Long-term effects of vegetation management treatments on growth and yield and stand development: a summary of PMP installation methods, location, and baseline statistics
March 2007

Introduction

Since 1991, the PROBE (PRotocol for Operational Brushing Evaluations) project has studied the effects of operational brushing treatments on conifer seedlings and vegetation. This project currently includes experiments on 96 sites across the southern interior of BC, and 10-year data is being collected at many of these sites. The results are providing forest managers with valuable guidance regarding a) where brushing is and is not required, b) the selection of appropriate treatments, c) expected conifer and vegetation responses, d) the effects of treatment on forest health, and e) the effects of treatment on non-timber site values. PROBE sites that have already yielded 10 years of data now have the potential to provide valuable information about the long-term effects of brushing on conifer growth and yield, stand dynamics, and plant community development and diversity at relatively low cost.

Data regarding the effects of brushing treatments on growth and yield and stand development have a number of important potential uses. Firstly, it can be used to validate existing policy and regulations or to suggest appropriate changes. This is especially important for broadleaf complexes because of the long time period during which conifers and broadleaves interact, because of the controversy that currently exists regarding appropriate levels of broadleaves that can be retained at free-growing, and because these complexes occur in some of the most productive ecosystems in BC. Broadleaves are well known for their contribution to ecosystem health (e.g., Gerlach et al. 1997; Simard et al. 2001; Aitken et al. 2002; Delong et al. 2002; Baleshta et al. 2004) but policy makers are hesitant to alter the free-growing guidelines without firm information regarding the effects on stand development and conifer yield.

A second use of our growth and yield data is in the development and calibration of stand development models that predict the effects of silvicultural treatments on growth and yield, stand structure, and forest health over one or more rotations. Managers would find such models extremely useful for conducting accurate cost-benefit analysis regarding different treatment options, and for predicting stand development. At present, the PROGNOSIS^{BC} and SORTIE-BC models appear well suited to this purpose.

Methods

The following methodology for installing and measuring long-term plots on existing PROBE sites has been adapted from Biring et al. (1998).

Establishing Permanent Measurement Plots (PMPs)

A PMP is a circular plot with an area of 0.1 ha (r=17.84 m) (or 0.04 ha (r=11.28 m) if stand density exceeds 7500 stems ha^{-1}). At each PROBE site, a PMP is established at the centre of each of the treatment and control plots. An aluminum post marks plot centre and rebar is used to mark the plot perimeter at N, NE, E, SE, S, SW, W, NW.

Measurements

a) Soil and site descriptions

A full soil pit is described (B.C. Min. For. 1998) in each of the control and treatment plots. Photos are taken from each PMP centre towards the N, S, E, and W. Site description information has already been collected for each PROBE site.

b) Tree measurements in PMPs
Each conifer and broadleaf tree ≥ 2 m tall is tagged with a uniquely numbered aluminum tag and painted at DBH. The following measured and descriptive variables will be assessed: species, total height (cm), DBH (cm), percent live crown, tree vigour, damaging agent, severity of damage, pathological indicators, position of pathological indicators on tree. Trees less than 2 m tall will be counted according to species. Height will be measured for 5 randomly selected stems of each species.

c) Site index measurements
Site index (SI) will be determined according to standard methodology using 4 (minimum 3) stems in the 0.1 ha plots and one stem in the 0.04 ha plots. If the largest DBH stems are not acceptable for SI determination, SI will be determined using SIBEC ecosystem correlation (B.C. Min. For. 1997).

d) Non-crop vegetation species data and regeneration data (Habitat Monitoring Plots)
Habitat monitoring plots are circular plots with an area of 50 m^2 (r=3.99 m) that have already been established for PROBE. We will continue to collect information about individual species and regeneration in these plots. For every vascular and non-vascular species in each vegetation layer, we will record percent cover, distribution code, and vigour, and also measure modal height. We will collect the following regeneration data: total number of conifers and broadleaves by species, number of well-spaced trees of each species, and number of free-growing trees of each species.

e) Measurement schedule
Following installation of PMPs, data will be collected in PMPs and Habitat Monitoring Plots at approximately 5 year intervals, subject to funding.

