Assessing the Effects of Environmental Variables and Landscape Change on Tree Stands at The Ridges Land Lab

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Why research forests?

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- Forests are crucial to maintaining biodiversity and ecosystem health
- Proper management requires understanding forest dynamics
- Recent anthropogenic change has endangered forests
- Forest landscapes are incredibly important but at risk

Importance of Landscape Variables

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- Can explain small-scale differences in composition
- View conclusions at different scales (site-to-site vs. landscape)
- Understand environmental change
- Look at disturbance regimes

Hypotheses

- Landscape factors (slope, aspect, and elevation) have a limited effect on tree diversity and density.
- Tree size by species is not distributed randomly and have clear patterns in size distributions.
- Shade tolerance (≈ successional state) is related to the size distribution of tree species.

Study Site

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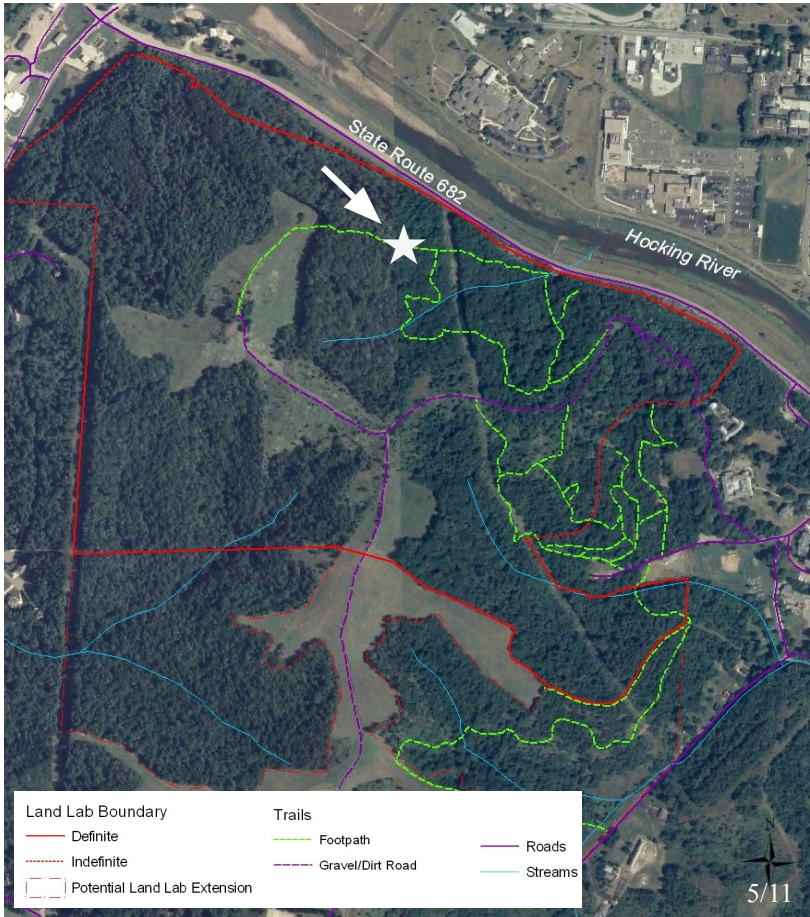
Ridges Land Lab [1]

