Extension Note

Effects of Red Alder on Stand Dynamics and Nitrogen Availability (MOF EP1121.01)

This extension note provides an update on the ongoing additive and replacement series experiments of Experimental Project (EP) 1121.01; no conclusions are drawn. This project was established to assess the competitive effects of a range of red alder densities on understorey conifer growth.

Why Manage for Red Alder?

An understanding of both the competitive and beneficial effects of red alder (*Alnus rubra* (Bong.)) in mixture with conifers is fundamental to making sustainable management decisions for complex forests. Red alder is a common component of low-elevation CWH zone forests in southwestern British Columbia, and is often an aggressive competitor with young conifer stands on highly productive sites. As a result of improved markets over the last decade, red alder has become valuable as a source of lumber, and, with an intensive management regime, is a viable economic alternative to conifers on some sites. Red alder can also contribute to the long-term productivity of a site as well as to biodiversity and forest health at both the stand and landscape levels.

The Effects of Red Alder on Conifer Growth

Young red alder rapidly overtops juvenile conifers, resulting in subsequent challenges and costs associated with meeting current free-growing obligations. Growth of Douglas-fir in mixture with red alder is often less than in pure stands (Cole and Newton 1986), as a result of lower levels of light reaching the overtopped conifers (Shainsky et al. 1994; Comeau 1996). The competitive effects of alder on light are counterbalanced by increased N availability due to fixation of atmospheric N. Nitrogen fixation rates in alder stands usually range between 20 and 85 kg ha\(^{-1}\) yr\(^{-1}\) (Binkley et al. 1994), but rates up to 320 kg ha\(^{-1}\) yr\(^{-1}\) have been reported (Van Miegroet et al. 1989). As a result, managing red alder in mixedwood stands requires striking a balance between the detrimental effects of overtopping alder on light reaching understorey conifers and the nutritional benefits of the alder.

Red alder can remain dominant in a stand for up to 40 years. When it overtops conifers, it can substantially reduce light availability, and can cause
physical damage to crop trees. The degree of light reduction and the amount of damage to conifers depends on the density and size of the red alder component of the stand and the species of understorey conifers.

Long-term studies were initiated in 1992 and 1994 to improve our understanding of both the competitive and beneficial effects of red alder when grown with conifers. These studies were established to document and demonstrate the effects of different amounts and spatial arrangements of red alder on tree growth and survival, stand dynamics, crown characteristics, and long-term productivity. Only height and diameter at breast height (dbh) are reported in this extension note. This study has two components: 1) additive field experiments, and 2) replacement series field experiments, the locations of which are described in Table 1.

**Additive Field Experiments**

The additive field experiments (Figure 1) were replicated at three locations (Table 1). In the additive design, Douglas-fir and western redcedar were planted in all plots at a total density of 1100 trees per hectare (tph) with the two species planted in equal proportions at alternating planting spots; and one of five “broadleaf” density treatments (Table 2) was applied to 0.36 ha or 0.49 ha square treatment plots. In each treatment plot a 0.1-ha (17.54 m radius) permanent measurement plot was established, and numbered tags affixed to all measurement trees.

Average height and diameter for each of the five treatments at Gough Creek (2004) are shown in Figures 2 and 3. Height of western redcedar, Douglas-fir, and red alder ranged from 260 to 417 cm, 725 to 972 cm, and 808 to 1002 cm, respectively. Diameter at breast height for red alder, Douglas-fir, and western redcedar...
ranged from 22 to 44 mm, 82 to 117 mm, and 151 to 181 mm, respectively. At Gough Creek, tree heights and dbh for all species were largest in the 200 red alder/ha treatment.

Waterloo Creek (Figures 4 and 5) was measured in 2004 and the height and diameter for each of the treatments are illustrated in Figures 6 and 7. Height of western redcedar, Douglas-fir, and red alder ranged from 280 to 448 cm, 556 to 743 cm, and 864 to 962 cm, respectively. Diameter at breast height for western redcedar, Douglas-fir, and red alder ranged from 31 to 61 mm, 83 to 123 mm, and 129 to 169 mm, respectively. For Douglas-fir, maximum height and diameter was found in treatment 1 where there is no alder planted; however, the differences among treatments were not significant. Height and dbh of western redcedar were largest with 100 red alder/ha.
These differences were also noted at age 5 (1996), and these small differences could be a reflection of differences in initial seedling size and not the presence or absence of red alder. It is premature to conclude that any differences among treatments is the result of the presence or absence of red alder. Statistical analysis of treatment effects will be completed after collection of 15th-year data from Holt Creek in 2008, at which time we will have 15 years of data from all three replicates.

**Replacement Series Field Experiments**

Replacement series experiments are useful for identifying the nature of interactions between two species and how they change as the proportion of each species changes. A replacement series experiment involves planting two species together in a succession of different proportions, while keeping the total number of trees per hectare constant. In this experiment, red alder and Douglas-fir were planted in a series of five proportions (Table 3) at a total density of 742 tph (3.67 m spacing), following a design protocol prepared by the Oregon State University Hardwood Silviculture Cooperative. One installation was planted at East Wilson Creek in 1992 and another at Holt Creek in 1994 (Table 1). Three additional installations were also established in Oregon and Washington by other members of the Hardwood Silviculture Cooperative.

Each installation consisted of one replicate of each of the five treatments described in Table 3. Treatment plots measured 70 × 70 m (0.49 ha) at East Wilson Creek and 60 × 60 m (0.36 ha) at Holt Creek.

In each treatment plot a 0.10-ha (17.54 m radius) permanent measurement plot was established, and numbered tags affixed to all measurement trees. Height and diameter at breast

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>A description of the five treatments established for the replacement series experiment</th>
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</table>

**Figure 6** Average and standard error of tree heights after 13 growing seasons at Waterloo Creek (Cw = western redcedar; Fd = Douglas-fir; Dr = red alder).

**Figure 7** Average and standard error of diameter at breast height (dbh) after 13 growing seasons at Waterloo Creek (Cw = western redcedar; Fd = Douglas-fir; Dr = red alder).
height were collected for all tagged trees. After 12 growing seasons at East Wilson Creek, height of Douglas-fir ranged from 557 to 915 cm and height of red alder ranged from 704 to 991 cm (Figure 8).

Diameter at breast height of Douglas-fir ranged from 66 to 114 mm and dbh of red alder ranged from 111 to 150 mm (Figure 9). It is interesting to note that both the height and dbh of Douglas-fir increased with increasing alder density.

**Literature Cited**


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