Data analysis
We will continue with the same analytical approach as is used in PROBE, where analysis of Variance (ANOVA) is used to compare treatment effects with controls using data from a number of replicate sites (treatments replicated in time and space). Once there are enough evenly-spaced repeated measurements, we may use repeated measures analysis to determine how treatment effects change over time. Regression analysis will be used to examine relationships between crop tree performance variables and competition indices or vegetation abundance. Categorical variables (e.g., vigour, stem condition, foliage condition) will be summarized in multi-way contingency tables with cells defined by treatment.

Study areas
PROBE sites are located throughout southern interior British Columbia (in the former Kamloops and Nelson Forest Regions). As of March 2007, PMPs have been installed on the following sites:

Table 1. A summary of PMP installation up to March 2007

PROBE site	Vegetation complex	Target conifer species	Brushing treatment	BEC zone
27 - Kathleen Lake	Aspen	Pl	Manual cutting	IDF
58 - Fowler Creek	Aspen	Pl	Manual cutting	MS
66 - McConnell Lake	Aspen	Pl	Manual cutting	IDF
77 - Boone Creek	Aspen	Pl	Manual with retention	IDF
80 - Skimikin	Aspen	Pl	Manual with retention	ICH
52 - Chuck Creek	Aspen	Fd	Manual cutting	ICH
28 - Mabel Creek	Aspen	Fd	Girdle	ICH
74 - 2km Rd 1221	Aspen	Fd	Girdle	ICH
126 - Marl Creek	Aspen	Fd	Triclopyr	ICH
1 - John Creek	Mixed Broadleaf-Shrub	Fd	Cut stump-glyphosate	ICH
2 - Upper John	Mixed Broadleaf-Shrub	Fd	Cut stump-glyphosate	ICH
7 - Larch Hills	Mixed Broadleaf-Shrub	Fd	Cut stump-glyphosate	ICH
15 - Gordon Bay	Mixed Broadleaf-Shrub	Fd	Girdle	ICH
21 - Scotch Creek	Mixed Broadleaf-Shrub	Fd	Girdle	ICH
30 - Russell Creek	Mixed Broadleaf-Shrub	Fd	Girdle	ICH
3 - Enterprise Creek	Mixed Broadleaf-Shrub	Fd	Manual cutting	IDF
12 - Mabel Lake	Mixed Broadleaf-Shrub	Fd	Manual cutting	ICH
29 - Johnson Lake	Mixed Broadleaf-Shrub	Fd	Manual cutting	ICH
41 - Homestead FSR[1]	Mixed Broadleaf-Shrub	Pl	Manual cutting	ICH
51 - Spahats Creek[1]	Mixed Broadleaf-Shrub	Pl	Manual cutting	ICH
46 - Burnyeat Creek	Mixed Broadleaf-Shrub	Pl	Foliar glyphosate	ICH
4 - Buck Creek	Dry Alder	Pl	Manual cutting	MS
23 - Slate Creek	Dry Alder	Pl	Manual cutting	MS
55 - Ross Lake	Dry Alder	Pl	Manual cutting	MS

