Persistence of the leaf economic spectrum across the temperate-boreal ecotone in New York and northern New England

Matthew Hecking[1] (mjheckin@esf.edu), **Julia Burton[1]**, **Jenna Zukswert[1]**, **Martin Dovčiak[2], and John Drake[2].**
State University of New York, Environmental Science and Forestry. Departments of [1]Sustainable Resources Management, [2]Environmental and Forest Biology

Background

Trait-based analyses help explain how forests are responding to climate change. Challenges may arise when a single mean value is used to describe traits, or when global trait covariation weakens at smaller spatial scales.

- Key concepts: species crossover, global trait covariation

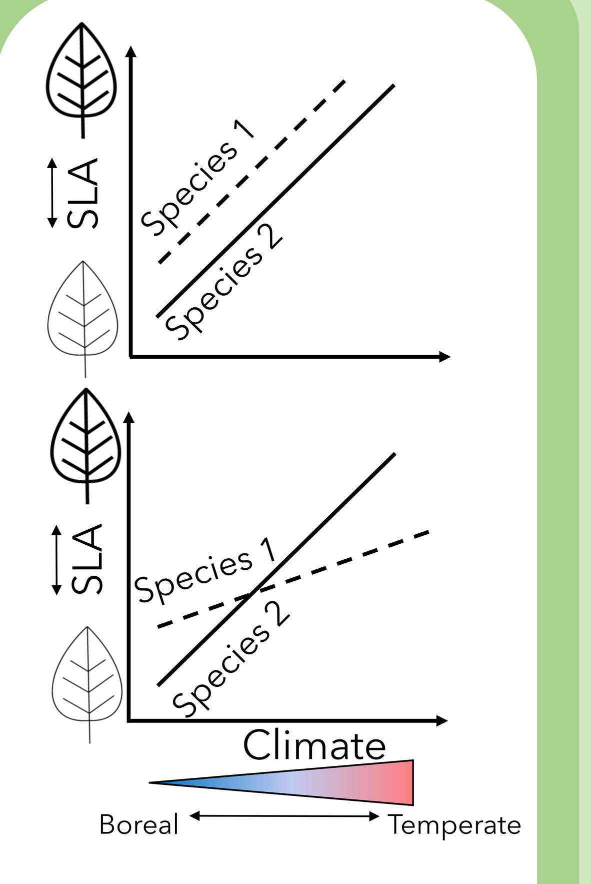


Fig 1. Theoretical example of species crossover

Study goal

Measure intraspecific trait variation and covariation in forest communities across local environmental and developmental gradients.

Research Questions

1. Are trait-trait relationships consistent at local scales?
2. How is trait variation partitioned amongst taxa?
3. How do traits vary across gradients?

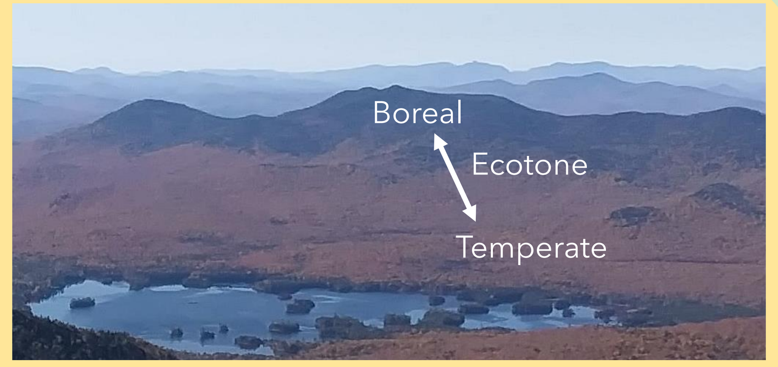


Fig 2. Example of the temperate-boreal ecotone

Materials and Methods

- Leaf and samples were collected from 13 tree species in established transects at elevations of 500-1000 masl.
- 5 light conditions, 3 developmental stages.
- Climate data was obtained from annual PRISM 1981-2010 norms.
- We addressed our research questions using 1) a non-metric multidimensional scaling analysis, 2) a variance partitioning analysis, and 3) a step-wise linear mixed model selection process, respectively.

