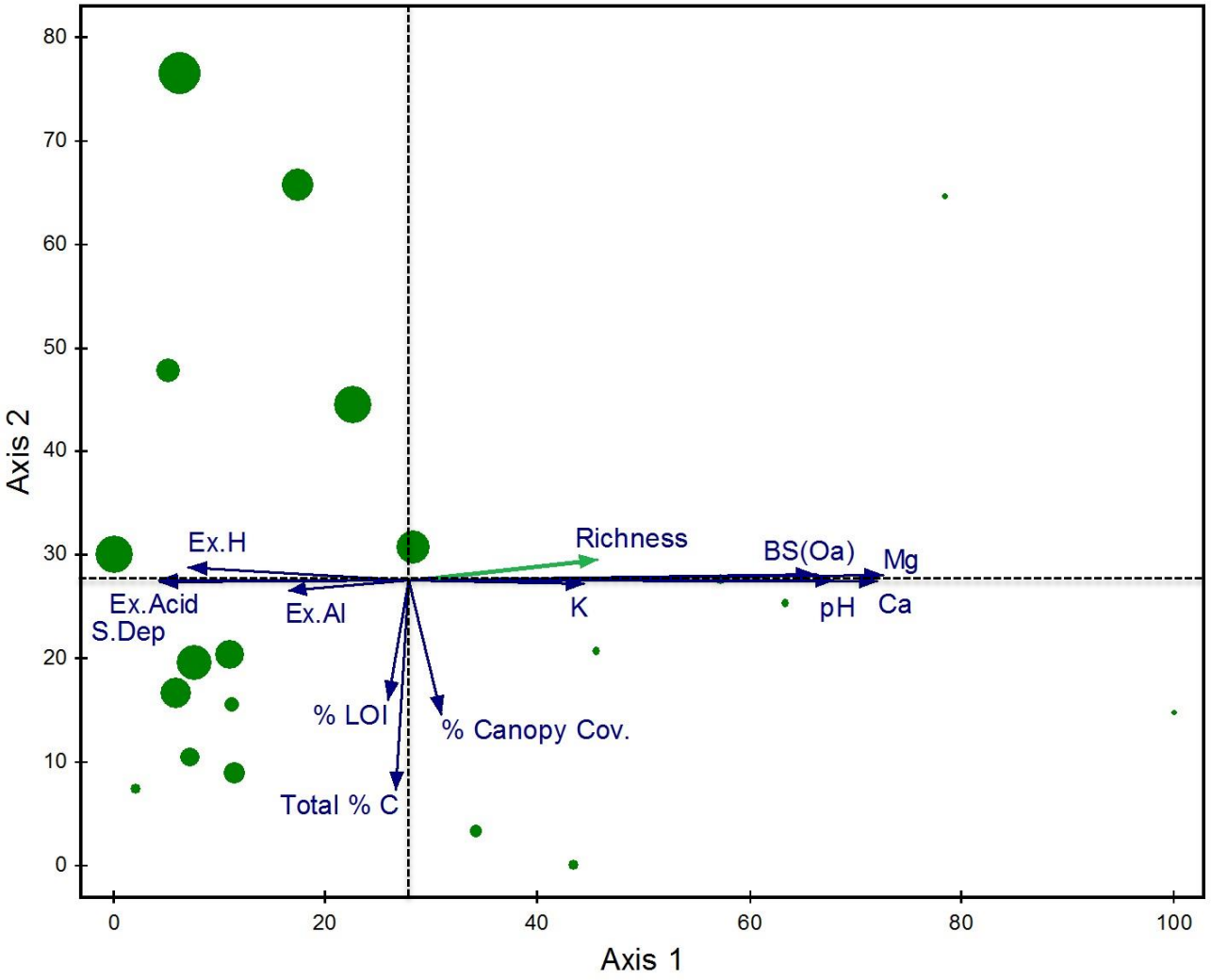
Axes scaled proportionate to longest axis.

