

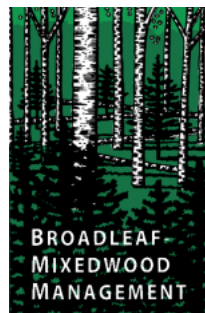
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## Effects of Spacing Paper Birch–Mixedwood Stands in Central British Columbia FRBC Project HQ96423-RE (MOF EP 1193)

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This extension note describes two studies that have been established in the central interior of British Columbia to provide information on the effects of thinning paper birch on growth of understorey conifers.

### Introduction

Paper birch is found throughout the British Columbia interior. It is also found in pure stands and in mixture with conifers across a broad range of sites in the Interior Cedar–Hemlock, Sub-Boreal Spruce, and Boreal White and Black Spruce zones.

In the past, paper birch was largely ignored during conifer harvesting and reviled in conifer plantations. Recent recognition of the contribution of broadleaf trees to biodiversity and site productivity and opportunities for the commercial utilization of broadleaves has stimulated interest in managing mixedwoods in British Columbia. Current utilization of paper birch is low in British Columbia (less than 10% of potential, province-wide) but there are opportunities to manufacture birch veneer, plywood, and lumber products for markets in the United States and Pacific Rim countries.

### What Is the Ecological Value of Paper Birch?

In mixedwood stands, the presence of a component of paper birch can be beneficial. Birch is resistant to root disease and may reduce the impact of root disease on conifers. Birch can also reduce damage from frost and insects. Birch has recently been shown to transfer carbon to Douglas-fir seedlings through mycorrhizal fungi. Birch also rapidly cycles nutrients through litterfall and can improve long-term site productivity.

### How Does Paper Birch Influence Conifer Growth?

Birch can regenerate rapidly from seed or by resprouting after a disturbance such as fire or harvesting. Height growth of birch outpaces that of conifers such as white spruce or sub-alpine fir during the first 30–40 years of growth. Competition between birch and conifers is principally for light. In general, the amount of light reaching the understorey declines as basal area of the birch increases. Birch may also compete with conifers for water and nutrients and can cause physical damage to conifer crowns.

Successful management of mixed-wood stands requires that the detrimental effects of competition be balanced with the beneficial effects of birch on nutrient availability, forest health, and biodiversity. The two studies described in this extension note were established to provide information on the effects of manipulating overstorey birch densities on the growth of understorey conifers.

### Thinning in a Mixedwood Stand at Spey Creek

In 1994 and 1995, a study was established in a 33-year-old mixedwood stand located in the SBSwk1 at Spey Creek in the Prince George Forest District. In 1994, the canopy was dominated by paper birch and willow, with

abundant subalpine fir and some spruce in the understorey.

Four treatments were replicated four times using a completely randomized design: 1) untreated control; 2) space to 1200 birch/ha; 3) space to 600 birch/ha; and 4) complete removal of paper birch (replicated three times only) (Figure 1). Prior to spacing of each 0.64 ha (80 × 80 m) treatment plot, understorey conifers were spaced to a density of 1200 trees per hectare, willow were cut, and aspen and black cottonwood stems were girdled. Willow and birch were cut within 10 cm of the ground.

Spacing was completed in the fall of 1994 (plots 1–9), and fall 1995 (plots 10–15). Table 1 summarizes selected characteristics of each plot at this site.

