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Extension Note

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The use of red alder to enhance Sitka spruce growth in the Queen Charlotte Islands

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BRITISH COLUMBIA

INTRODUCTION

On many forest sites in the Queen Charlotte Islands (QCI) and other coastal areas of BC, Sitka spruce growth is limited by low nitrogen (N) availability. This is particularly true of coastal lowland ecosystems on the east side of Graham Island, where Sitka spruce comprises a relatively small proportion of second-growth stand volumes, its growth being influenced by limited soil rooting volumes and soil N content (Green 1989).

There may be opportunities for enhancing the growth of Sitka spruce on such sites by interplanting N-fixing red alder in managed stands. Interplanting alder has been shown to increase total ecosystem and Douglas-fir production once the conifer canopy has expressed dominance (Murray and Miller 1986). These gains may be best realized on infertile sites (Binkley and Greene 1983). Observations made on naturally established second-growth stands on Graham Island, QCI, containing Sitka spruce and alder mixtures, suggest spruce growth is improved when growing in association with alder.

The objectives of this study are:

1. to determine the effect of varying admixtures of interplanted alder on the productivity of Sitka spruce on nutrient-poor to medium sites on Graham Island, and
2. to monitor the effects of the alder admixtures on soil chemical properties and spruce foliar nutrition.

TRIAL AREA

The two trial areas are in the CWHwh1 biogeoclimatic variant (Green and Klinka 1994) and are located at Watt Lake near Port Clements, and at Small Lake near Queen Charlotte City. Prior to logging, the Watt Lake trial area featured a poor productivity stand of western redcedar and western hemlock with a mi-

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Table 1: Soil and site properties for study locations.

Properties	Watt Lake	Small lake
elevation (m)	50	240
slope (%)	0	20
slope position	flat	mid
aspect	flat	NE
parent material	sandy glaciofluvial	loamy morainal
forest floor depth (cm)	14	10
coarse fragment content (% volume)	2	5
rooting depth (cm)	19	18
soil moisture/nutrient regime	very moist/poor	fresh/medium
drainage class	poorly drained	moderately well drained
site series	04 CwHw-salal, 10 CwYc-goldthread	01 HwSs-lanky moss

Table 2: Description of treatments

treatment	1	2	3	4[1]
ratio spruce:alder	**100:0**	**89:11**	**75:25**	**50:50**
# spruce ha^{-1}	1600	1424	1200	800
# alder ha^{-1}	0	176	400	800

[1]The 50:50 treatment is only represented at Small Lake.

nor amount of lodgepole pine and spruce. At Small Lake the stand showed medium to good productivity spruce, redcedar and hemlock. The slash had been burned at Small Lake after logging, consuming much of the forest floor. The two study locations are characterized in Table 1.

EXPERIMENTAL LAYOUT AND SAMPLING

The treatments are described in Table 2. Each treatment was replicated three times in a completely randomized design. The individual plot (experimental unit) sizes were 30 x 30 m, with 5m buffers between plots. The tree spacing was 2.5 m, resulting in 169 trees per plot, but there was a perimeter of spruce reducing the number of measurement trees to 121. The pattern of interplanted spruce and alder is depicted in Figure 1. Both alder and spruce were planted in spring 1992.

In September 2000, ninth year tree measurements were taken including height, diameter at breast height (dbh), and condition. Individual tree volume was calculated using dbh^2 x height x 0.5. Spruce foliar samples were collected from 10 trees per treatment/plot replicate. At least three branchlets of current year's foliage were clipped from the top third of the crown. Spruce foliar samples were analyzed for total N, P, K, Ca, Mg, S, Cu, Zn, B, Mn, Fe, and Al. Mineral soil samples were collected from the surface 15 cm from 15 points within the treatment/plot combinations. These were analyzed for pH, total C, total N, mineralizable N, available (Bray) P, exchangeable Ca, Mg, K, Na, Mn, Fe, Al and cation exchange capacity (CEC).

RESULTS AND DISCUSSION

Initial severe deer browsing of the alder made it necessary to replant the Watt Lake alder in 1993, using protective Vexar™. Additional alder mortality occurred in 1994 and 1995. The Small Lake alder were initially browsed, but because it is a more productive site they quickly grew beyond the browse height and protection was not used.

The problems with establishment and slower growth of alder at the Watt Lake site have delayed comparison with Small Lake. After nine years, heights of the alder and spruce average 1.2 and 3.0 m, respectively. Tree growth did not vary with treatment. As a result, further reporting from the Watt Lake trial will be delayed until the alder has become established.

At Small Lake, ninth year mean height for the 50:50 treatment was 4.6m; for other treatments the mean heights ranged from 3.8 to 3.9 m. Diameter at breast height followed the same pattern, with 6.8 cm for the 50:50 treatment and an average 5.4 cm for the other treatments. Individual tree volume was totalled per plot and averaged per treatment. As spruce decreased in proportion on a treatment basis (100:0 to 50:50), its volume declined, except for the 50:50 treatment (Figure 2). On a mean plot basis this indicated that 800 spruce growing with 800 alder (50:50) produces the same spruce volume as 1600 spruce alone (100:0). The alder plus spruce volume in the 50:50 treatment yields over 3.5 times the spruce volume alone (100:0). The mean plot volume for the 50:50 treatment was significantly larger compared with all other plot means.

No significant differences were found between soil nutrient levels other than CEC, and this showed that CEC levels were different between the 100:0 and 50:50 treatments. The degree to which soil nutrient levels change with increasing alder appeared to be masked by background soil variability. Alternatively, rapid uptake of nutrients in spruce and alder

Figure 1. Interplanting arrangement of spruce (S) and alder (A) within treatments (only a portion of trees per treatment are shown).

