

Responses of lodgepole pine and the *Mixed Broadleaf-Shrub* complex to manual cutting: A summary of 10 year PROBE results

About the *Mixed Broadleaf-Shrub* complex

This community has the potential to interact with young conifers for long periods of time because of the rapid juvenile growth of paper birch, aspen, and black cottonwood, and because these are tree species that are a natural component of mature ICH zone stands. Broadleaves benefit sites through annual cycling of nutrients, reduced spread of *Armillaria* root disease, reduced spruce weevil damage, protection against frost damage, reduced incidence of ungulate browsing, increased complexity in vertical stand structure, and possibly the transfer of nutrients to conifers via root contact. However, at high densities broadleaves can also negatively affect conifer seedling growth and vigour by reducing light availability under and within the broadleaf canopy. ([Full complex description](#))

Results

This section summarizes 10-year results from the fully replicated PROBE experiment that studies lodgepole pine and vegetation responses to manual cutting of the *Mixed Broadleaf-Shrub* complex in 3-10 year-old stands in the ICH zone. Study sites were submesic to mesic, gently to moderately sloping (15-40%), with variable aspect. Elevation ranged from 900-1330 m, and broadleaf cover averaged 16% at the time of treatment. ([Full Methods description](#)):

Table 1. A summary of 10-year lodgepole pine responses

Was there a significant ^a improvement in conifer performance 10 years after treatment?	
Survival	No†
Basal stem diameter	No
Stem diameter increment	No
Height	No
Leader length	No
Height:diameter ratio	Yes

^a Differences are significant where $p \leq 0.05$ according to ANOVA.

† Indicates that although $p > 0.05$, there was a strong trend of improved performance in the cutting treatment.

Lodgepole pine responses 10 years after brushing

- **Survival** - Lodgepole pine survival was declining in the untreated control after 10 years (63%), but did not differ significantly from survival in the manual cutting treatment (81%). The lack of statistical significance was due to high variability between sites.
- **Vigour** - Lodgepole pine vigour was declining in the control relative to the treatment when stands were 13-20 years-old (Figure 1), which suggests survival could continue to decline more rapidly in the control than the treatment. Twenty-six percent of control trees were of poor vigour in year 10, compared to 9% in the treatment.

- **Stem diameter** - Lodgepole pine stem diameter had not increased relative to the control 10 years after manual cutting. The difference in stem diameter was statistically significant in years 3-5 after treatment, but had become marginally insignificant by year 10 (Figure 2a). The lack of statistical significance is attributed to the relatively high variability among sites.
- **Height** - There were no significant differences in lodgepole pine height within 10 years of manual cutting (Figure 2b **Error! Reference source not found.**).
- **Height:diameter ratio** was significantly reduced in the treatment relative to the control in year 3, and the difference continued through year 10 (Figure 2c).

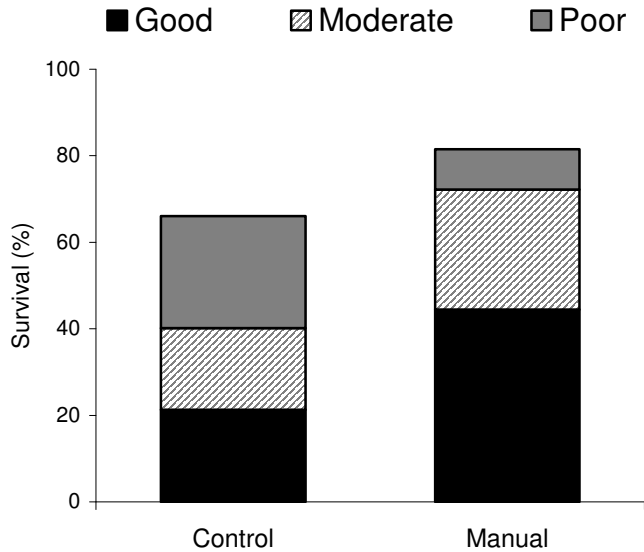


Figure 1. A comparison of lodgepole pine survival and vigour in the control and treatment 10 years after manual cutting of the *Mixed Broadleaf-Shrub* complex.

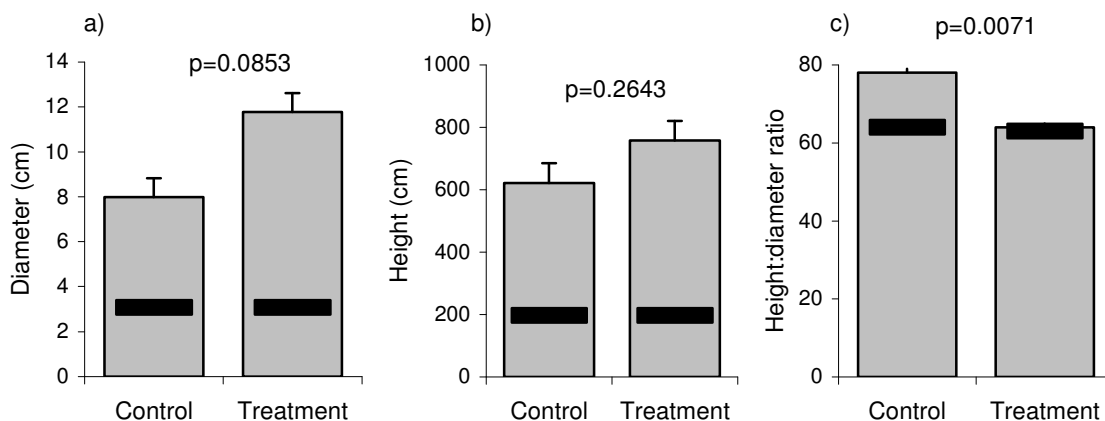


Figure 2. Comparisons of lodgepole pine (a) basal stem diameter, (b) height, and (c) height:diameter ratio in the control and treatment 10 years after manual cutting. Horizontal bands represent lodgepole pine size at the time of treatment. Error bars represent 1 standard error.