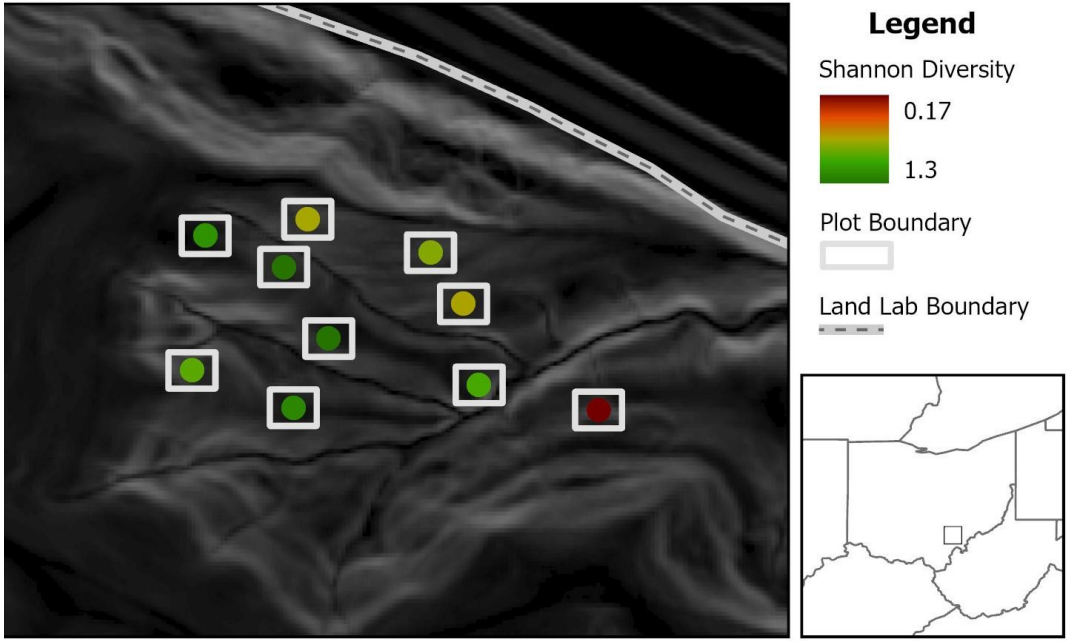
- Oak and maple dominated forests. Previously more oak-beech forest type.
- 163 acres. Partially disturbed forests with mixed infrastructure and preserved natural areas.
- Used as an environmental research area for Ohio University.



[1] Ohio University (2015)

Field & Statistical Methods

- Delineated ten 15 x 15 meter plots
- All trees within measured and IDed
  - Only those taller than breast height
- Density (basal area / plot area) and Shannon diversity calculated [1]
- Slope, aspect, and elevation pulled from DEM
- Used linear models and generalized linear models with Poisson distributions [2]



[1] Oksanen et al. (2022)
[2] R Core Team (2023)

Results – Environmental Variables

1. **Slope and Shannon diversity:**
   < -0.01; $F_{1,8} = 0.29$, $P = 0.87$; $R^2_{adj} = -0.12$

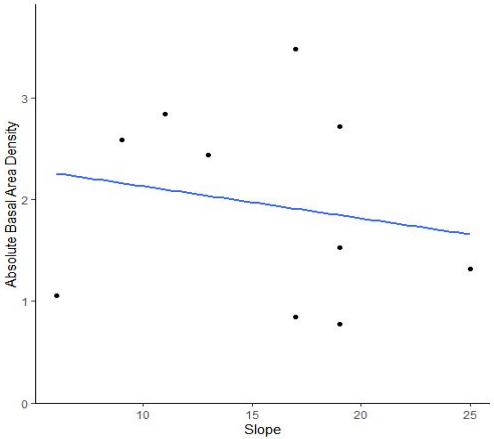
   Slope and density:
   -0.03; $F_{1,8} = 0.29$, $P = 0.61$; $R^2_{adj} = -0.09$

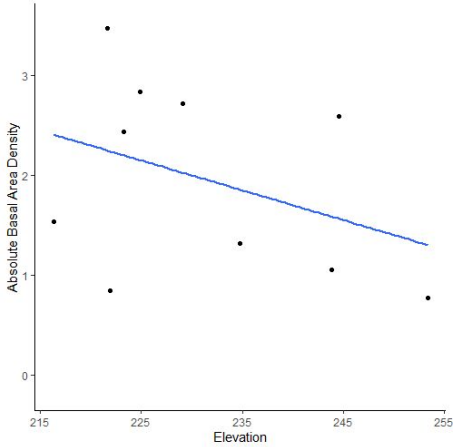
2. **Elevation and Shannon diversity:**
   < 0.01; $F_{1,8} = 0.33$, $P = 0.58$; $R^2_{adj} = -0.08$