1 The third replicate site in the Mixed Broadleaf-Shrub/Pl/Manual cutting cell was destroyed by fire in 2003

Summary of baseline statistics

1. Manual cutting of the Mixed Broadleaf-Shrub complex in Douglas-fir plantations

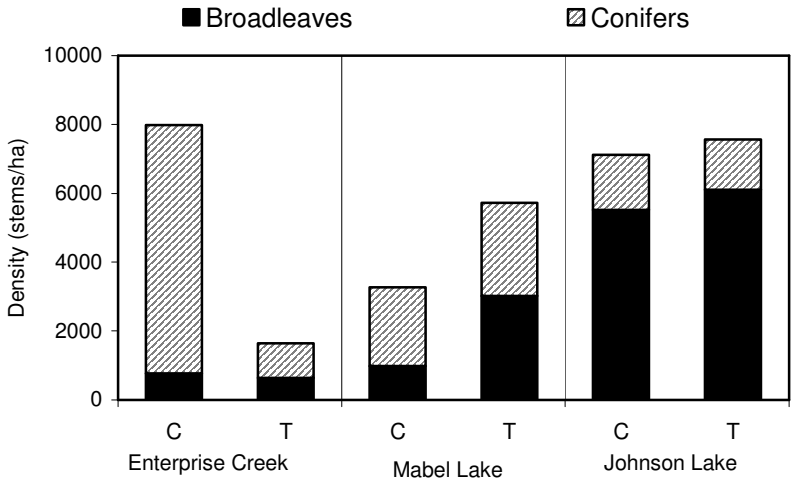

Figure 1. A comparison of conifer and broadleaf density on sites where the *Mixed Broadleaf-Shrub* complex was manually cut in Douglas-fir plantations.

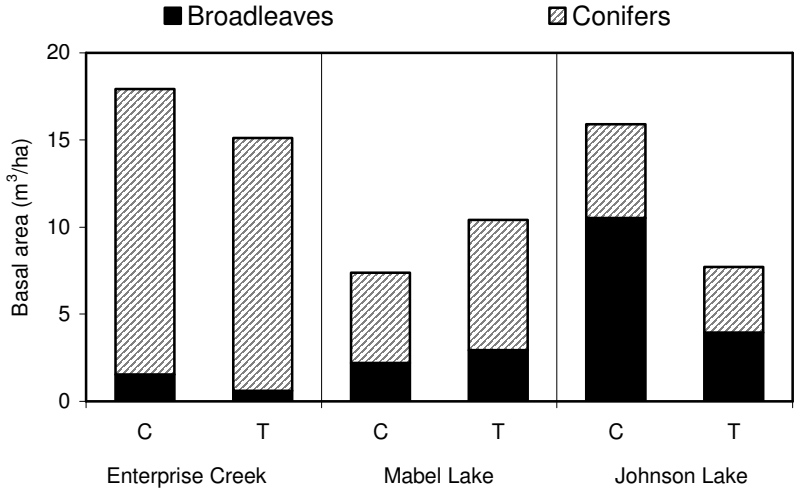

Figure 2. A comparison of conifer and broadleaf basal area on sites where the *Mixed Broadleaf-Shrub* complex was manually cut in Douglas-fir plantations.

2. *Cut stump-glyphosate treatment of the Mixed Broadleaf-Shrub complex in Douglas-fir plantations*

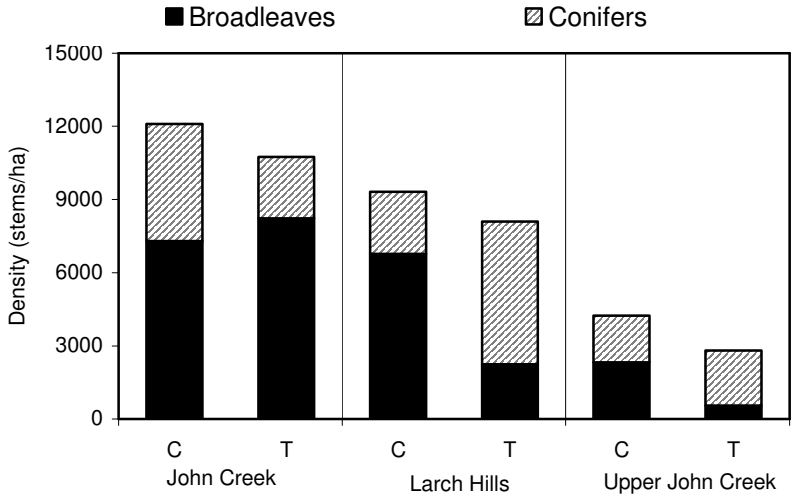

Figure 3. A comparison of conifer and broadleaf density on sites where the *Mixed Broadleaf-Shrub* complex was treated with cut stump-glyphosate in Douglas-fir plantations.

