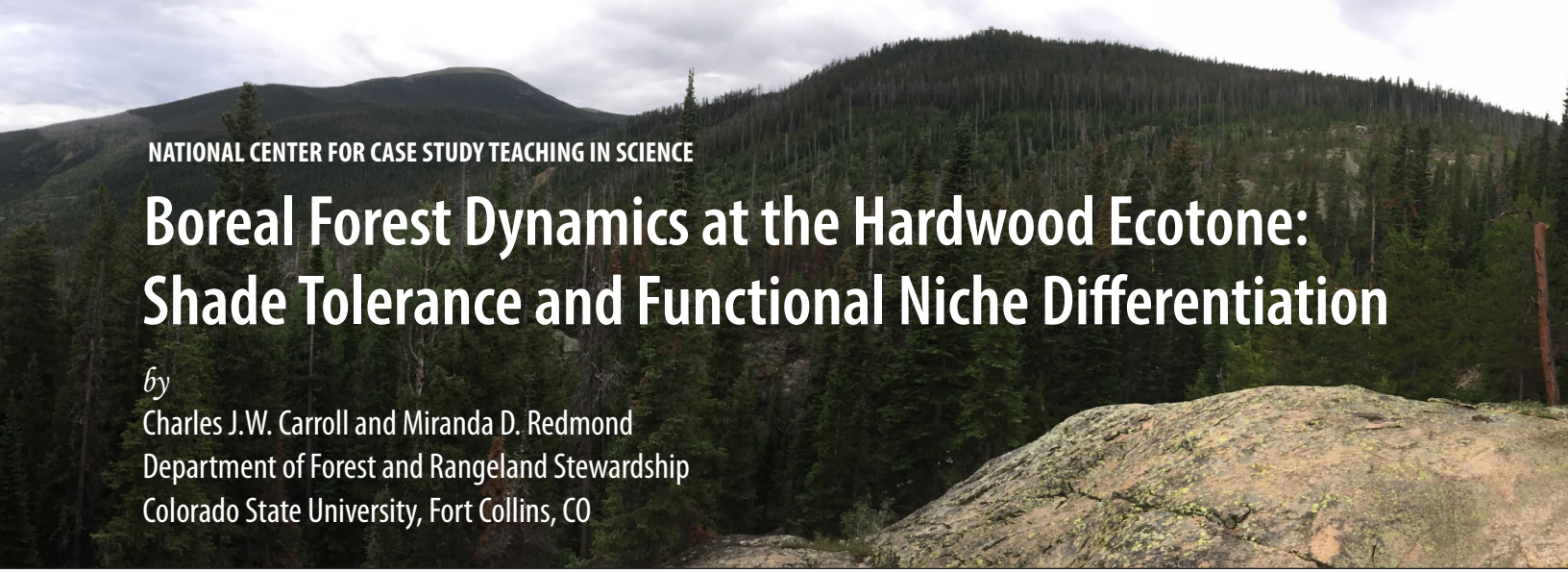

NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Boreal Forest Dynamics at the Hardwood Ecotone: Shade Tolerance and Functional Niche Differentiation

by
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Pre-Class Assignment

Acidification of the montane habitat of red spruce (*Picea rubens*) contributed to substantial mortality in the second half of the 20th century (Siccima *et al*., 1982). Recently, reduction in acid rain pollution in the eastern United States has led to a rebound in red spruce abundance. Often found co-occuring with balsam fir *(Abies balsamea)*, these two coniferous trees represent some of the most important species of the boreal forest in the northeast United States. With warming temperatures leading to shifting forest distributions, the ecotone between these slower-growing boreal species and the encroaching faster-growing northern hardwood trees has resulted in shifts in the competitive interactions among these groups of species and raises the question of how these two boreal trees will interact with one another.

To prepare for the class meeting, please define the following terms.

*Boreal forest:*_____

_____

Functional trait: _____

_____

Life history strategy: _____

_____

Ecological niche: _____

_____

Ecotone: _____

_____

_____

In-Class Questions

1. Which life history strategies would help trees survive understory conditions in an undisturbed forest?

2. Draw what you think the responses of these traits are to increasing shade. Use different lines (e.g., full line, dashed, dotted) to denote the following different traits: leaf mass per area (LMA), wood density, and leaf dry matter content (LDMC). Be sure to label the axes.

3. Using Figure 1 on the following page, which species appears to be more shade tolerant based on leaf mass per area? Do the other two traits lead to the same conclusions regarding shade tolerance?

4. Based on Figure 2 on the following page, how do you expect the interactions of these two boreal species to shift in the future at this ecotone?