Frequency of *Acer saccharum* among watersheds



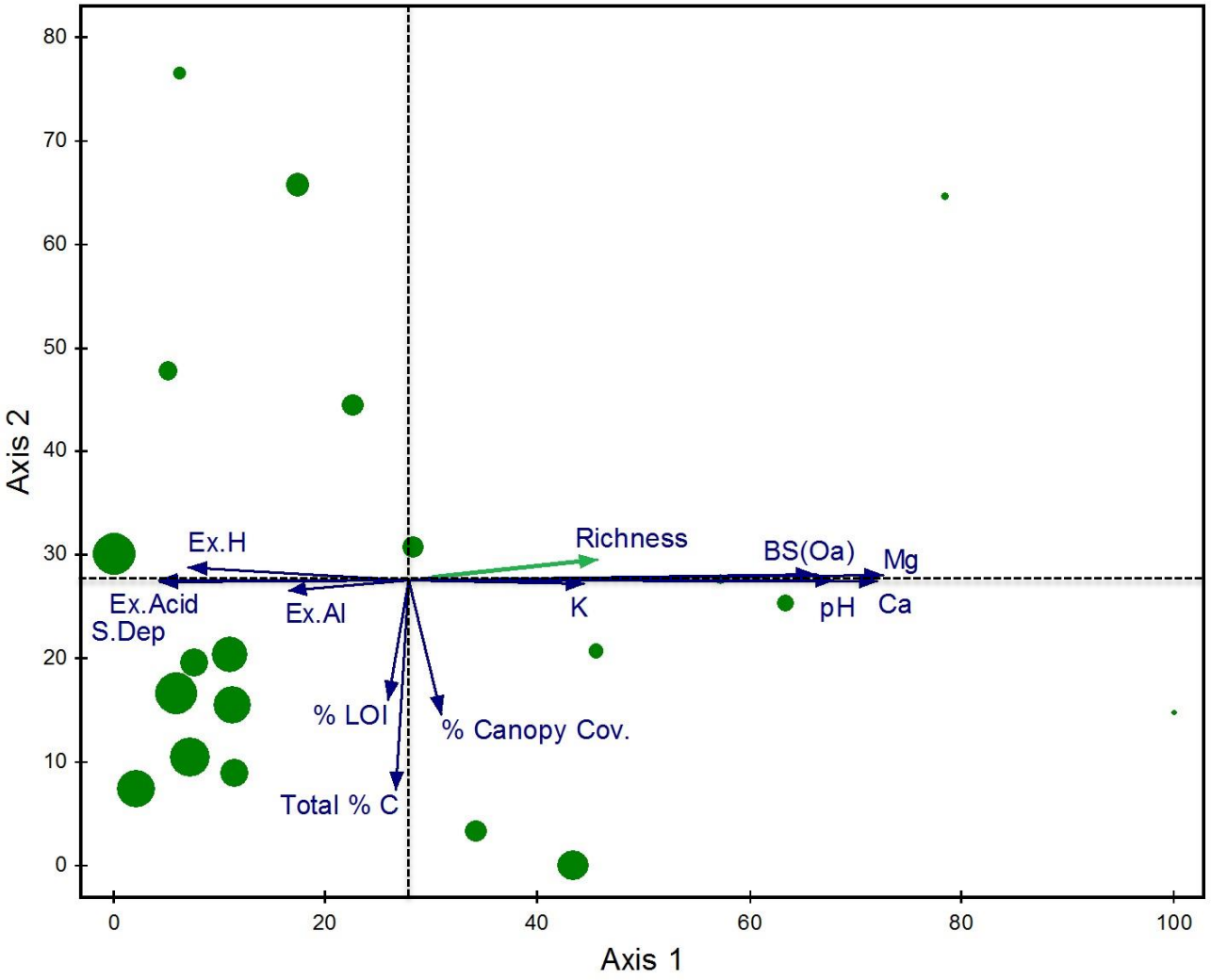
Correlations with axes
Axis 1: *r* = 0.72
Axis 2: *r* = -0.267

Frequency of *Acer rubrum* among watersheds



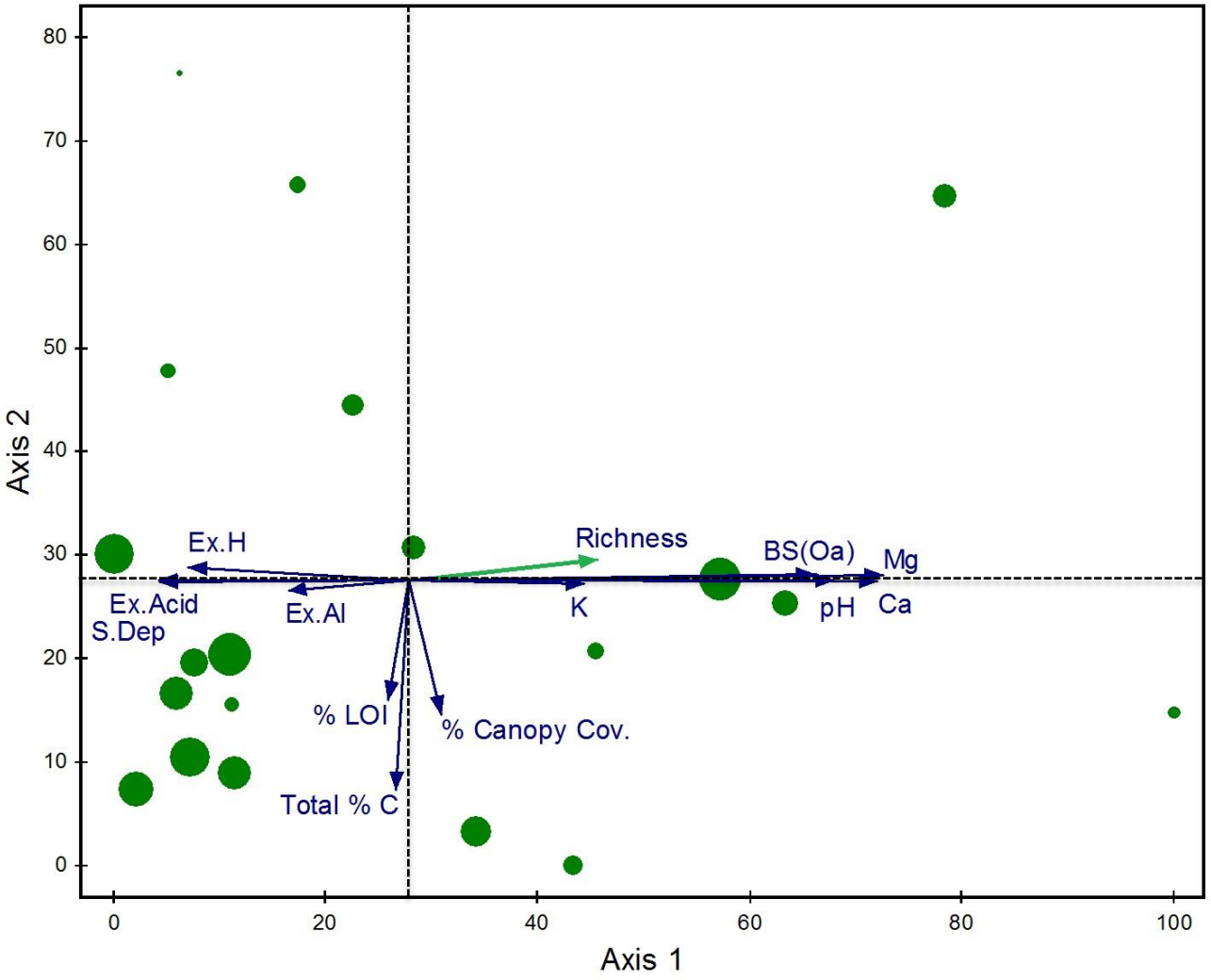
Correlations with axes
Axis 1: *r* = -0.684
Axis 2: *r* = 0.433