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S S S S S S S S S	S S S S S S S S S	S S S S S S S S S	S S **A** S **A** S **A** S S
S S S S S S S S S	S S S S S S S S S	S **A** S **A** S **A** S **A** S	S **A** S **A** S **A** S **A** S
S S S S S S S S S	S **A** S S **A** S S **A** S	S S S S S S S S S	S S **A** S **A** S **A** S S
S S S S S S S S S	S S S S S S S S S	S **A** S **A** S **A** S **A** S	S **A** S **A** S **A** S **A** S
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S S S S S S S S S	S S S S S S S S S	S S S S S S S S S	S S S S S S S S S
treatment - 1 100:0	treatment 2 - 89:11	treatment 3 – 75:25	treatment 4 – 50:50

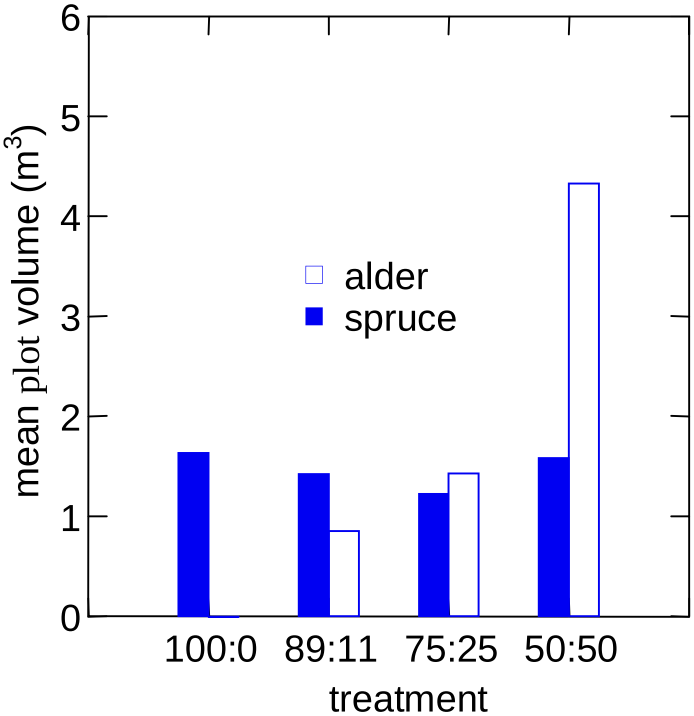

Figure 2. Nine year mean (n=3) plot volumes (m^3) at Small Lake for spruce and alder in relation to species mixture.

biomass overrides any mixture effect influencing soil nutrient levels.

The mean foliar N and P for the 50:50 treatment are significantly greater compared with other means. Other significant differences are shown in Table.3.

At Small Lake the alder are 2 m taller on average than the spruce. More spruce trees are damaged by alder branches in the 50:50 plots compared with the 75:25 or 89:11 plots. Eleven per cent of the spruce in the former had terminal leader damage including breakage and needle loss (Figure 3). For the latter treatments, 2-3 % of the trees received this damage.

CONCLUSIONS

Alders may contribute significant amounts of N in many coastal forest soils (Bormann et al 1994). Farr et al (1977) found that four-year-old Sitka spruce seedlings growing near

Figure 3. Damage to spruce leader as a result of alder branch abrasion.

Sitka alder had higher foliar concentrations of N, P and K.

Nine years after planting, soil N levels did not differ between the varying admixtures of alder in spruce, but foliar N concentrations increased significantly as the proportion of alder increased. Other nutrients followed this trend. Treatment heights and diameters were also significantly greater, but only for the 50:50 treatment compared with the other treatments. This greater height and diameter was attained despite the

Table 3. Mean foliar nutrient levels of Sitka spruce by treatment at Small Lake. Significant differences between means are designated by letter (*P*=0.05).

treat-ment	%: N	P	K	Ca	Mg	S	ppm: Cu	Zn	B	Mn	Fe	Al
100:0	0.89a	0.15a	1.02a	0.25	0.082	0.087a	1.96a	19.4	11.3a	872a	21.9a	70.6
89:11	0.96a	0.16ab	0.91b	0.25	0.075a	0.089a	2.14ab	18.8	12.8a	1068b	31.9	67.5
75:25	1.14b	0.18b	0.97	0.28	0.088b	0.101b	2.47b	19.7	12.7a	1125c	32.2	81.9a
50:50	1.63c	0.21c	0.93	0.26	0.079a	0.110b	3.60c	19.4	16.2b	993	39.1b	63.5b

greater alder crown expansion and top height damage caused by the alder. Total plot volumes increased with increasing alder.

The use of alder and conifer mixtures may result in greater conifer growth rates and in overall stand volume increases. This may vary under different site conditions, the species mixture, and the density, growth rate and shade tolerance of the component species. At Watt Lake, the site conditions are only marginally suitable for alder and it is slow to establish. At Small Lake, the alder has resulted in increased Sitka spruce growth but at a higher density (50:50) than might be operationally feasible for spruce management. However, if both spruce and alder are marketable species then such a mixture might be more profitable than spruce alone. Results to date indicate that volume production is higher, but wood quality objectives and harvest planning also need to be considered. It will be important to see if the 75:25 and 89:11 treatments demonstrate better spruce growth as the stand develops. Such a result might warrant leaving well spaced natural alder ingrowth in conifer plantations.

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