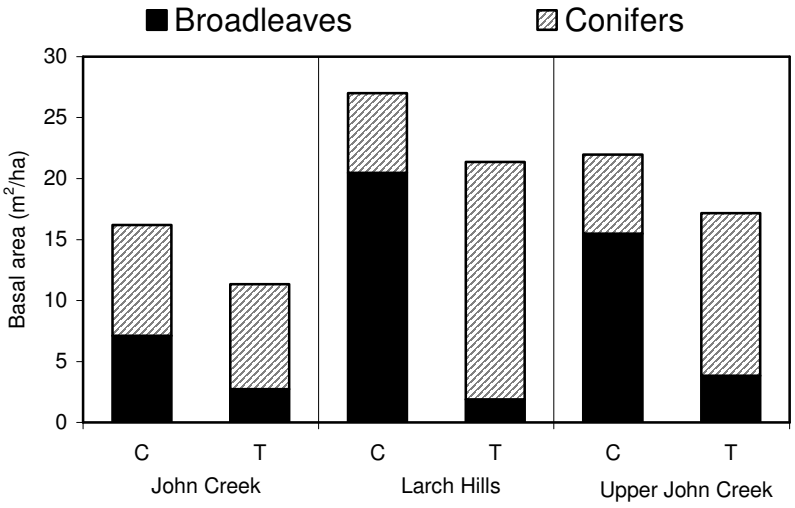

Figure 4. A comparison of conifer and broadleaf basal area on sites where the *Mixed Broadleaf-Shrub* complex was treated with cut stump-glyphosate in Douglas-fir plantations.

3. Girdling of the Mixed Broadleaf-Shrub complex in Douglas-fir plantations

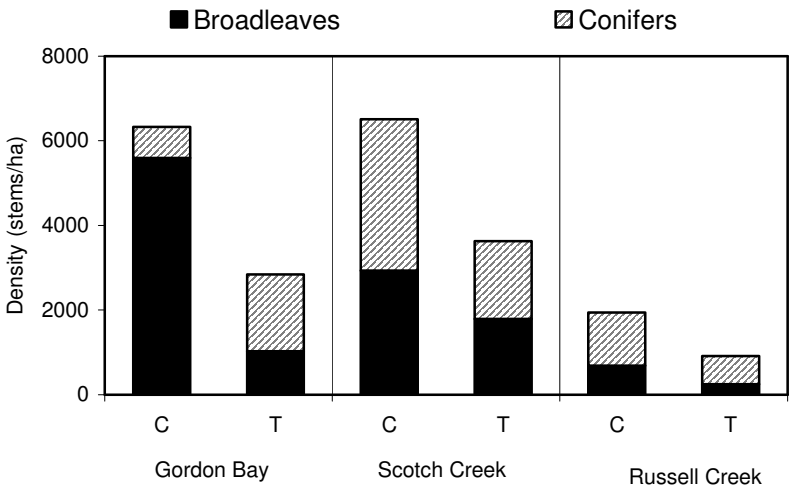

Figure 5. A comparison of conifer and broadleaf density on sites where the *Mixed Broadleaf-Shrub* complex was girdled in Douglas-fir plantations.

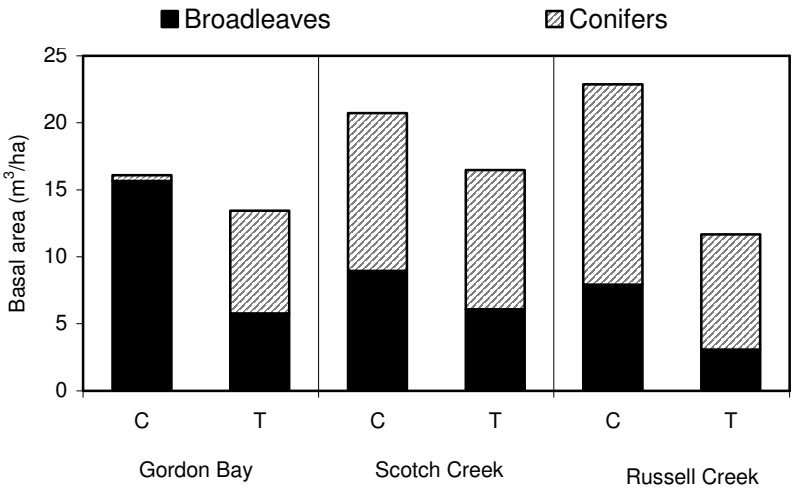

Figure 6. A comparison of conifer and broadleaf basal area on sites where the *Mixed Broadleaf-Shrub* complex was girdled in Douglas-fir plantations.