Frequency of *Acer pennsylvanicum* among watersheds



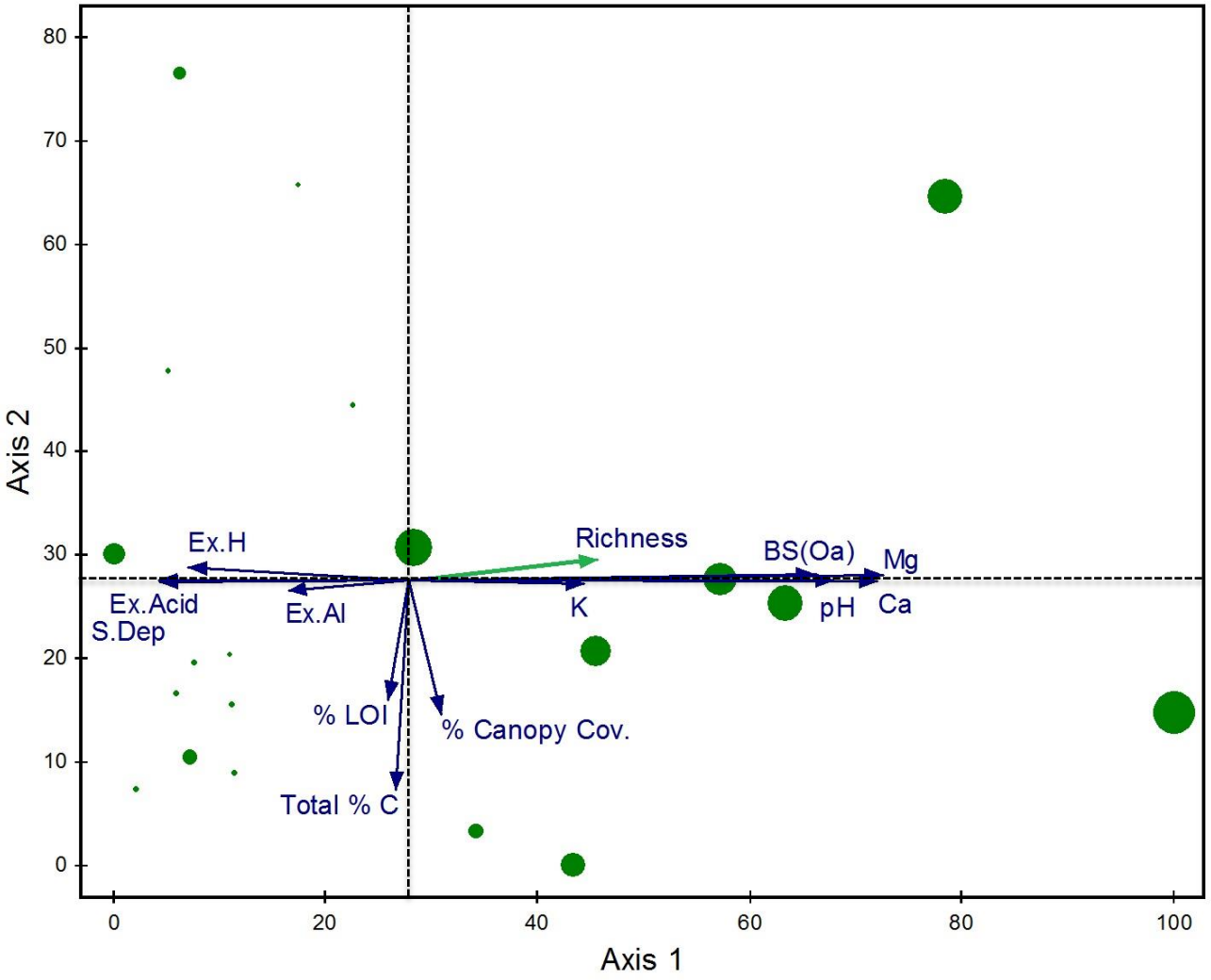
Correlations with axes
Axis 1: *r* = -0.74
Axis 2: *r* = -0.46