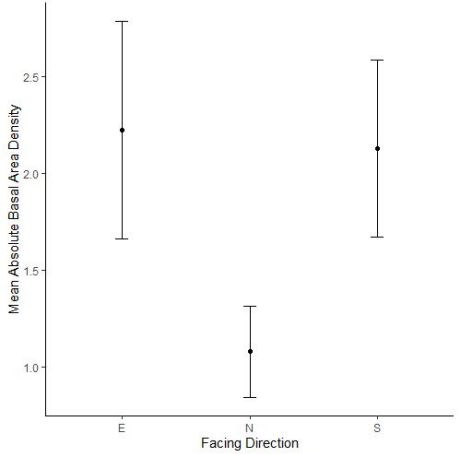
   Elevation and density:
   -0.03; $F_{1,8} = 1.35$, $P = 0.28$; $R^2_{adj} = 0.04$

3. **Aspect and Shannon Diversity:**
   E: 0.83 ± 0.22; N: 0.48 ± 0.45; S: 1.12 ± 0.16;
   $F_{2,7} = 4.68$, $P = 0.051$

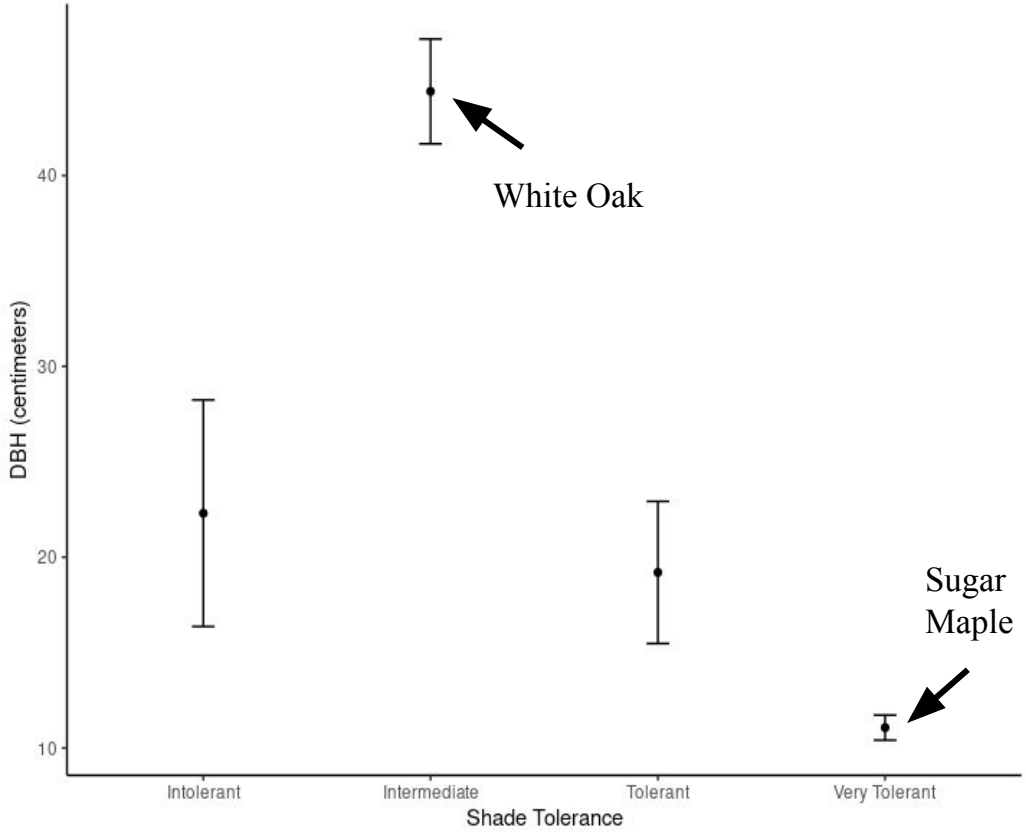
   Aspect and density:
   E: 2.22 ± 1.12; N: 1.08 ± 0.33; S: 2.13 ± 0.91;
   $F_{2,7} = 1.06$, $P = 0.39$







