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RESEARCH ARTICLE

Species-Specific Barriers to Tree Regeneration in High Elevation Habitats of West Virginia

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Abstract

Herbaceous competition and herbivory have been identified as critical barriers to restoration of native tree species in degraded landscapes around the world; however, the combined effects of competition and herbivory are poorly understood. We experimentally manipulated levels of herbivory and herbaceous competition and analyzed the response of tree seedling performance over three growing seasons as a function of species and habitat in north-central West Virginia. Four native tree species were planted in old field and forest experimental plots: *Castanea dentata* (American chestnut), *Quercus rubra* (red oak), *Acer saccharum* (sugar maple), and *Picea rubens* (red spruce). Red spruce demonstrated the highest growth increment and greatest survival (64%) and most consistent results among treatments and habitats. Red spruce survival was not reduced in the presence of *Odocoileus virginianus* (white-tailed deer) browse and herbaceous competition; however, growth was improved by suppression of herbaceous competition. We suspect that this deciduous forest landscape would regenerate to a red spruce dominated forest if seed source was available. In contrast, the other three species tested had very low survival when exposed to deer and were more responsive to competing vegetation and habitat type. American chestnut had low survival and growth across all treatments, suggesting basic climate limitations. Vigorous natural regeneration of *Prunus serotina* (black cherry) occurred in forest plots where both competing herbs and deer were excluded. Our results demonstrated the importance of testing multiple potential recruitment barriers and species at once and the need for species and habitat-specific restoration treatments.

Key words: ***Acer saccharum, Castanea dentata,* competing vegetation, forest restoration, herbivory, *Odocoileus virginianus*, *Picea rubens, Prunus serotina, Quercus rubra,* tree regeneration, West Virginia.**

Introduction

Predation and competition are often identified as among the most important biotic factors structuring plant and animal populations (Gurevitch et al. 2000). In the case of plants, literature reviews have concluded that both herbivory (predation by animals) and competition limit plant performance, especially survival. Herbivory usually has a larger influence on plant survival. Unlike animals, plant survival tends to suffer more from competition in the presence of predation (herbivory) than in its absence (Gurevitch et al. 2000). Herbivory and competition tend to have similar and modest impacts on plant growth (Sih et al. 1985; Gurevitch et al. 2000).

However, these conclusions are predominantly derived from studies on herbaceous plants. The influence and interactions of herbivory and competition are poorly understood in the context of tree regeneration, and it is not clear if the general trends for plants described above apply to trees. Although few studies have tested the combined influence of these two factors for trees, various studies have identified a strong influence of one of the two factors, and an elevated influence when caused by exotic species and/or preceded by human disturbance. Herbivory examples include insects in Texas (Siemann & Rogers 2003), crabs on Christmas Island (Green et al. 2004), voles in New York (Ostfeld & Canham 1993), rats in New Zealand (Campbell & Atkinson 2002), and *Odocoileus virginianus* Zimm. (white-tailed deer) in West Virginia (Schuler et al. 2002). Herbaceous competition examples include ferns in Massachussets (George & Bazzaz 1999), *Saccharum spontaneum* L. grass in Panama (Hooper et al. 2002), understory bamboo in Chile (Veblen 1982).

The few studies that test both factors on tree performance in field experiments show varied outcomes, including (1) dominant effect of one factor, without interactions (Midoko-Iponga et al. 2005); (2) negative interactions, such as competing vegetation sheltering seedlings from herbivores (Stange and Shea 1998; Griscom et al. 2005); or (3) positive interactions, such as when both factors act as dual barriers to tree performance (Meiners & Handel 2000).

Although outcomes were region-specific, results were similar enough among species within a region to indicate a generalized influence of plant competition and herbivory on tree

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