Frequency of *Fagus grandifolia* among watersheds



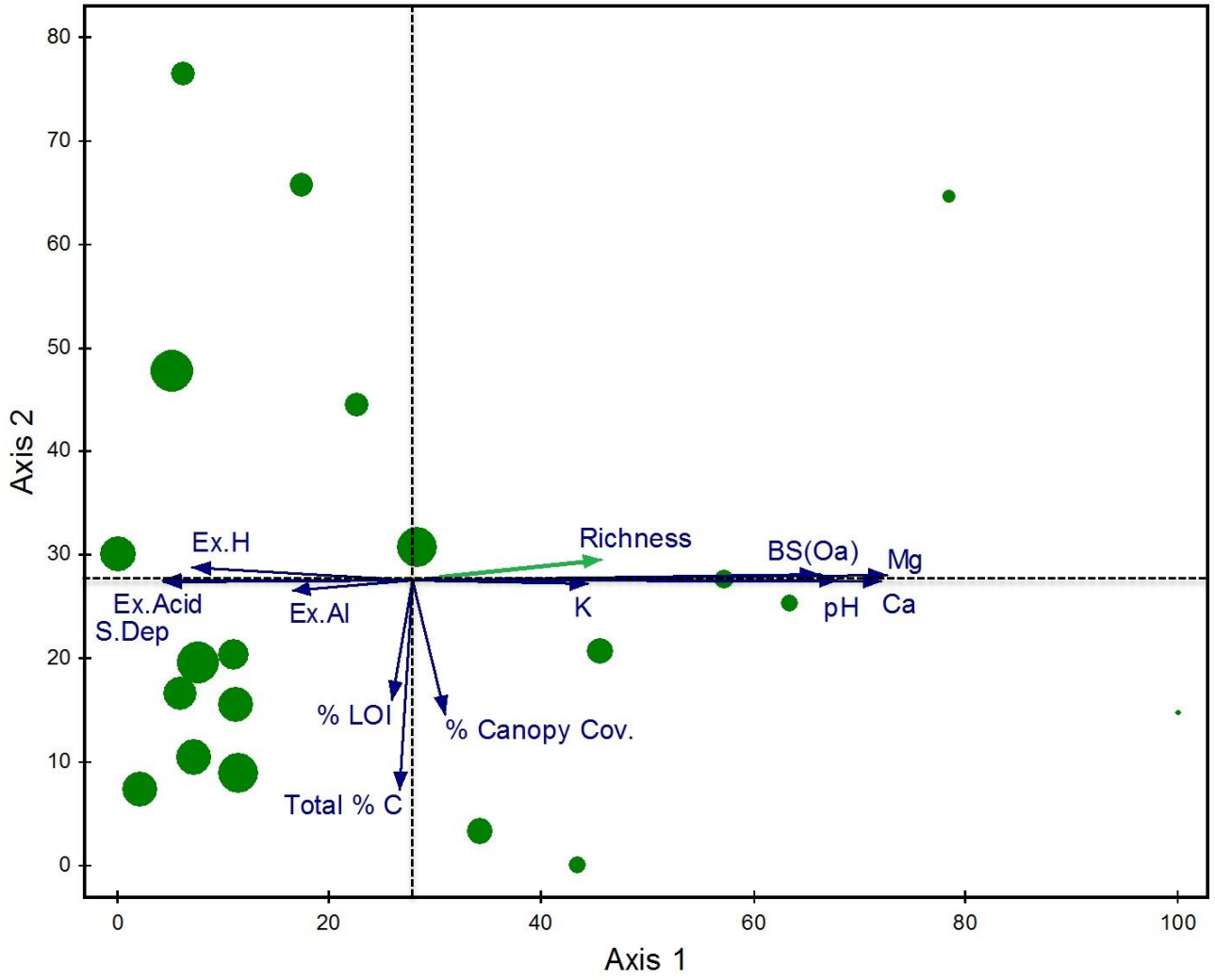
Correlations with axes
Axis 1: *r* = -0.248
Axis 2: *r* = -0.463