4. Manual cutting of the Mixed Broadleaf-Shrub complex in lodgepole pine plantations

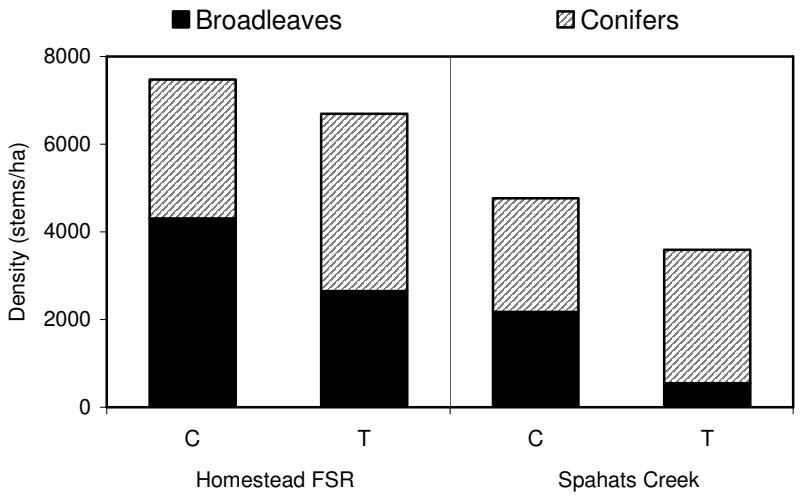

Figure 7. A comparison of conifer and broadleaf density on sites where the *Mixed Broadleaf-Shrub* complex was manually cut in lodgepole pine plantations.

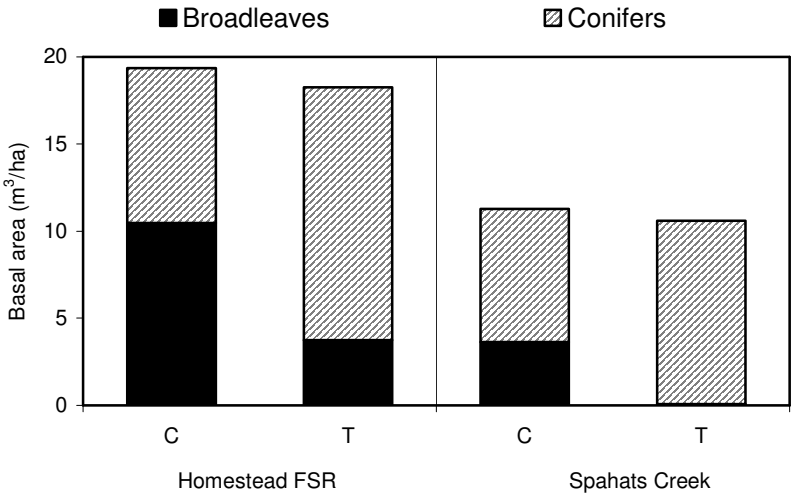

Figure 8. A comparison of conifer and broadleaf basal area on sites where the *Mixed Broadleaf-Shrub* complex was manually cut in lodgepole pine plantations.

5. Foliar glyphosate treatment of the Mixed Broadleaf-Shrub complex in lodgepole pine plantations

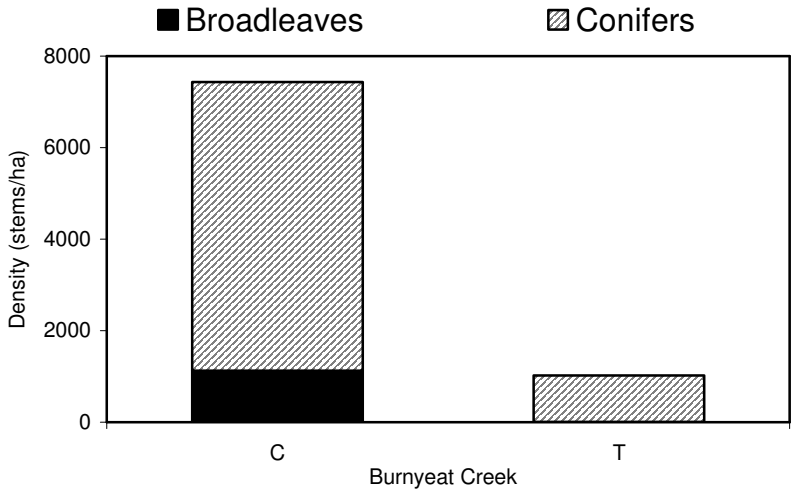

Figure 9. A comparison of conifer and broadleaf density on sites where the *Mixed Broadleaf-Shrub* complex was treated with foliar glyphosate in lodgepole pine plantations.