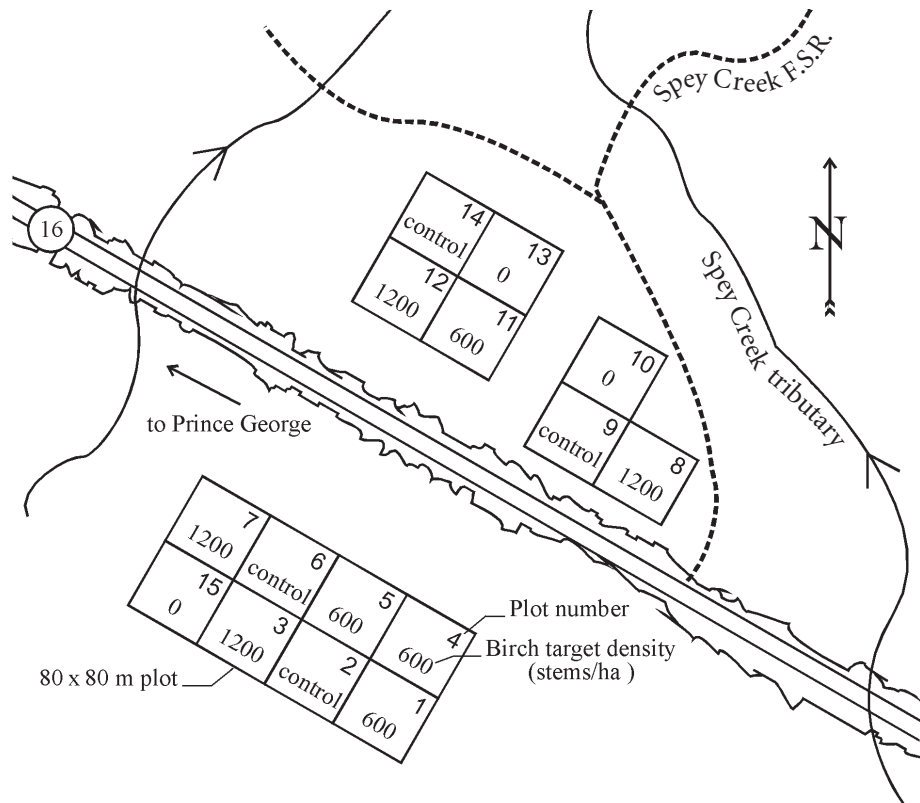


FIGURE 1 Plot layout for the birch–conifer mixedwood study at the Spey Creek site east of Prince George.

## Thinning and Underplanting in a Paper Birch Stand at Raft Creek

In 1996, a study was established in a 35-year-old paper birch stand located in the ICHmk at Raft Creek in the Horsefly Forest District. Five birch density treatments (0, 400, 800, and 1200 birch per hectare, and an untreated control) were randomly distributed among fifteen 70 × 70 m plots (Figure 2). Thinning treatments were completed in the fall of 1996. Four conifer species—subalpine fir, western redcedar, Douglas-fir, and interior spruce—were planted in the spring of 1997. Table 2 summarizes selected information for each plot at Raft Creek.

## Preliminary Results

At both sites, we are studying growth of residual birch and understorey conifers, resprouting of cut birch, development of understorey vegetation, and understorey light regimes.

Climate stations have been installed in selected plots at each site to provide a continuous record of light, soil moisture, and soil and air temperatures.

### Leaf Area Index and Understorey Light

Leaf area index (LAI) is the area of leaf surface per unit area of ground and is a commonly used measure of canopy density. At both Spey Creek and Raft Creek, LAI increases with increasing

TABLE 1 Summary of birch characteristics, leaf area index (LAI), and understorey light levels (diffuse non-interceptance, DIFN), by treatment and plot at Spey Creek, 1996

Treatment (target birch stems/ha)	Plot no.	Stems/ha	Basal area (m <sup>2</sup> /ha)	Average dbh (cm)	Average height (m)	LAI <sup>a</sup> (m <sup>2</sup> /m <sup>2</sup> )	DIFN <sup>b</sup>
Unthinned	2	663	2.82	7.4	8.5	0.853	0.565
Unthinned	6	2231	8.45	6.4	9.4	1.320	0.351
Unthinned	9	5319	19.96	6.5	9.8	2.060	0.128
Unthinned	14	894	8.01	10.0	11.7	1.296	0.400
1200	3	894	9.42	10.2	11.8	1.110	0.376
1200	7	1306	6.24	7.7	9.8	1.275	0.393
1200	8	1450	10.20	9.3	10.8	1.376	0.291
1200	12	1669	7.91	7.3	10.0	1.349	0.414
600	1	500	2.82	8.2	9.9	1.409	0.155
600	4	563	4.89	10.5	11.7	0.982	0.601
600	5	619	7.33	12.4	13.4	1.126	0.420
600	11	875	5.79	8.8	10.8	1.567	0.329
0	10	0	0	-	-	0.575	0.783
0	13	0	0	-	-	0.569	0.835
0	15	0	0	-	-	0.777	0.659

a LAI: average of four readings from each of 40 stake positions in each plot, using LAI-2000 Plant Canopy Analyzers.

b DIFN: the fraction of full sunlight (transmittance) reaching 1 m height, determined using LAI-2000 Plant Canopy Analyzers.

stand density. As LAI increases, understorey light—expressed as transmittance (the fraction of above-canopy light that reaches the understorey)—decreases. At both sites, transmittance decreases with increasing basal area (Figure 3).