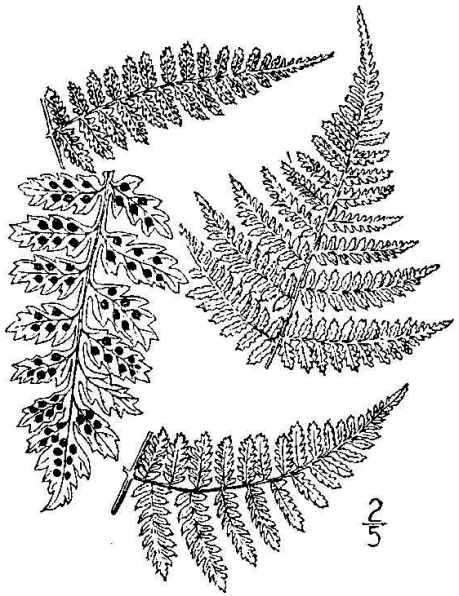
Frequency of *Arisaema triphyllum* among watersheds



Correlations with axes
Axis 1: *r* = 0.833
Axis 2: *r* = 0.006

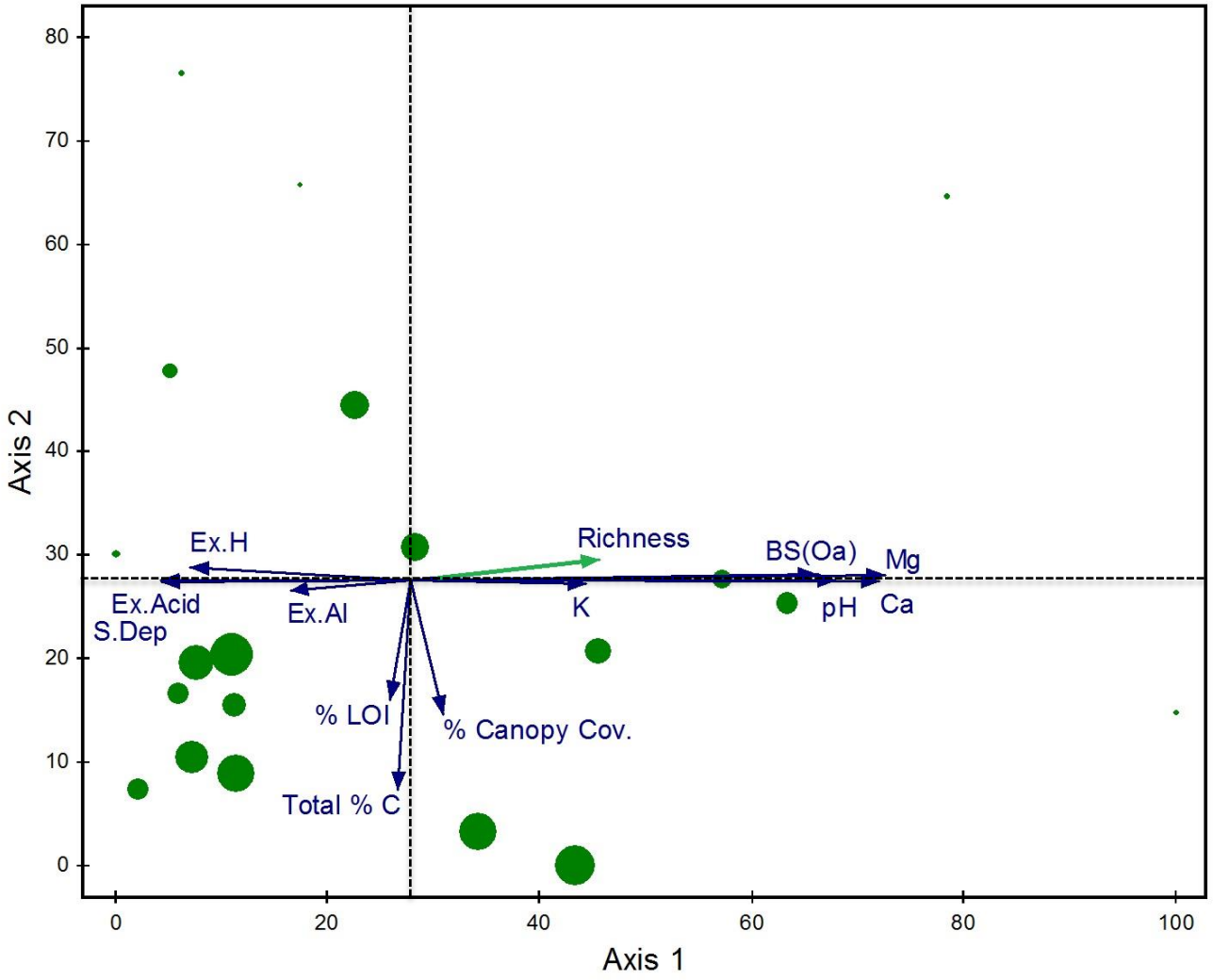
Frequency of *Dryopteris intermedia* among watersheds