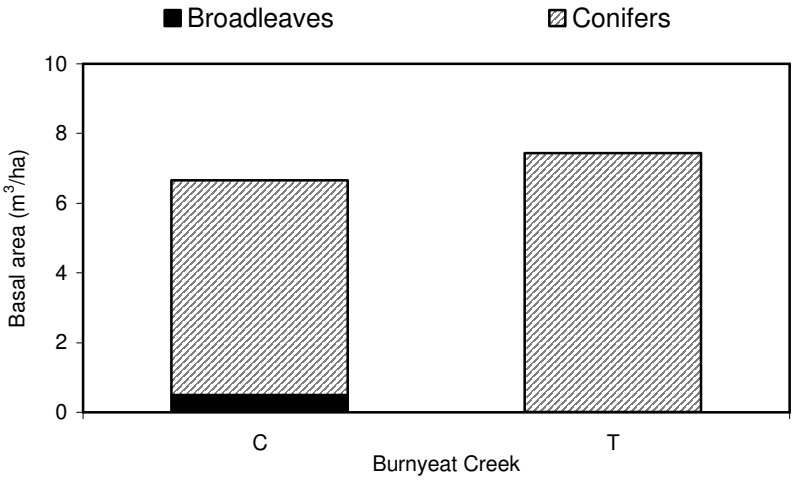

Figure 10. A comparison of conifer and broadleaf basal area on sites where the *Mixed Broadleaf-Shrub* complex was treated with foliar glyphosate in lodgepole pine plantations.

6. Manual cutting of the Aspen complex in lodgepole pine plantations

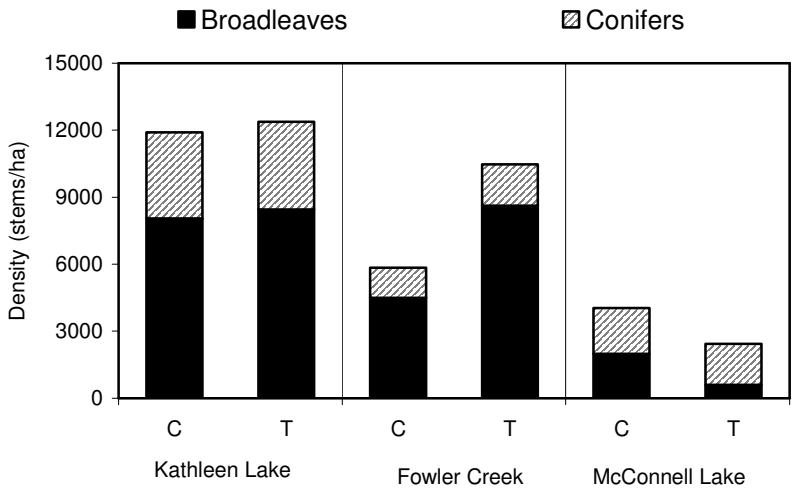

Figure 11. A comparison of conifer and broadleaf density on sites where the *Aspen* complex was manually cut in lodgepole pine plantations.