Lieffers and Stadt (1994) suggest that using a shelterwood system that permits transmittance levels of 0.3–0.4 under broadleaf canopies may provide favourable conditions for the establishment and growth of white spruce. At Spey Creek, 600 birch/ha resulted

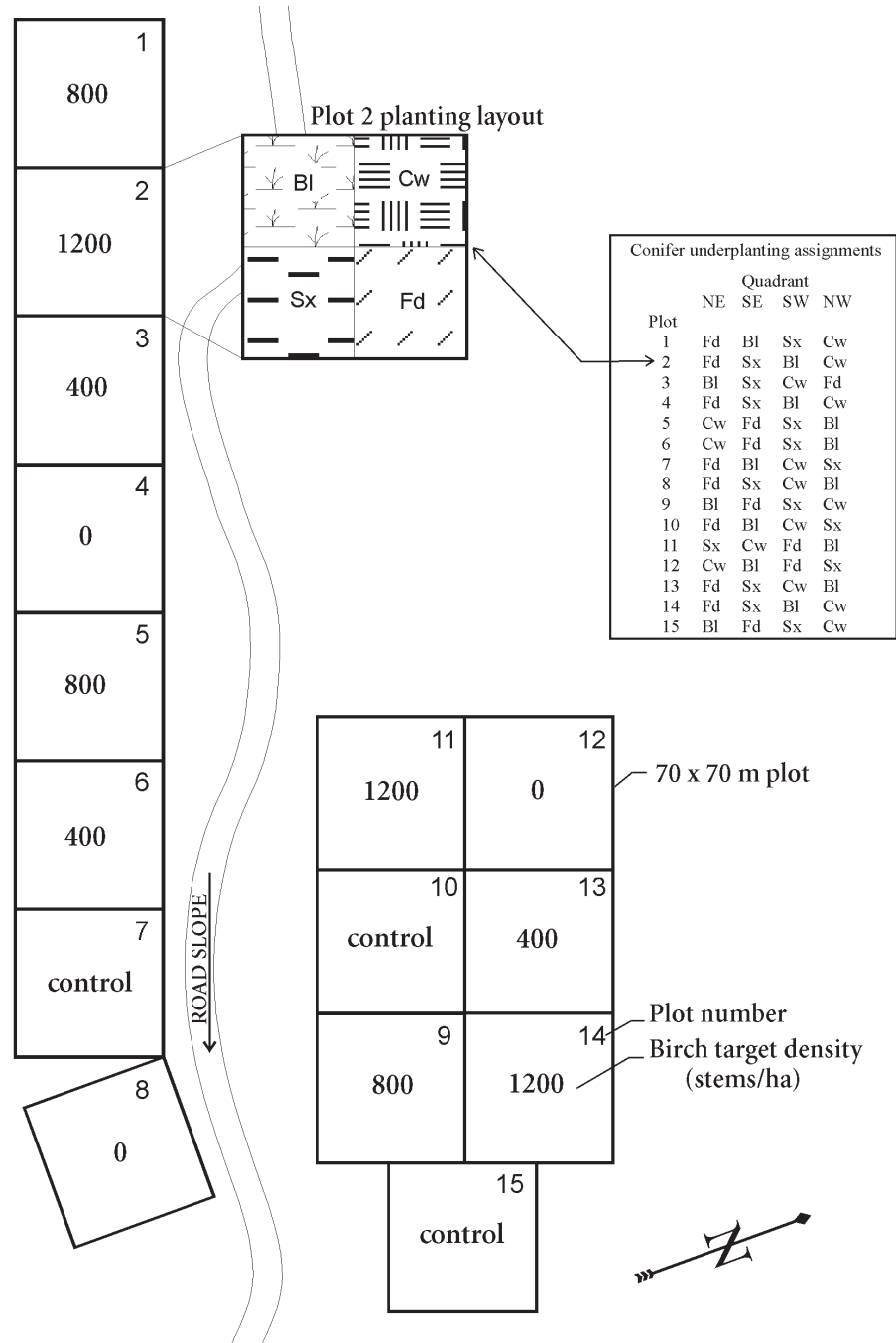


FIGURE 2 Plot layout for the thinning and underplanting study at Raft Creek, Horsefly Forest District.

TABLE 2 Summary of birch characteristics, leaf area index (LAI), and understorey light levels (DIFN), by treatment and plot at Raft Creek, 1997

