Using Western Hemlock Regeneration to Explore Potential Climate Responses in Old-Growth Forests of the Pacific Northwest

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Introduction and Background

A complex combination of physical and biological processes determines the distribution of species across landscapes. Global climate change is a major factor accelerating shifts in species distributions. Simulated studies predict that future climatic conditions will result in significant impacts to forest ecosystems of the Pacific Northwest, including range changes for Abies amabilis, Tsuga heterophylla, and Pseudotsuga menziesii (Shaffer et al. 2001). While many species will move upward and poleward in response to a warmer climate, other species may remain static or shift in the opposite direction due to physical or biotic variables such as available moisture and increasing biotic interaction (Ettinger 2011). Our study closely examines Tsuga heterophylla in order to determine whether the species has shifted upslope along a forest ecotone, and, if in fact a shift is occurring, what variables are most responsible for this shift. Understanding the variables driving both species distribution and composition changes is crucial to understanding the future of all ecosystems.

HJ Andrews Experimental Forest

The HJ Andrews Experimental Forest (HJA) is a 6400 ha research forest located in the Willamette National Forest. The forest is one of 25 Long-Term Ecological Research (LTER) sites in the United States, and is comprised of 40% old-growth forest. The elevation range within the Lookout Creek drainage basin is 410 m to 1630 m above sea level. The lower elevation forests are dominated by Pseudotsuga menziesii (Douglas-fir), and the higher elevation forests are dominated by Abies amabilis (Pacific silver fir), and Tsuga heterophylla (Western hemlock), and Mountain Hemlock (Tsuga mertensiana).

Methods

- **Materials**: 10 randomly selected transects were investigated within the HJA, along with the site boundaries, in 3rd and fourth growth.

- **Sampling**: Recorded the height where lichen begins to grow on nurse logs on the forest floor (Table 1). This finding is consistent with recent studies that indicate more snow packs that persist into the summer in the past decade (Figure 9). Western hemlock regenerates very successfully, but also has a higher seedling mortality rate than the true firs it competes with at the studied ecotone.

- **Climate Trends**: Precipitation has not changed significantly over the past century in the Pacific Northwest. The relative precipitation between 2001 and 2011 (Figure 9) shows a short-term trend of higher precipitation and lower temperatures. This trend is more pronounced than the true firs it competes with at the studied ecotone.

Results

- **Western Hemlock Regeneration**: The HJA Andrews Experimental Forest (HJA) is a 6400 ha research forest located in the Willamette National Forest. The forest is one of 25 Long-Term Ecological Research (LTER) sites in the United States, and is comprised of 40% old-growth forest. The elevation range within the Lookout Creek drainage basin is 410 m to 1630 m above sea level. The lower elevation forests are dominated by Pseudotsuga menziesii (Douglas-fir), and the higher elevation forests are dominated by Abies amabilis (Pacific silver fir), and Tsuga heterophylla (Western hemlock), and Mountain Hemlock (Tsuga mertensiana).

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Discussion and Conclusion

Our examination of Western Hemlock seedling regeneration reveals that the spread of seedlings is best explained by the presence and density of Western Hemlock in the forest overstory (Figure 7) and nurse logs on the forest floor (Table 1). This finding is consistent with recent studies that indicate more localized precipitation events and biotic interactions near the range limit of species in climatic-overstory forests (Ettinger 2011). Western Hemlock regenerates very successfully, but also has a higher seedling mortality rate than the true firs it competes with at the studied ecotone (Figure 8). Recent climate data for the HJ Andrews (Figures 5 and 6) shows a short-term trend of higher precipitation and lower temperatures. This has resulted in large snow packs that persist into the summer in the past decade (Figure 9). Western Hemlock regeneration appears to be at least somewhat limited by these winter snowpacks (Figure 10) especially at high elevation (Figure 11), which is consistent with general conifer response to snowy winters (Peterson et al. 2002). Data from throughout the entire watershed suggest that barerseeded understory plant species may be even more sensitive to the high snowfall observed and have significantly shifted downslope over the past decade (Table 1). Clearly, species responses to changes in climate are complex and future studies should consider changes in the amount and form of precipitation as well as any changes in temperature.

Works Cited

- Dr. Todd Lookingbill and Dr. Ettinger; Twin study of Richmond, Department of Geography and the Environment
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