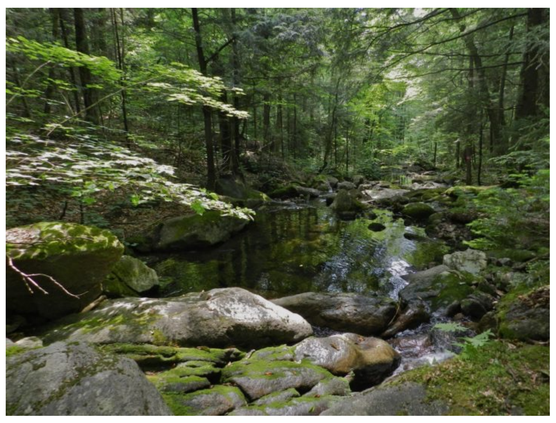
Changes in Seasonality & Nitrogen Oligotrophication through Leaf Litter Chemistry in the Northern Forests of Hubbard Brook

Ruby Gutierrez[1,2], Stephen Caron[2], Pamela Templer[2]
George Washington University Online High School,
44983 Knoll Square Room 153, Ashburn, VA 20147 [1],
Templer Lab, Boston University, Boston, MA 02215[2]

Introduction

- Nitrogen (N) is an essential, yet limiting nutrient in temperate forest ecosystems [2]
- Significant declines in soil N availability are brought about by a rise in temperatures, atmospheric carbon dioxide, and lengthening growing seasons, ultimately leading to possible increases in N resorption by trees and increases in leaf litter C:N ratios
- Increases in the concentration of carbon dioxide in the atmosphere could lead to greater leaf C:N that contributes to the observed declines in foliar N [3]
- A shift from N oversupply to N oligotrophication (a deficiency of nitrogen) occurred as a result of the Clean Air Act of 1990, which led to reductions in the supply of nitrogen as the demand for it increased due to climate change. Essentially, N demand by plants is not being met by N supply in soils of temperate forest ecosystems
- ***Our objective for the Litter Box Experiment is to discover whether litter C:N effects on microbial N demand during the spring can explain the patterns of N oligotrophication (soil N availability relative to plant N demand) in temperate northern forests***



Methods

- The litterbox experiment occurred at six sites along an elevated-climate gradient, creating variation in soil climate as well as in N microbial immobilization → This can aid in determining how changes across seasons play a role in N oligotrophication
- Three plots separated by 50 meters (m) were established at each of the six sites. One of the plots has native litter, another has low C:N litter collected in the early fall, and the third has high C:N litter collected in the late fall
- Foliage from two dominant species (sugar maple & American beech) were collected in early August and measured for N concentration
- Within the 18 litter manipulation plots, changes in N concentration in the decomposing litter are measured twice a year for three years (648 litter bag samples)
- Root ingrowth cores (strip of mesh that allows roots to grow freely in soil) and exclusion cores (extra mesh to prevent roots and other soil debris from entering them) in the 18 plots were installed to observe the role of litter C:N and climate measurements

Acknowledgements

Templer Lab of Forest Ecology
The Hubbard Brook Experimental Forest

Results

A

Sugar Maple Foliar Data	
Mean %N at High Elevation	1.44
Mean %N at Low Elevation	1.54
Mean %C at High Elevation	49.92
Mean %C at Low Elevation	47.36
Mean C:N at High Elevation	35.05
Mean C:N at Low Elevation	30.91

B

American Beech Foliar Data	
Mean %N at High Elevation	2.01
Mean %N at Low Elevation	1.83
Mean %C at High Elevation	48.50
Mean %C at Low Elevation	49.17
Mean C:N at High Elevation	24.41
Mean C:N at Low Elevation	27.96

Figure 1. Average foliar %N, %C, and C:N concentrations at high and low elevations in Sugar Maples (A) and American Beech trees (B).