Treatment (target birch stems/ha)	Plot no.	Stems/ha	Basal area (m <sup>2</sup> /ha)	Average dbh (cm)	Average height (m)	LAI <sup>a</sup> (m <sup>2</sup> /m <sup>2</sup> )	DIFN <sup>b</sup>
Unthinned	7	10680	8.06	3.1	7.24	2.51	0.14
Unthinned	10	9680	11.56	3.9	8.72	2.04	0.20
Unthinned	15	11960	8.45	3.0	7.30	2.67	0.13
1200	2	1160	3.62	6.3	8.68	0.62	0.62
1200	11	1470	4.73	6.4	9.10	2.04	0.20
1200	14	1180	6.38	8.3	11.53	0.82	0.54
800	1	810	5.99	9.7	9.92	0.83	0.54
800	5	810	2.69	6.5	10.87	0.48	0.69
800	9	770	5.46	9.5	12.09	1.03	0.47
400	3	530	1.17	5.3	9.98	0.40	0.74
400	6	350	1.89	8.3	9.93	0.46	0.72
400	13	450	2.38	8.2	10.25	0.36	0.55
0	4	0	0	-	-	-	-
0	8	0	0	-	-	-	-
0	12	0	0	-	-	-	-

a LAI: average of four readings from each of 36 stake positions in each plot, using LAI-2000 Plant Canopy Analyzers.

b DIFN: the fraction of full sunlight (transmittance) reaching 1 m height, determined using LAI-2000 Plant Canopy Analyzers.

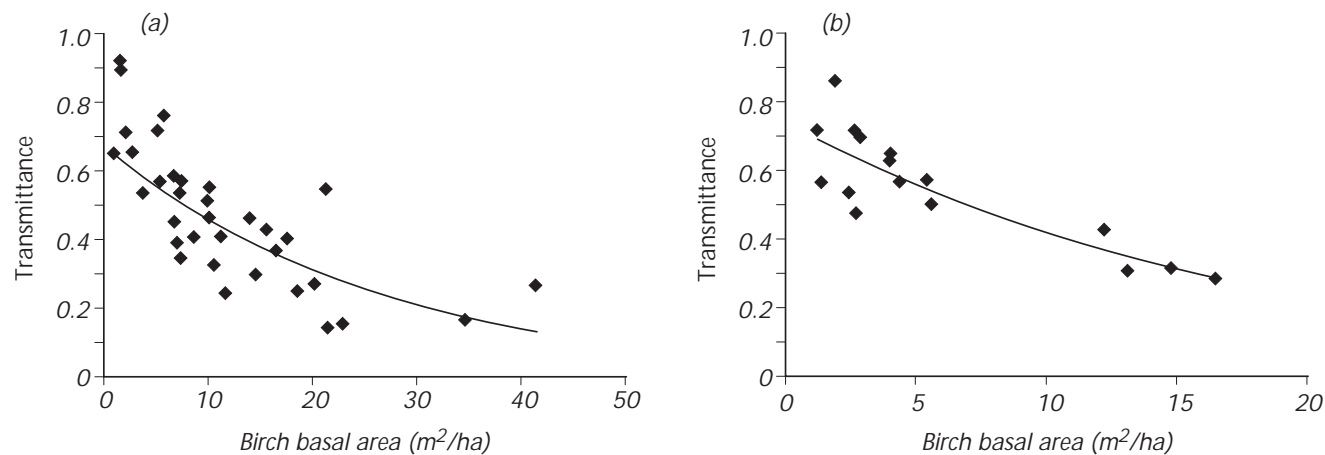


FIGURE 3 The amount of light reaching the understorey over the growing season (transmittance—measured using fisheye photographs) decreases as the basal area of paper birch increases at Spey Creek (a) and Raft Creek (b).

The relationship is described by the following equations:

$$a) \text{ for Spey Creek: } \ln(T) = -0.4354 - (0.0353 \times E) - (0.0087 \times B) - (0.1528 \times S) [n=34, R^2=0.62],$$

$$b) \text{ for Raft Creek: } \ln(T) = -0.3047 - (0.0564 \times E) [n=16, r^2=0.80],$$

where E is basal area of paper birch, B is basal area of subalpine fir, and S is basal area of white spruce.

in understorey transmittance values of 0.45. At Raft Creek, the 800 birch/ha treatment resulted in transmittance values of 0.57, and the 1200 birch/ha treatment resulted in values of 0.45. Understorey light levels are expected to decline as the crowns of residual birch expand. At Raft Creek, light levels in the understorey of the untreated stand average 0.16. At Spey Creek, due to removal of willow, understorey light levels in the “untreated” plots average 0.29.

### Responses of Understorey Conifers

Specific leaf area (SLA) is the ratio of leaf surface area to leaf biomass and is a good indicator of the leaf light environment. Foliage of the subalpine fir at Spey Creek responded quickly to the thinning treatments. New needle growth was greatest in the 600 birch/ha treatment, which yielded the largest area and dry weight per 100 needles of all treatments. This suggests that 600

birch/ha may be an appropriate density for understorey subalpine fir.

Competition indexes can be useful for quantifying inter-tree competition. Daniel’s Competition Index was calculated for spruce trees at Spey Creek under the influence of birch. Stem volume growth of the spruce in 1996 generally decreased with increasing competition index (Figure 4).