Results – Tolerance

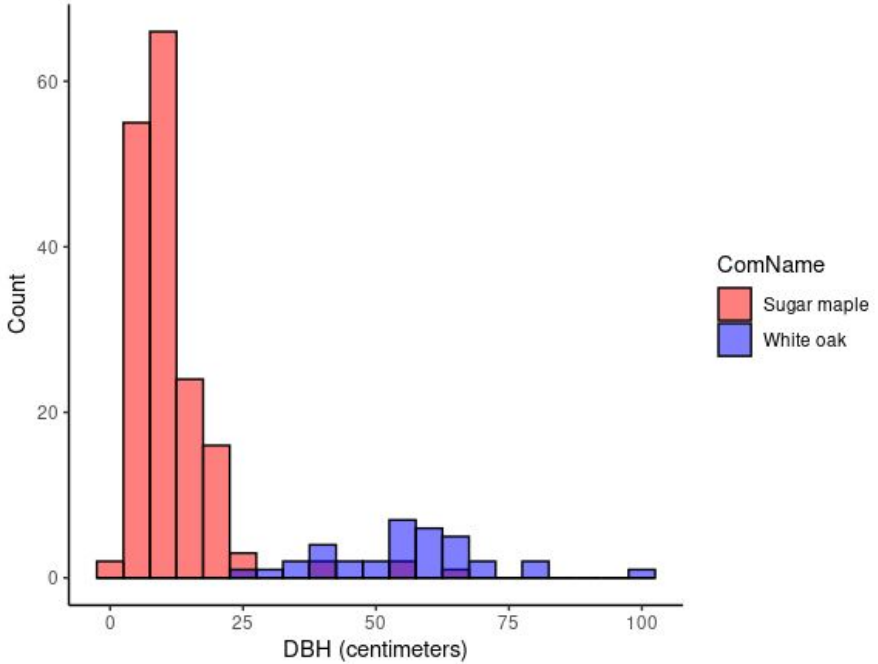


Shade tolerance and size:
Intolerant: 44.41 ± 2.75;
Intermediate: 22.30 ± 5.93;
Tolerant: 19.20 ± 3.72;
Very Tolerant: 11.07 ± 0.66;

$F_{11,231} = 96.85$, $P = < 2.16e\text{-}^{16}$ ***; $R^2_{adj} = 0.69$

Results – Species Curves

Found Species Distributions

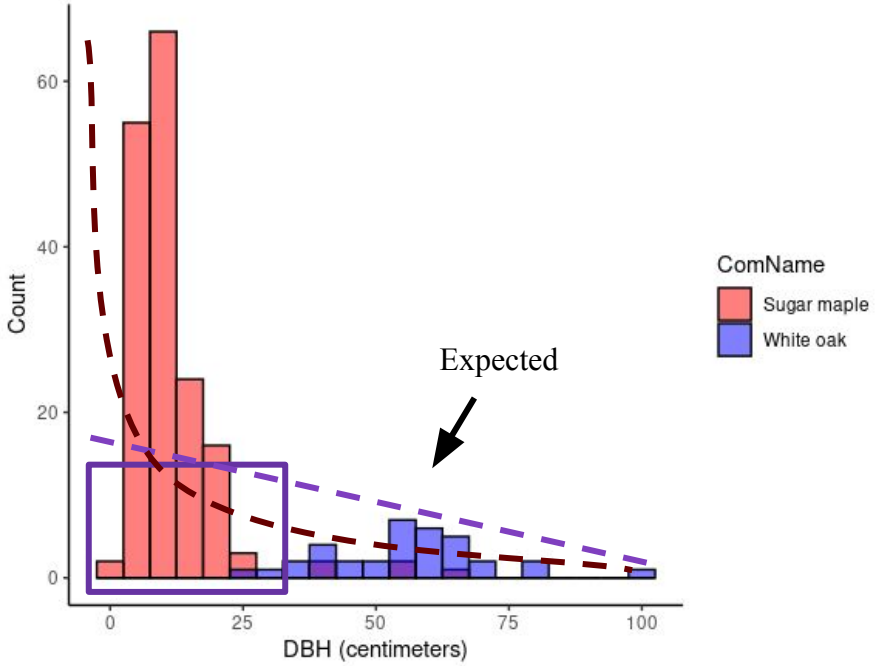


DBH and Species:

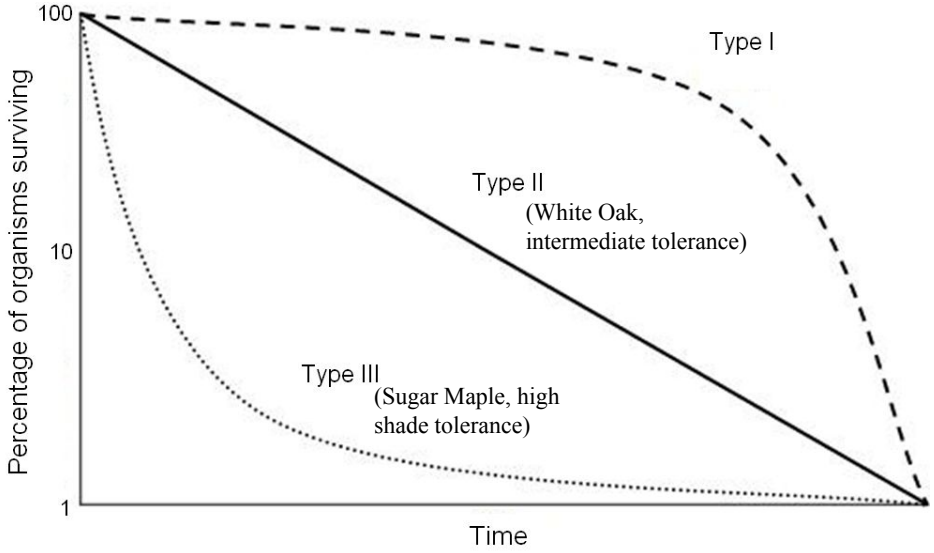
White Oak: z = 7.54, $P = 4.61e^{-14}$ ***;
Sugar Maple: z = 2.69, $P = 0.007$ ***

Results – Species Curves

Found Species Distributions



Expected Species Distributions (K vs. r selection)