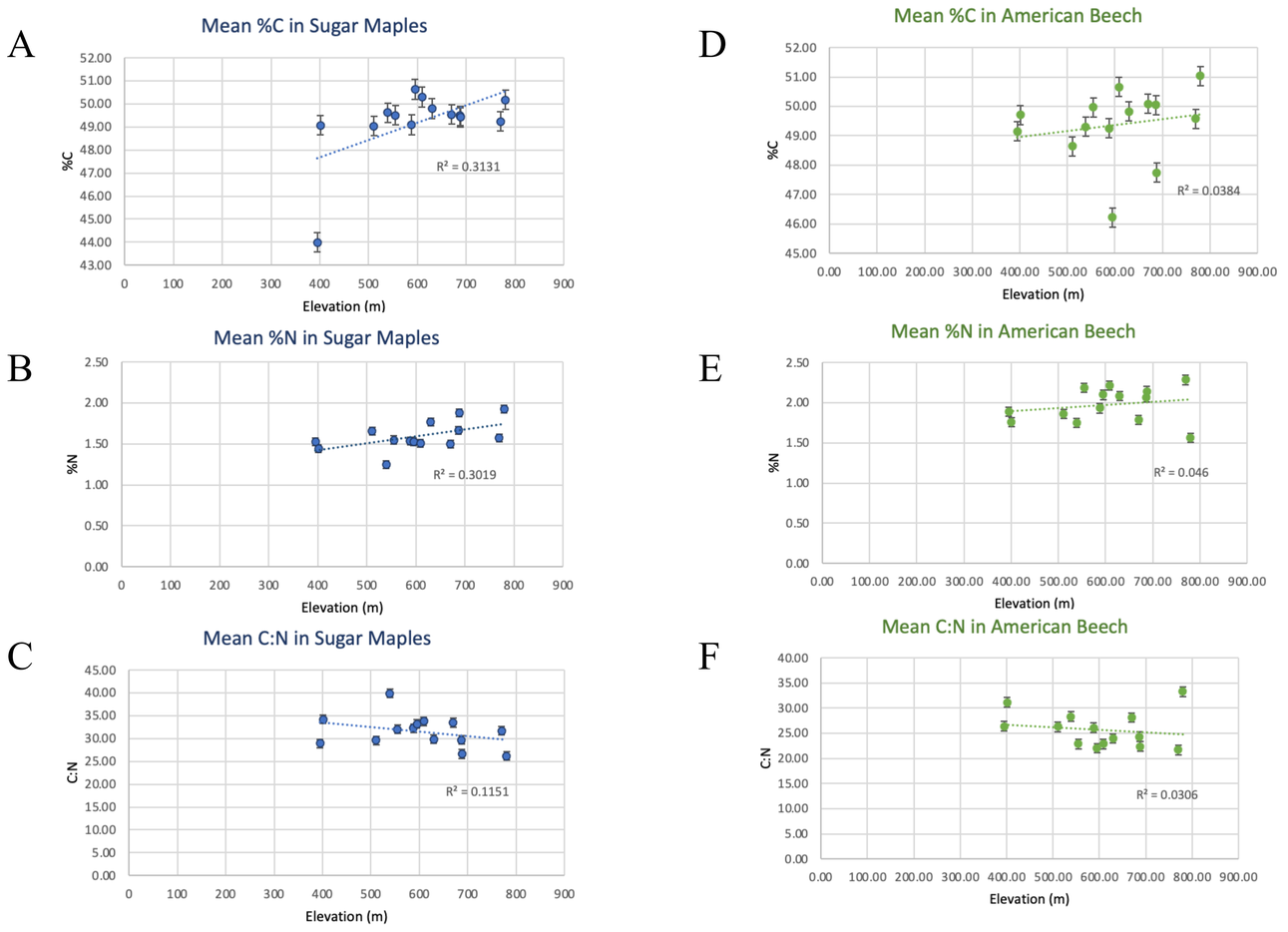


Figure 2. Average foliar %C, %N, and C:N concentrations over elevation (m) in Sugar Maples (A, B, C) & American Beech trees (D, E, F)

Discussion/Conclusions

- Our data helps us understand how increases in litter C:N may lead to N microbial immobilization, as well as a lower N uptake by trees in forests during the spring, potentially explaining the patterns of N oligotrophication in northern hardwood forests
- We found that foliar **C:N is greater** in sugar maple trees in comparison to American beech, that the foliar C concentrations in sugar maples has a **similar trend** to the American beech, and that the N concentrations in sugar maples is **lower** in comparison to American beech
- Foliar concentrations of C and N tend to increase with elevation, while foliar C:N declines with elevation. Increasing foliar N concentrations (i.e. N uptake) at higher elevations indicates that these trees, particularly sugar maple, may be increasingly susceptible to N limitation in a warming climate
- ***Based on our findings, we conclude that the amount of C and N uptake in these two tree species varies with elevation and climate, indicating that N oligotrophication is likely to continue to progress in northern hardwood forests***
- If there is to potentially be a higher litter C:N that leads to microbial N immobilization and reduced N availability to trees, then we can predict that our experimental data from this year and the next will show litter chemistry to be a mechanism of N oligotrophication

References

1 Templer, P.; Groffman, P.; Driscoll, C.; Fahey, F.; Garlick, S.; Reinmann, A.; Campbell, J.; Rustad, L. 2020. Changing Seasonality and Nitrogen Oligotrophication in the Northern Hardwood Forest. *NSF DEB Ecosystems Grant*.
2 Vitousek, P. M.; Howarth, R.W. 1991. Nitrogen Limitation on land and in the sea - How can it Occur? Biogeochemistry **13**:87-115.
3 Hiltbrunner, E.; Korner, C.; Meier R.; Braun, S.; Kahmen, A. 2019. Data do not support large-scale Oligotrophication of Terrestrial Ecosystems. Nature Ecology and Evolution **3**:1285-1296.