### Resprouting of Paper Birch

The height of resprouting birch 2 years after treatment was significantly lower in the 600 birch/ha treatment (88.6 cm) than in the 0 birch/ha treatment (139.6 cm) (Figure 5). At Raft Creek no significant differences were found in height of resprouting birch after 1 year, but the height of resprouts generally decreased with increasing birch density. Survival and growth of sprouts will be monitored over time and related to stump size and light regime.

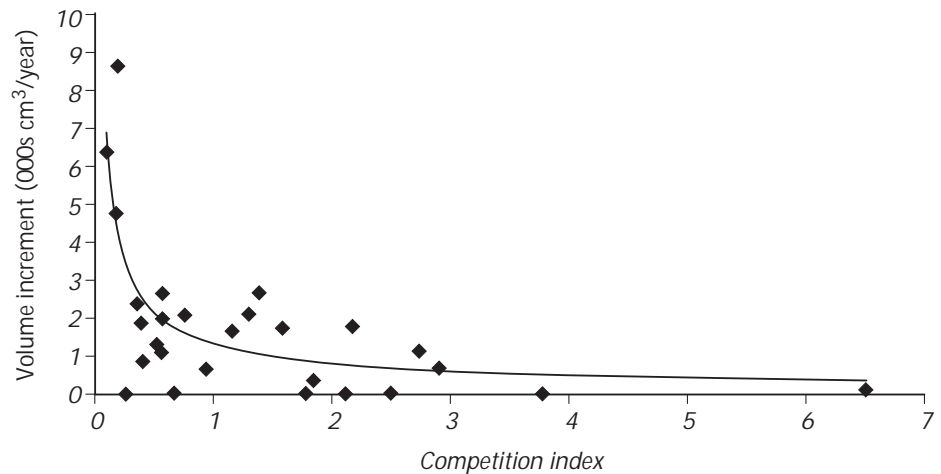


FIGURE 4 Stem volume growth of white spruce in 1996 decreased with increasing competition index. The graph relates growth to Daniel’s Competition Index (CI) given by the equation:

$$CI = (\sum di/pi) / dc$$

where  $di$  is the dbh of each birch,  $pi$  is the proximity of each birch to the spruce, and  $dc$  is the diameter (ground line) of the spruce.

The line is described by the equation:

$$\ln(VI) = 7.2523 - 0.7182 (\ln[CI]) \quad [n=21 \quad r^2=0.557].$$

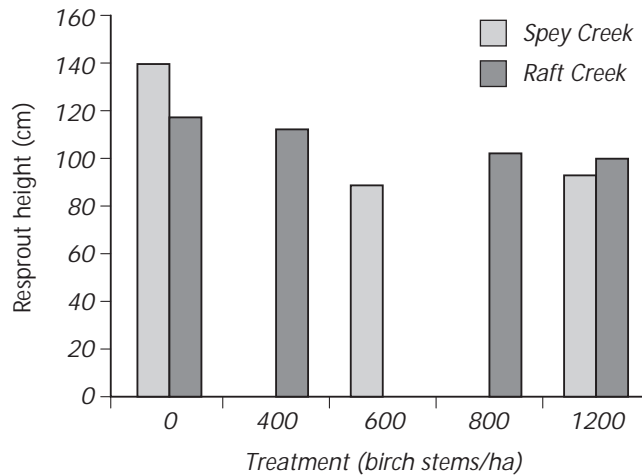


FIGURE 5 Top height of resprouting birch by treatment at Spey Creek (2 years after treatment) and Raft Creek (1 year after treatment).

## Conclusion

At both Spey Creek and Raft Creek, thinning of the birch overstorey increased the amount of light reaching understorey conifers. The amount of light reaching the understorey is strongly correlated with basal area of birch and conifers.

Preliminary results from Spey Creek suggest that leaving 600 birch/ha may result in less sunscald and wind damage to understorey conifers, and reduced resprouting of cut birch, compared to complete removal of the birch canopy. At this density, growing conditions for spruce and subalpine fir are favourable. Ongoing measurements will provide information on how these conditions change over time.

These two studies will provide both short-term and long-term data on the

effects of thinning overstorey birch on understorey light, tree growth, and stand development. This information should be useful in the management of mixedwood stands in the central interior.

## Acknowledgements

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## Reference

- Lieffers, V.J. and Stadt, K.J. 1994. Growth of understorey *Picea glauca*, *Calamagrostis canadensis*, and *Epilobium angustifolium* in relation to overstorey light. *Can. J. For. Res.* 24: 1193–8.