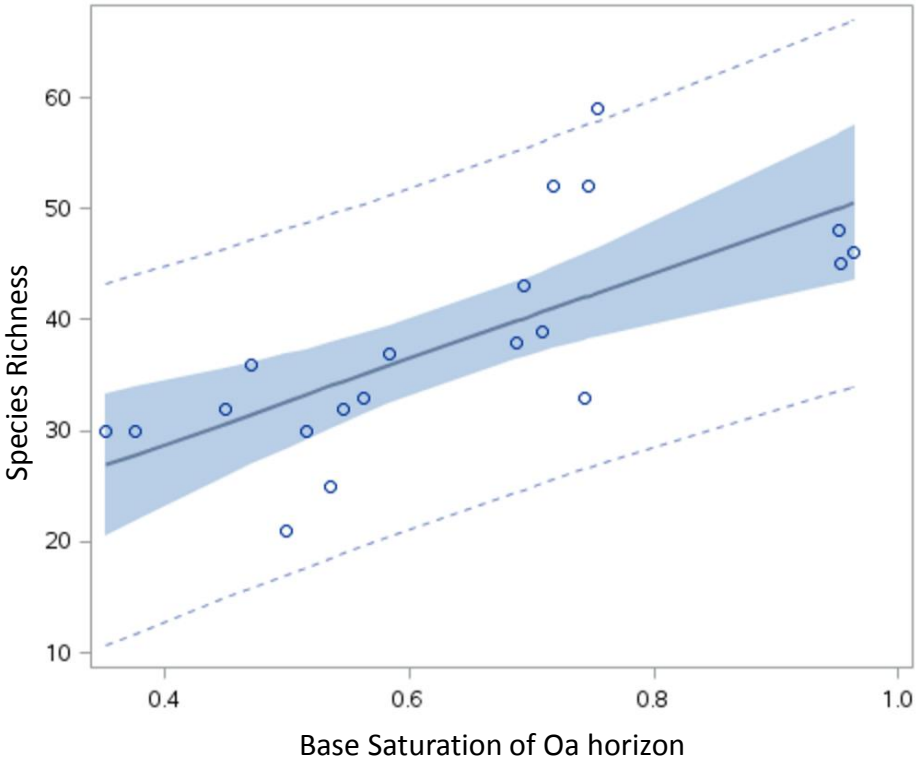
Correlations with axes
Axis 1: *r* = -0.855
Axis 2: *r* = -0.144

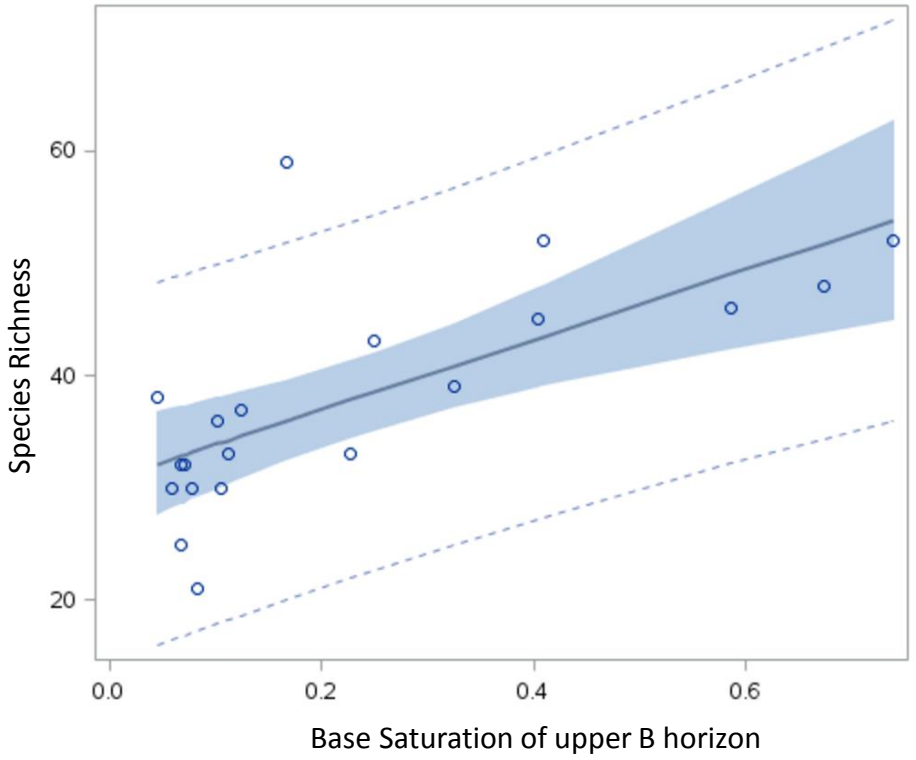
Frequency of *Huperzia lucidula* among watersheds