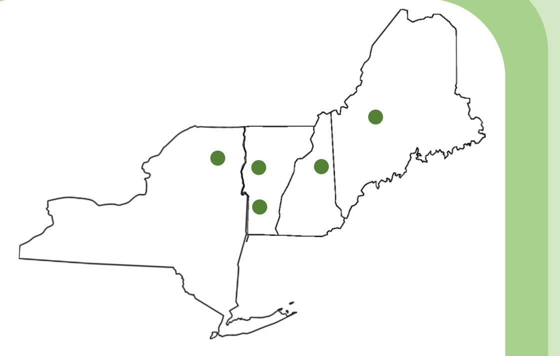


Fig 3. Study sites: Bigelow (ME), Madison (NH), Killington, Abraham (VT), and Whiteface (NY).

Results

1. We found that trait covariance resembled global level trends, suggesting that trait dimensions such as the LES persisted at local scales (Fig 4).
2. We found intraspecific trait variability differed considerably between traits. Taxonomic differences explained much of the observed variability in traits, largely driven by differences between angiosperms and gymnosperms (Fig 5).
3. There was little statistical evidence of species crossover. Environmental variation was an important component in many trait models (Fig 6).

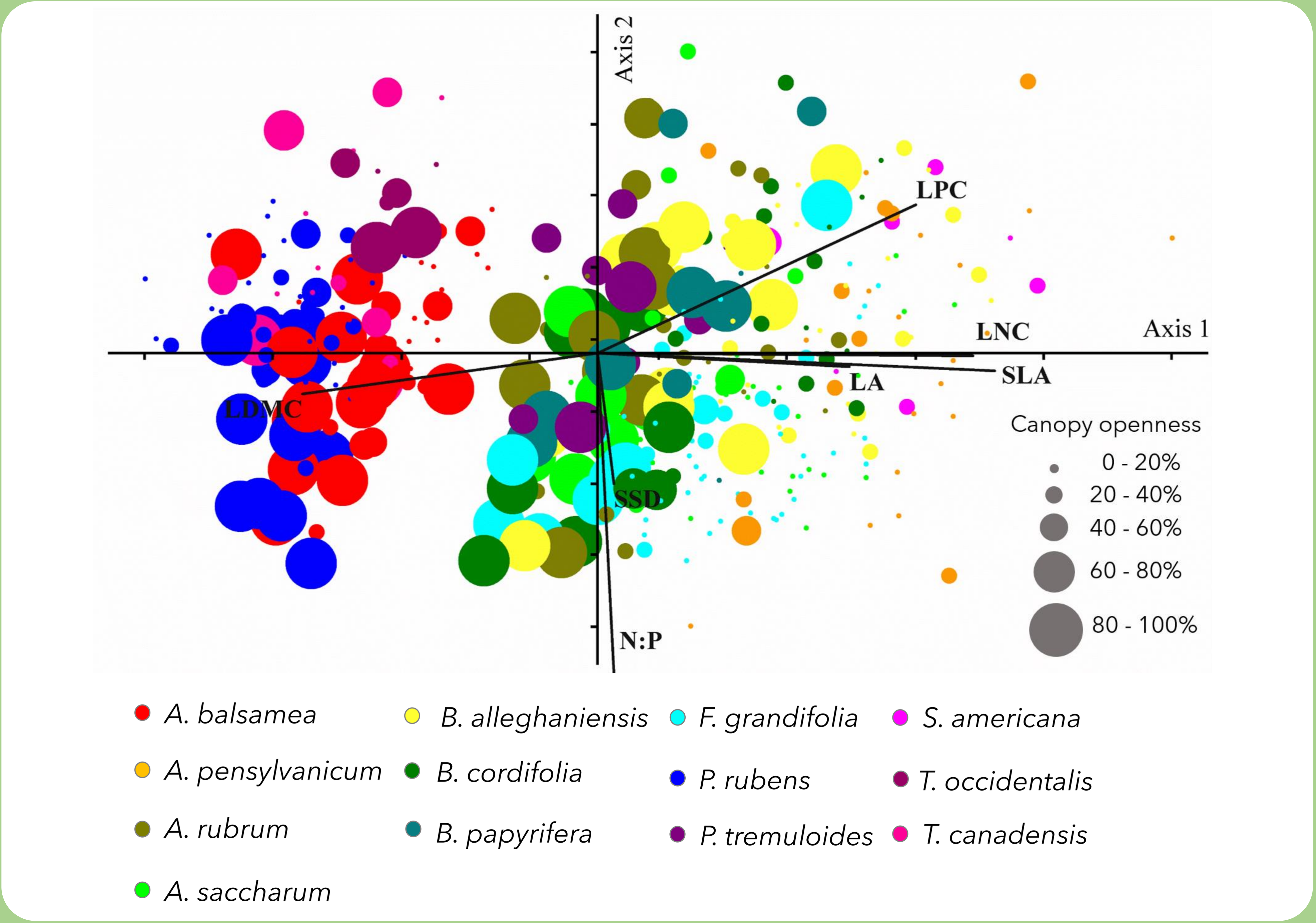


Fig 4. Ordination of functional traits overlayed against light openness. Increasing size of circles indicates increasing canopy openness advancing developmental stage. **SLA**, specific leaf area; **LNC**, leaf nitrogen concentration; **LPC**, leaf phosphorous concentration; **LDMC**, leaf dry matter content; **SSD**, stem specific density; **LA**, leaf area; **N:P**, leaf nitrogen to phosphorous ratio.

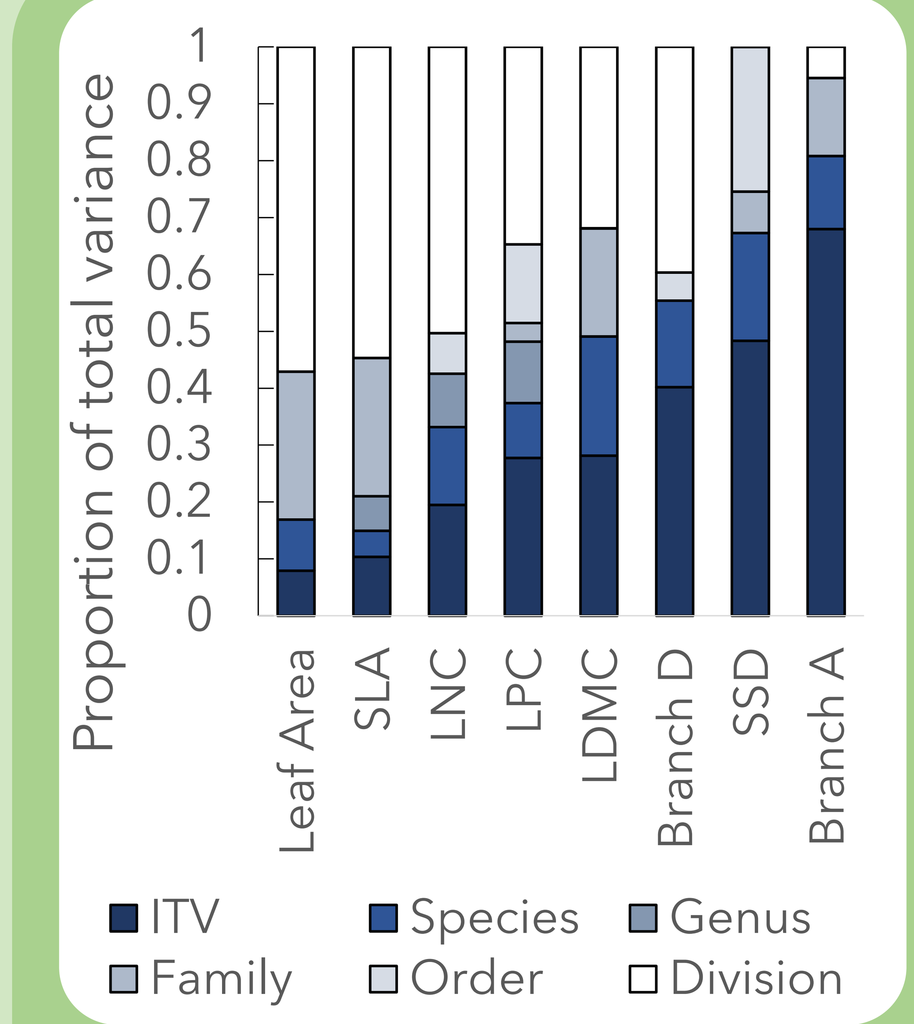


Fig 5. Variance decomposition of measured leaf and stem economic traits across different taxonomic units. **Branch A**, branch angle. **Branch D**, branch diameter.

