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# Variation in logging debris cover influences competitor abundance, resource availability, and early growth of planted Douglas-fir

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ABSTRACT

Logging debris remaining after timber harvest can modify the microclimate and growing conditions for forest regeneration. Debris also can influence tree seedlings indirectly through its effects on development of competing vegetation, although the mechanisms are poorly understood. At two sites in Washington and Oregon (USA) that differed in availability of soil water and nutrients, mechanisms were studied by which logging debris and competing vegetation interacted to influence performance of planted Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*) seedlings. In a split-plot design, two levels of competing vegetation (presence and absence) and three covers of logging debris (0%, 40%, and 80%) were replicated eight times at each site on 2 × 2-m areas centered on individual Douglas-fir seedlings. Vegetation abundance, seedling growth, and resource availability were monitored for 4 years (2005–2008). Soil water depletion was lower and Douglas-fir water potential and foliar nitrogen were higher in the absence of competing vegetation, resulting in increased seedling growth. The highest seedling growth rates and foliar nitrogen contents occurred where absence of vegetation was combined with 80% debris cover. Where competing vegetation was present, 40% debris cover was associated with decreases in herb cover and soil water depletion and increases in seedling growth relative to 0% or 80% debris covers. At the Washington site where soil quality was lower, the combination of presence of vegetation and 80% debris cover was associated with a 2.4 °C average reduction in summer soil temperatures at 15 cm depth, reduced foliar nitrogen content, and the slowest rates of seedling growth. Potential effects of logging debris, such as mulching (i.e., reduced evaporation of soil water) and interception loss (i.e., reduced precipitation inputs), were minor to non-detectable from sensors buried at 20–40 cm soil depth. Results of the research suggest that retention of moderate levels of logging debris (i.e., 40% cover) after forest harvesting in the Pacific Northwest is likely to increase early growth of Douglas-fir by increasing soil water availability through reduced herb abundance. Where intensive vegetation control is practiced, retention of higher debris levels (i.e., 80% cover) may provide further benefits to seedling growth.

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## 1. Introduction

Management of competing vegetation is a primary silvicultural strategy for focusing productivity of forest sites on the desired tree species (Balandier et al., 2006). Limited site resources are channeled effectively to the crop, accelerating production of biomass and shortening the period until economic and other values can be realized (Walstad and Kuch, 1987). Observations of significant benefits from competing vegetation control to survival and growth of tree seedlings are consistent throughout North America (Fleming et al., 2006) and other areas of commercial forest production in the world (Wagner et al., 2006). During the early years of forest development, vegetation control increases availability of growth-limiting soil resources, especially water and nutrients (Harrington and Tappeiner, 1991; Zutter et al., 1999; Dinger and Rose, 2009). Thus, an understanding of the mechanisms by which competing vegetation limits performance of tree seedlings is critical to the efficient practice of forest vegetation management.

Forest productivity research has identified interactions between competing vegetation and logging debris that occur soon after forest harvesting. In general, retention of logging debris in temperate zone forests inhibits development of herbaceous, and sometimes woody, species. This finding has been reported for a wide range of forest ecosystems including mixed stands of balsam fir (*Abies*

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