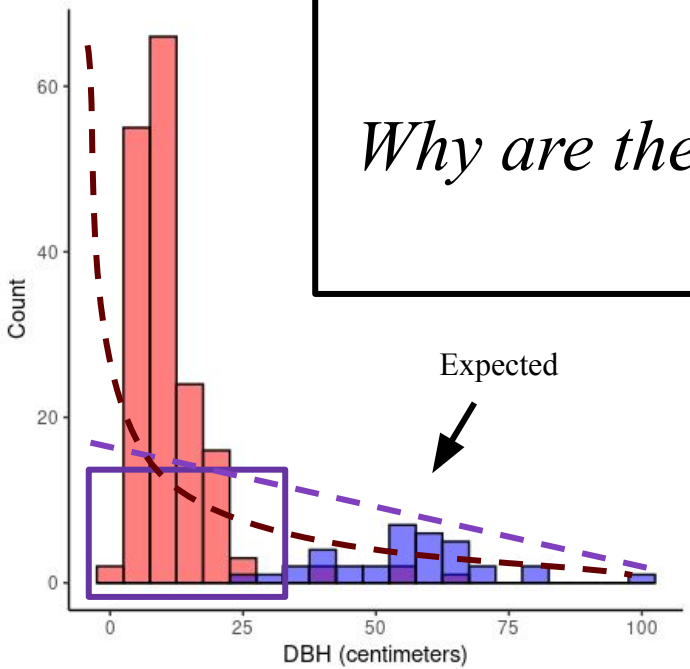


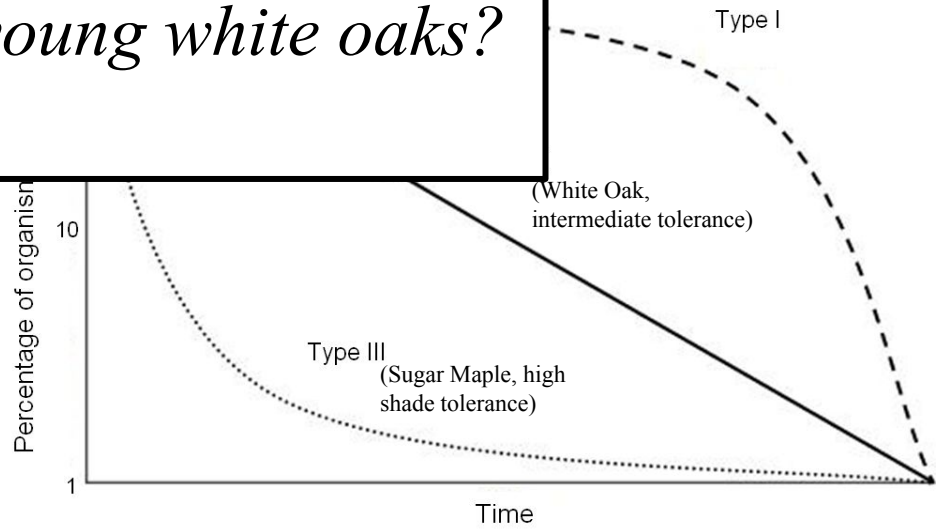
Results – Species Curves

Found Species Distributions

Expected Species Distributions (K vs. r selection)

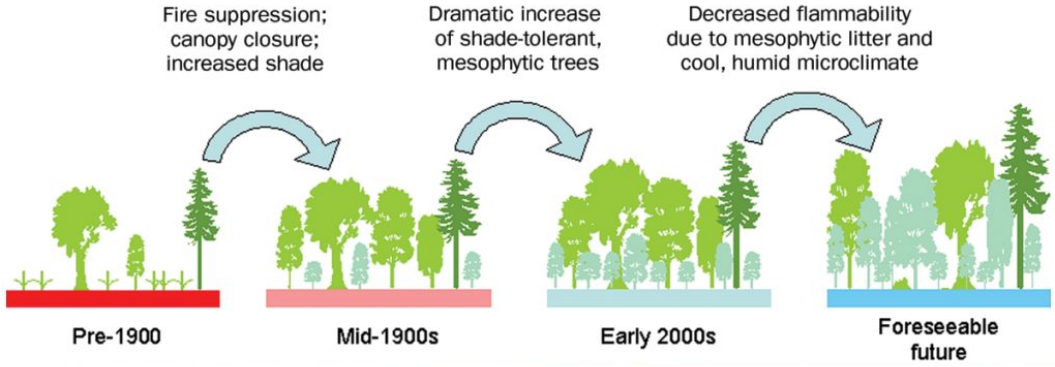
Why are there no young white oaks?

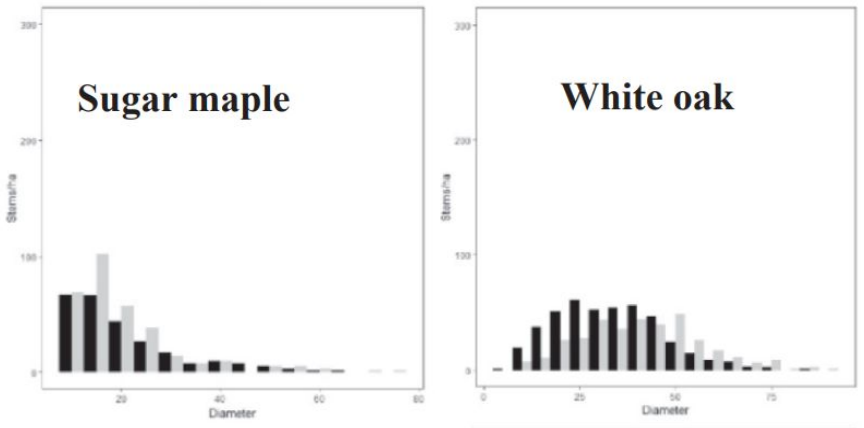




Interpretation

- Landscape variables have a small effect on composition
- Mesophication is occurring
- Preference for maples over oaks
  - Supported by other research[1]
- Reasons: fire suppression and climate change [1,2]
  - Water availability, canopy closure, and leaf litter [2,3]





Wayne National Forest: Palus et al., 2018

[1] Palus et al., 2018 [2] Babl-Plauche et al., 2022 [3] Pederson et al., 2014

Implications of Mesophication

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- Mesophication decreases overall diversity
- Removal of oaks negatively impacts specially adapted species
- When fires do happen, they are worse
- Wetter conditions increase flooding, erosion, and local hydrology

Questions?

(*& Comments/Concerns*)

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