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Survival and growth response of seedlings in root disease infected partial cuts in the Interior Cedar Hemlock zone of southeastern British Columbia

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Abstract

Widespread concern about the sustainability of clearcut regeneration systems has led to the increased use of partial retention systems in British Columbia. In particular, uncertainty surrounds the relative performance of tree species of different shade tolerance, prompting increasing interest in seedling response to a range of light environments. Even more uncertainty surrounds our understanding of the development of trees in partially cut stands infected with the root diseases, *Armillaria ostoyae* (Romagnesi) and *Inontus tomentosus* (Fr.Fr) S. Teng. We compared light retention (25% of the original basal area), heavy retention (50% of the original basal area) and clearcut treatments at two sites. A root removal technique (pushover falling) was used for root disease mitigation. Light levels were measured using hemispherical photography. Growth rate increased as the level of canopy openness increased, but did not vary among species differing in shade tolerance. The root removal treatment, by contrast, had no effect on seedling survival after 5 years. Development and expression of the root diseases over the longer term may alter these results. Our findings demonstrate that a variety of partial retention systems can be used to regenerate mixed species forests in the Interior Cedar Hemlock zone.

Keywords: Partial retention harvesting; Shade tolerance; Light; Root disease; *Armillaria ostoyae*; *Inontus tomentosus*

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1. Introduction

Concerns about the sustainability of clearcut regeneration cutting systems have prompted a shift in societal attitudes about forest resource management in British Columbia (Vyse and DeLong, 1994). This change in public perception has prompted forestry practitioners to increasingly consider partial retention systems to address values beyond timber production. The species complexity and structural variability of the Interior Cedar Hemlock (ICH) zone in British Columbia (BC) (Braumandl and Curran, 1992) offers much opportunity for the use of partial retention systems.

The ICH is found in southeastern BC and around the Nass Basin and Hazleton areas in northwestern BC (British Columbia Ministry of Forests, 2001). It is typically distributed from valley bottoms to mid-elevations. These forests are considered valuable for human settlement, wildlife habitat, recreation, scenery, and timber. Late successional forests of western redcedar (*Thuja plicata* Donn ex D. Don in Lamb) and/or western hemlock (*Tsuga heterophylla* [Raf.] Sarg.) are widespread in the moister portions of the zone. Early to mid-seral species predominate in the drier, more southerly portions. Supporting 14 commercial tree species, the ICH zone boasts the highest tree species diversity of any biogeoclimatic zone in the province. Mixed species forests are common, and can include combinations of shade tolerant western redcedar and western hemlock, moderately shade tolerant species like western white pine (*Pinus monticola* Dougl. ex D. Don.), and shade intolerant species such as interior Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn)), lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm. Ex S. Wats.), and western larch (*Larix occidentalis*). Stands can also include broadleaf species such as paper birch (*Betula papyrifera* Marsh.) and trembling aspen (*Populus tremloides* Michx.).

Natural disturbance patterns also contribute to the variability in the ICH, and can vary widely depending on the local and regional climate, as well as the tree species present (Holt et al., 1999; Quesnel and Pinnell, 1998). In the last century, timber harvesting and fire have been the dominant forms of forest disturbance, although windthrow, disease and insects also play important roles, resulting in highly diverse natural disturbance patterns across the landscape (Vyse and DeLong, 1994; Braumandl and Curran, 1992). The natural diversity of species and disturbances, and the resultant stand structures, offer flexibility in regeneration cutting systems.

With increased use of partial retention systems (Vyse and DeLong, 1994), there is increasing interest in seedling response to a range of light environments, not just the full light conditions characteristic of clearcuts. However, information is lacking on the relative performance of different tree species growing under variable levels of overstory. Light availability is considered one of the most important factors influencing tree growth and is a good predictor of growth rates in field conditions (Wright et al., 1998). Shade tolerant species can survive and grow under very low levels of light, but the pattern of increased growth with increased light applies to all species regardless of shade tolerance rankings (Claveau et al., 2002; Coates and Burton, 1999; Williams et al., 1999; Wright et al., 1998; Klinka et al., 2000). That said, there remains uncertainty surrounding the comparative success of species of different shade tolerances growing in the field under a residual overstory. Even more uncertainty surrounds our understanding of survival and growth of regenerating trees in stands infected with root diseases, such as *Armillaria ostoyae* (Romagnesi) and *Inontus tomentosus* (Fr.Fr) S. Teng (Morrison et al., 2001).

In BC, *A. ostoyae* is distributed throughout the southern one-third of the province (Allen et al., 1996), with particular prevalence in the ICH zone, and occasional occurrence north of Quesnel to Prince George. *I. tomentosus* is found throughout BC, but is most prevalent in areas that are dominated by spruce, its main host (Allen et al., 1996). Data on the development of root disease in partially cut stands are few and inconsistent. Where a pathogenic *Armillaria* species is present on a tree's root system as epiphytic rhizomorphs or in lesions, it spreads through the cambial zone to colonize the root system (Morrison et al., 2001). This new inoculum can have a great effect on tree growth in partially cut stands because newly infected stumps can contact and infect the root systems of nearby residual trees and new regeneration. Root disease has raised serious concerns about the sustainability of partial retention regeneration systems