5. How confident do you feel about your previous answer?

6. What are two limitations of this study? Please provide some potential solutions to these limitations.

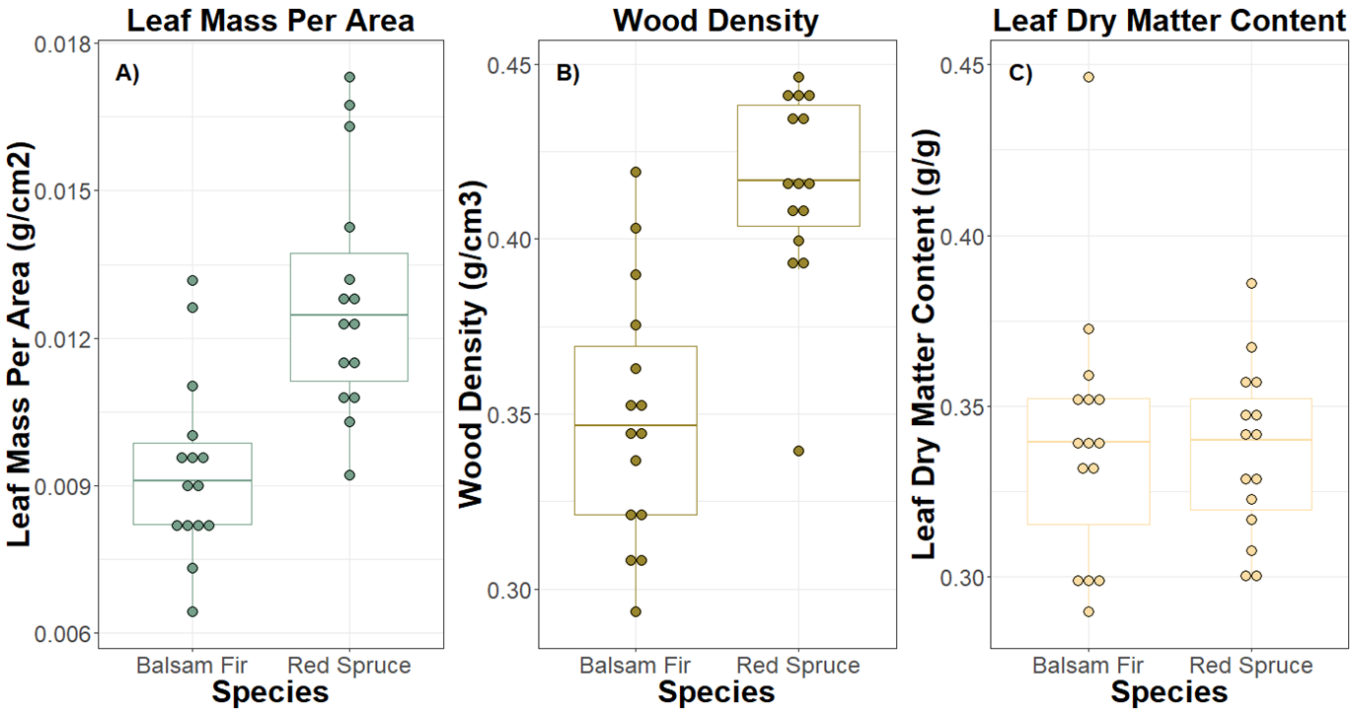

Figure 1. Trait values for balsam fir and red spruce trees at the ecotone. The middle line of each box corresponds to the mean trait value, with each dot representing the value from a single tree. The left panel shows leaf mass per area (LMA, g cm^2), the middle panel depicts stem wood density (g cm^3), and right panel shows leaf dry matter content (gram of dry weight per gram of fresh weight), a measure of how much structural tissue makes up the total weight.

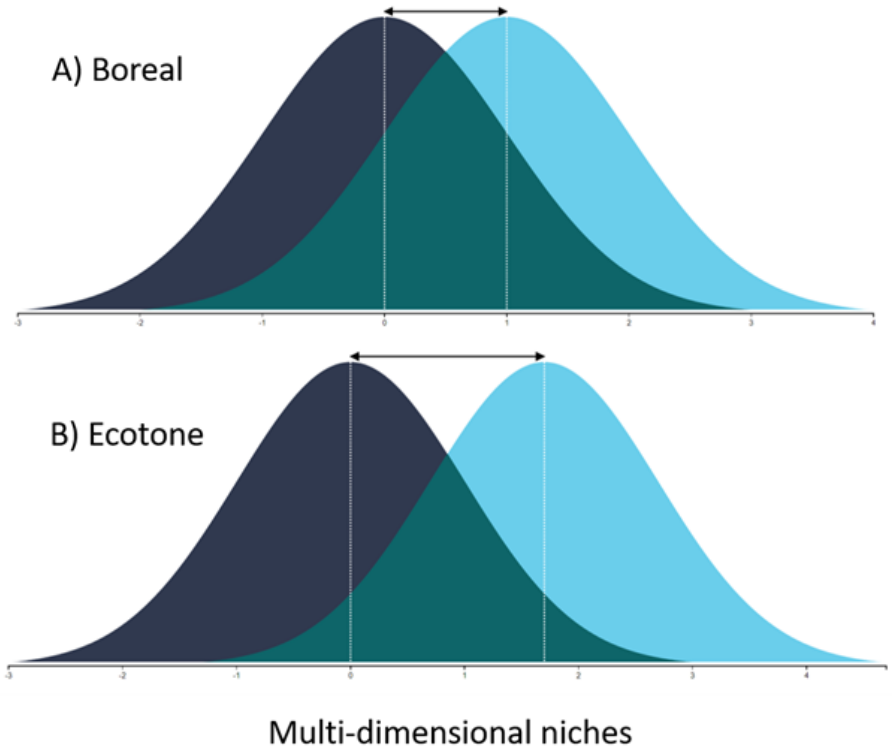

Figure 2. Multi-dimensional niche overlap for balsam fir and red spruce trees at A) the boreal population and B) the ecotone population. The darkest and lightest blues represent the niches of the two species, with the teal section showing the niche overlap. *Credit:* Image created with web app authored by K. Magnusson, *R Psychologist,* <https://rpsychologist.com/d3/cohend/>.