LANDSCAPE HETEROGENEITY INFLUENCES DIVERSITY OF SHRUBS AND TREE SPECIES IN TEMPERATE MIXEDWOOD FORESTS

Rudiger Markgraf, Frédérik Doyon, Daniel Kneeshaw and Marc Mazerolle
Plant diversity

- More than **120 hypotheses** identified by Palmer (1994)

- A hierarchical top down approach:
  - Climate regionally
  - **Environmental heterogeneity at intermediate scales**
  - Competition at local scales

Environmental heterogeneity

a. Species-Area Curve

Species Diversity vs. Area (ha)

(Rosenzweig 1991)
Environmental heterogeneity

b. Area & Habitat Diversity

Number of Habitats vs Area (ha)

(Rosenzweig 1991)
Environmental heterogeneity

Species Diversity

(c. Habitat Diversity Controls Species Diversity

Species Diversity vs. Number of habitats

(Rosenzweig 1991)
Environmental heterogeneity

- Heterogeneity correlates with richness

- Do not confuse with fragmentation studies
  - Non contiguous landscapes

- **Does this mean we should manage for heterogeneity?**
Introduction

Methods

Results

Conclusion

Species diversity will be greatest in heterogeneous landscapes having experienced multiple intermediate disturbances
Local diversity - Biomass diversity relationship

- 30 years of debate
- Hump-shaped relationship

(Adler et al. 2011)

Graph: Complementarity? vs. Biomass

(Grime 1979)
Biomass diversity

Species Diversity

Live Biomass

(Adler et al. 2011)
Methods

Index = variability
→ stand density
→ stand height
→ stand patch size
window size $= 1\text{km}^2$
Methods

12 landscapes (1 km$^2$)
223 gap and forest sites
1101 microquadrats

All on mesic soils
2 disturbances histories
Partial harvest
Partial harvest + SBW outbreak
## α Diversity

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<thead>
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<th>Shannon</th>
<th>Richness</th>
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<td><strong>Shrubs</strong></td>
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<td>Het &gt; Mod P(f) = 0.03</td>
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<td>Het &gt; Hom P(f) = 0.01</td>
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<td><strong>Tree seedlings</strong></td>
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<td>Hom &gt; Het P(f) = 0.02</td>
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<td><strong>Tree saplings</strong></td>
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<td>Hom &gt; Het P(f) = 0.05</td>
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**Hypothesis rejected for tree α-diversity**

*Statistics - Two factor ANOVA mixed models with gap or forest site identifier as the random factor*
Shrubs – β and γ Diversity

**Number of shrub species**

**Number of microquadrats (5 m²)**

- **Homogenous**
- **Moderate**
- **Heterogeneous**
Shrubs – $\beta$ and $\gamma$ Diversity

Hypothesis confirmed for $\beta$ and $\gamma$ Diversity
Trees – β and γ Diversity

Number of tree species (seedlings)

At small scales homogenous has greater α-diversity

Number of microquadrats (5 m²)
Trees – $\beta$ and $\gamma$ Diversity

Hypothesis confirmed for $\beta$ and $\gamma$ Diversity
Tree & shrub density vs. landscape heterogeneity

- Shrubs
- Trees

Heterogeneous
Moderate
Homogeneous
Diversity Biomass Relationship

A MAINLY positive relationship

Some sites with lower diversity

$R^2 = 0.2564$
Could the shrub response to heterogeneity simply be due to greater density? And not biological processes?
Rarefaction

Number of shrub species

Sample size

- Heterogeneous
- Moderate
- Homogeneous
**Introduction**

- Number of tree species (seedlings)

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**Methods**

- Sample size

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**Results**

- Homogenous
- Heterogeneous
- Moderate

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**Conclusion**
Conclusion

1. Hypothesis rejected for tree seedlings
   - $\alpha$-diversity in *Het* landscapes

2. Increased heterogeneity from multiple intermediate disturbances (SBW, tree harvest) favor the density and diversity of shrubs, and limits the density and diversity of trees

   shrub diversity in *Het* landscapes result of greater shrub density in *Het* landscapes? NO! Rarefaction results suggest a biotic interaction
3. Management implications heterogeneous landscapes are not necessarily more diverse for trees

**SPB + Cut + Natural disturbance = TOO MUCH!**

3.5 Precautions must be made in forest management to avoid crossing a threshold in landscape heterogeneity. Comprehension of previous disturbances must therefore be taken into account for future planning.