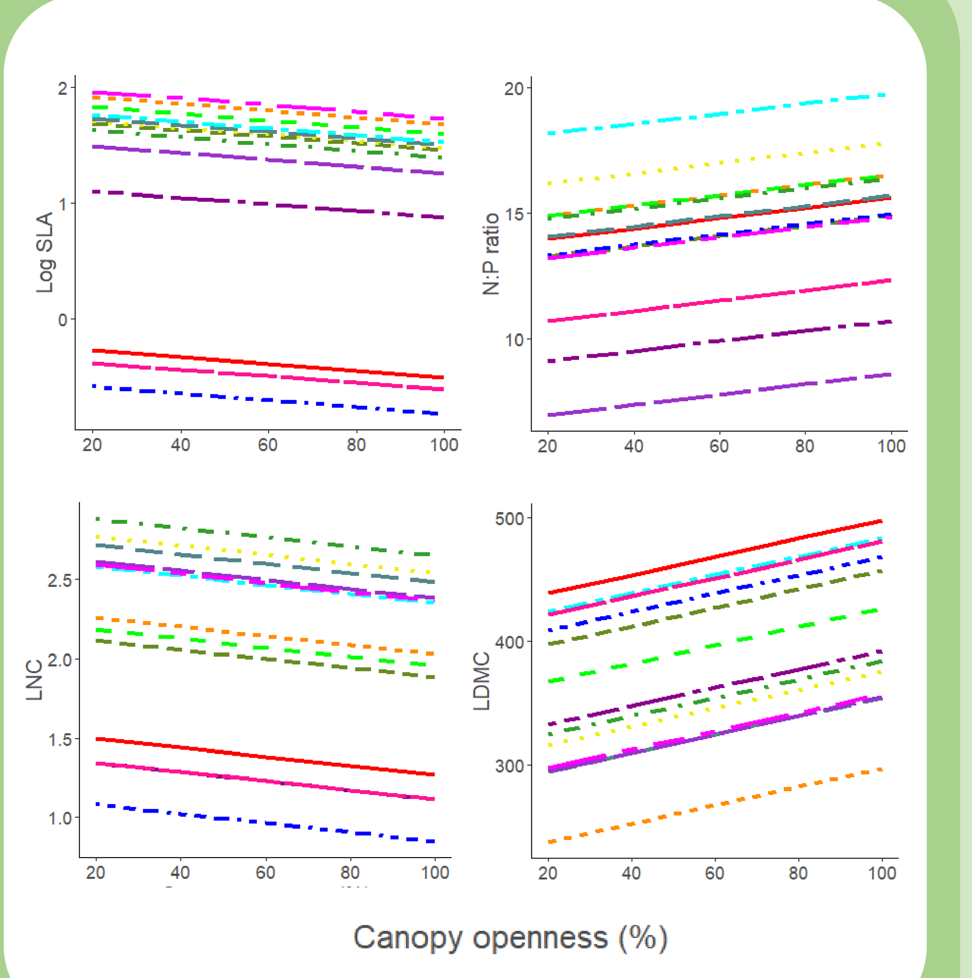
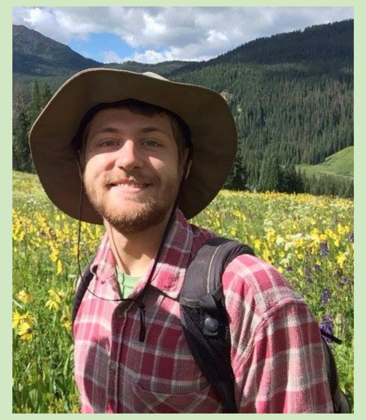


Fig 6. Selected best-fit models of traits to gradients of light. Colors correspond with species in Fig 4. Crossing lines are an indication of potential species crossover.

Conclusions

Collectively, our results showed that trees in temperate forests are aligned with the leaf economic spectrum (in contrast with previous studies), have low levels of intraspecific variability, and may be modeled with a single trait value over moderate spatial scales. However, other measured traits, specifically SSD and leaf N:P suggested trait dimensions beyond the LES are present at the spatial scale of our study. Environmental variables such as climate and light, as well as a plant's developmental stage, also play vital roles in determining trait values. Traits related to stem economics and branching architecture had higher levels of ITV, which may warrant additional study.



About the Presenter

Matthew (He/Him) is a graduate student of Dr. Julia Burton studying trait-based forest ecology.

Email: mjheckin@esf.edu

Sources

Burton JI, Perakis SS, McKenzie SC, *et al.* 2017. Intraspecific variability and reaction norms of forest understorey plant species traits (M Tjoelker, Ed). *Funct Ecol* **31**: 1881–93.

Messier J, McGill BJ, Enquist BJ, and Lechowicz MJ. 2017. Trait variation and integration across scales: is the leaf economic spectrum present at local scales? *Ecography* **40**: 685–97.

Wason JW and Dovciak M. 2017. Tree demography suggests multiple directions and drivers for species range shifts in mountains of Northeastern United States. *Global Change Biology* **23**: 3335–47