Correlations with axes
Axis 1: *r* = -0.255
Axis 2: *r* = -0.698

Effects of Base Saturation on Species Richness



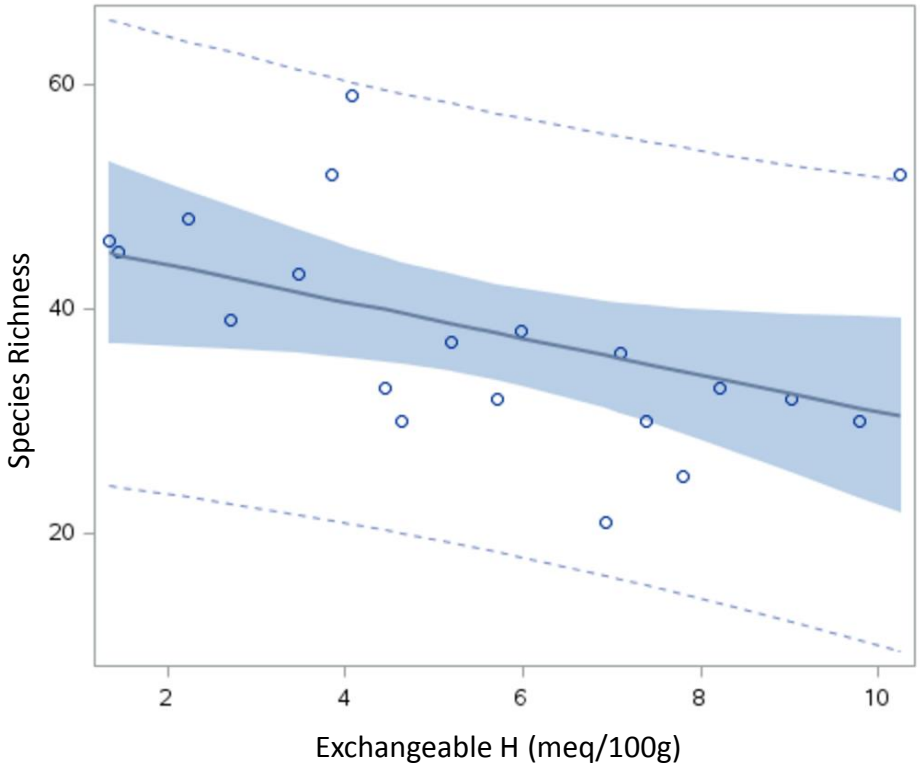


R-Square = 0.5062
P-value = 0.0004

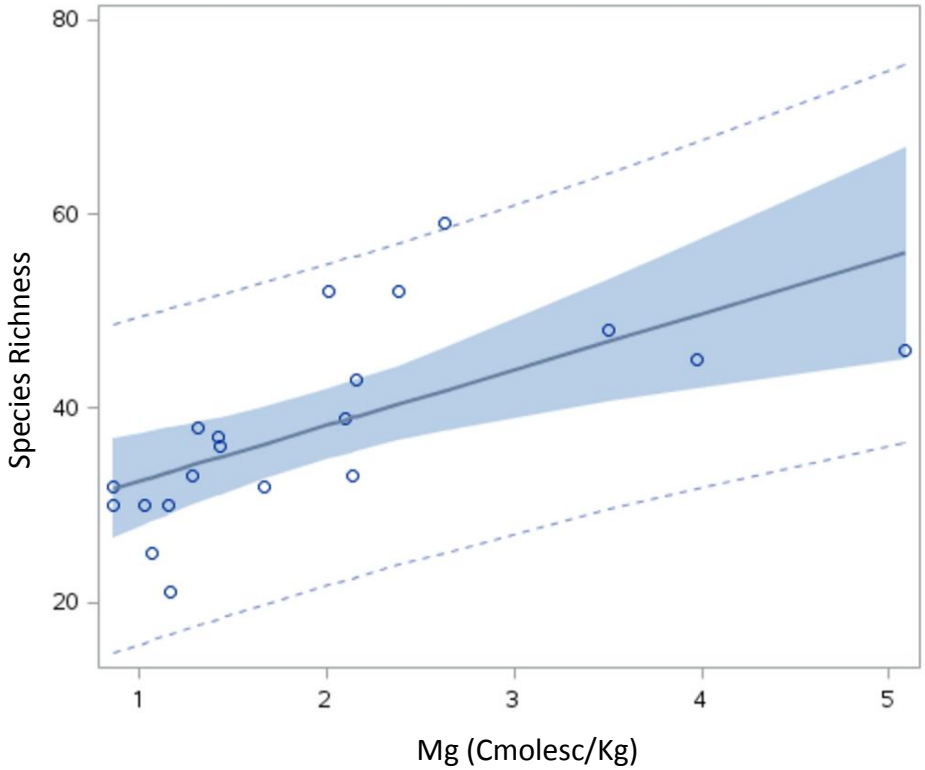
R-Square = 0.4735
P-value = 0.0008

Fit 95% Confidence Limits 95% Prediction Limits

Effects of H^+ and Mg on Species Richness



R-Square = 0.1977
P-value = 0.0495



R-Square = 0.4236
P-value = 0.0019

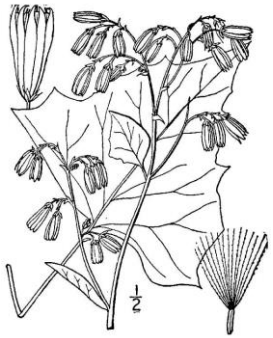
Fit 95% Confidence Limits 95% Prediction Limits

Indicators of Base Saturation < 12% in the upper B horizon

Species	Indicator Value	P-value
Dennstaedtia punctilobula	77.6	0.0056
Acer rubrum	70.8	0.012
Acer pennsylvanicum	65.4	0.023
Dryopteris intermedia	59.6	0.007

Note: “Indicator Value” represents relative abundance and constancy in either group