Vegetation responses

Table 2. Duration of vegetation responses

Years of significant ^a vegetation reduction	
Broadleaf cover	None
Broadleaf height	Years 3 - 10+

^a Differences are significant where $p \leq 0.05$ according to ANOVA.

Manual cutting significantly reduced mean broadleaf height for at least 10 years, which allowed the relatively fast growing lodgepole pine to maintain an ongoing height advantage (Figure 3). Manual cutting had no effect on overall broadleaf cover because of sprout abundance. There was an increase in shrub cover in the treatment relative to the control between years 5 and 10, but there were no significant treatment effects on other vegetation components (e.g., herbs). There were no significant treatment effects on the richness or diversity of vascular plant species within 5 years of brushing.

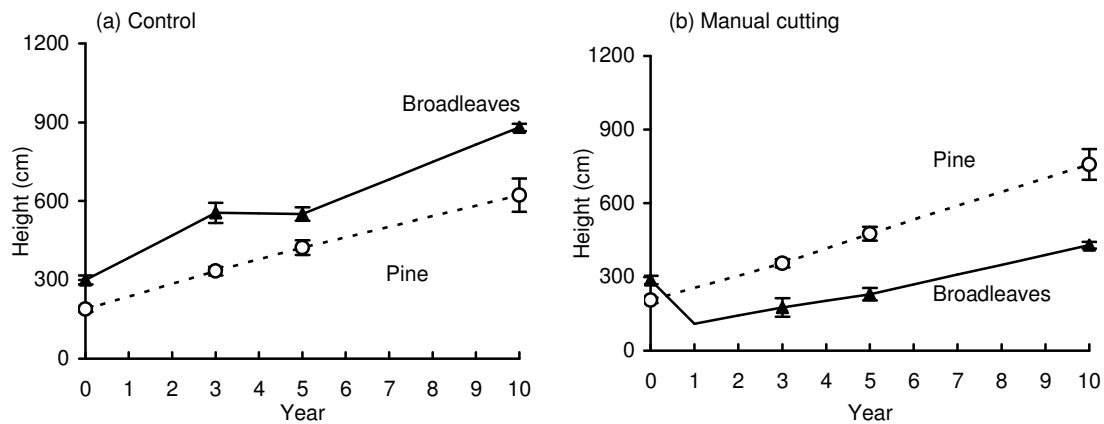


Figure 3. A comparison of average lodgepole pine and broadleaf height profiles in (a) the control and (b) the manual cutting treatment.

Management interpretations

Survival - By the time lodgepole pine were 13-20 years-old, pine survival in the untreated *Mixed Broadleaf-Shrub* complex was declining below acceptable levels. On average, manual cutting had improved lodgepole pine survival from 67 to 81% by year 10, although the difference was not statistically significant due to variability between sites. Pine vigour was continuing to decline in the control relative to the treatment in year 10, and longer-term assessments are required to determine whether further mortality and/or vigour decline was directly attributed to vegetation competition, but on one site, *Atropellis* canker had reduced pine vigour in both the treatment and control. Many of the control trees had died by year 10, probably because of the combined stress of vegetation competition and the disease.

Armillaria root disease - Early in this study, results suggested that the incidence of *Armillaria* related lodgepole pine mortality increased as a result of applying manual cutting treatments to the *Mixed Broadleaf-Shrub* complex. Similar early trends were found for Douglas-fir following manual cutting and girdling. The relationship between brushing and *Armillaria* root disease requires further study, but in the interim, we suggest that in stands where *Armillaria* is present: (a) brush only in high broadleaf-density areas, and (b) if possible, use spot glyphosate treatments rather than manual cutting or girdling treatments.

Conifer growth - Competition from the *Mixed Broadleaf-Shrub* complex was intense enough to reduce lodgepole pine stem diameter growth in stands where pine were 3-10 years-old at the time of brushing. The magnitude of the effect (but not the statistical significance) increased through the 10 year assessment period. Height was unaffected, probably because shade-intolerant lodgepole pine were putting resources into height rather than diameter growth. As a result, height:diameter ratio was lower for treated than untreated pine.

Treatment efficacy -The manual cutting treatment immediately reduced broadleaf height below that of lodgepole pine, after which pine increased in height at a slightly greater rate than broadleaves, and were able to maintain their height advantage. According to other PROBE results, cut stump-glyphosate and girdling also successfully reduce height and/or cover of the *Mixed Broadleaf-Shrub* complex ([Mixed Broadleaf-Shrub-Fd extension note](#)).

Richness and diversity - Manual cutting did not affect species richness or species diversity (according to the Shannon-Weaver diversity index) within 5 years of treatment. Full results are described in [LMH 48 \(Simard et al. 2001\)](#).

References

Simard, S.W., J.L. Heineman, W.J. Mather, D.L. Sachs, and A. Vyse. 2001. Effects of operational brushing on conifers and plant communities in the southern interior of British Columbia: Results from PROBE 1991-2000. Res. Br., Min. For., Victoria, B.C. Land Manage. Handb. No. 48.

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