Indicators of Base Saturation > 12% in the upper B horizon



Species	Indicator Value	P-value
Arisaema triphyllum	81.6	0.0004
Fraxinus americana	80	0.0008
Acer saccharum	78.6	0.0002
Viola rotundifolia	64.1	0.0426
Prenanthes alba	60	0.0106
Tiarella cordifolia	56.8	0.019
Lonicera canadense	56.4	0.0106

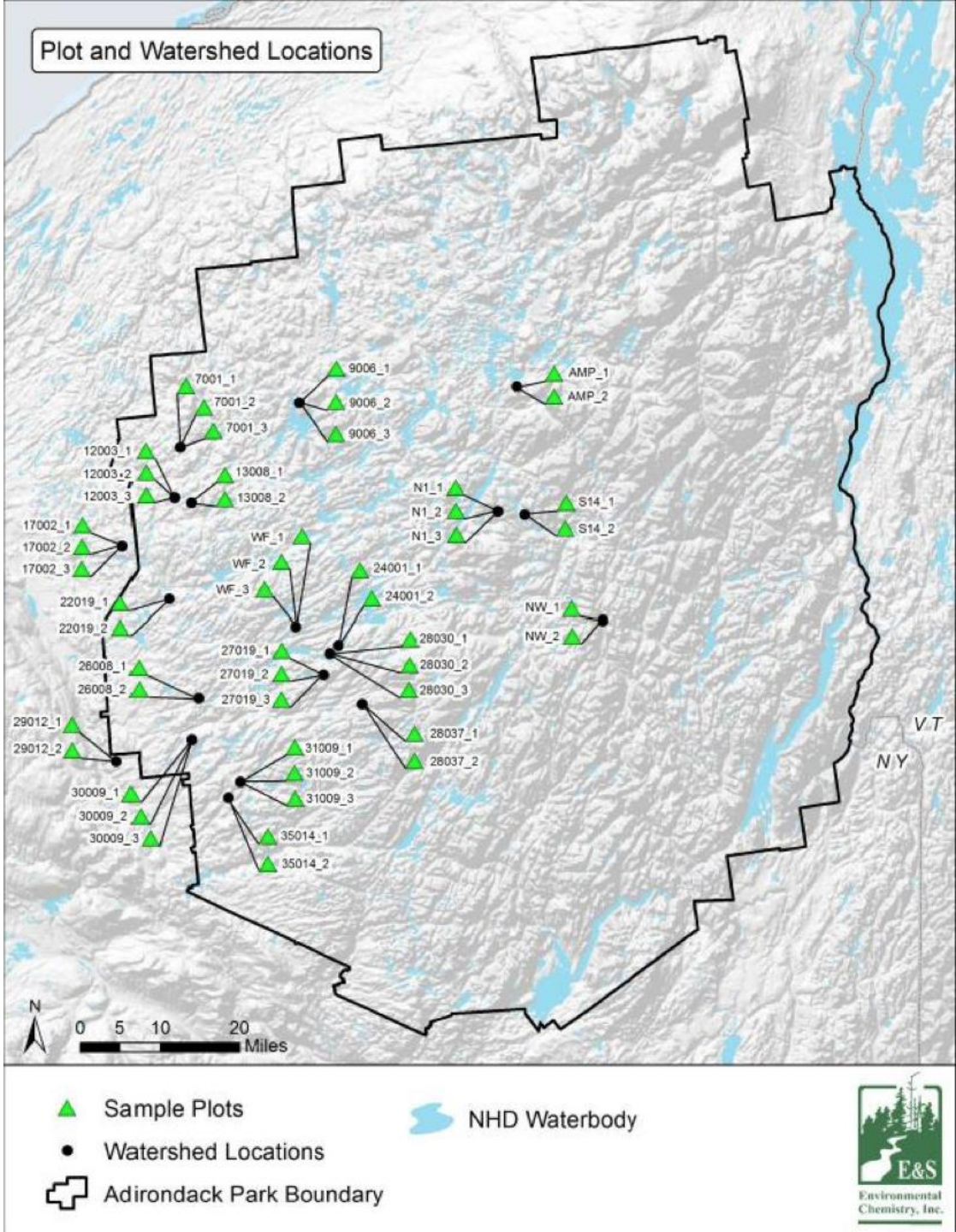
Note: “Indicator Value” represents relative abundance and constancy in either group

Conclusions

- Acid deposition correlated with soil acidification gradients!
- Species composition & richness correlated with both acid deposition and soil chemistry
- Some species served as indicators of soil acidification

Further Analysis

- Multivariate regression to parse influence of soil chemistry, moisture, and light variables
- Integrating deer browse
- Integrating other soil horizons



Potential Future Research

- Effects of decreased base saturation on the vulnerability of trees to disease (BBD)
- Foliar & litter chemistry across the deposition gradient
- Effects of Ca depletion on soil invertebrates and avian assemblages

Acknowledgements

Funding: NYSERDA

Project partners:

- E&S Environmental Chemistry
- USGS
- SUNY ESF

Permits: NYSDEC

Field crew: Jay Wason, Charlotte Levy, Timothy Callahan, Matthew Glaub

Other support:

- SUNY ESF Ranger School
- Adirondack Ecological Center