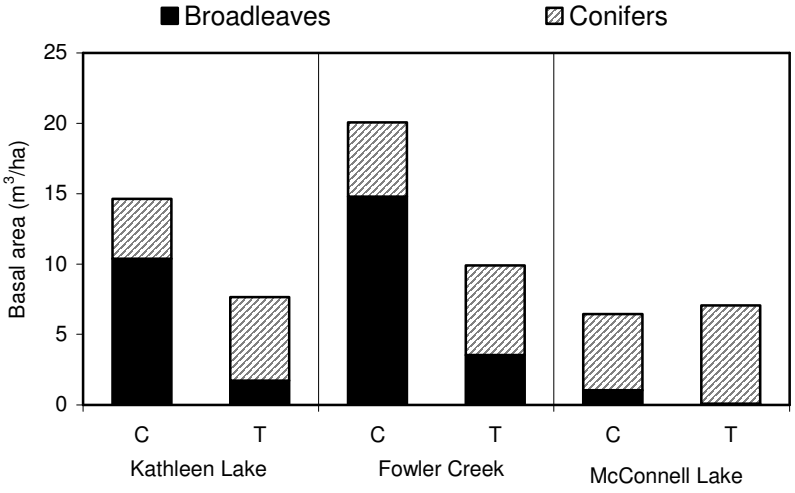

Figure 12. A comparison of conifer and broadleaf basal area on sites where the *Aspen* complex was manually cut in lodgepole pine plantations.

7. Manual cutting with aspen retention in lodgepole pine plantations dominated by the Aspen complex

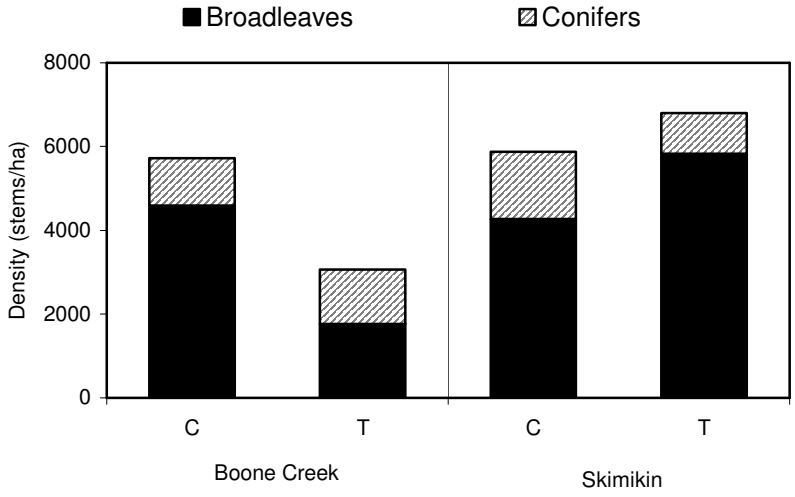

Figure 13. A comparison of conifer and broadleaf density on sites where aspen was retained in lodgepole pine plantations at densities of (a) 400 stems/ha at Boone Creek and (b) 1000 stems/ha at Skimikin.

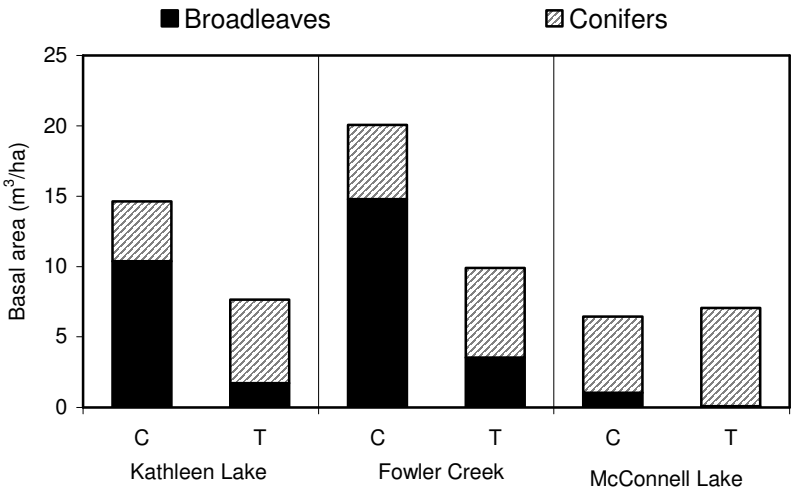

Figure 14. A comparison of conifer and broadleaf basal area on sites where aspen was retained in lodgepole pine plantations at densities of (a) 400 stems/ha at Boone Creek and (b) 1000 stems/ha at Skimikin.

8. Girdling of the Aspen complex in Douglas-fir plantations

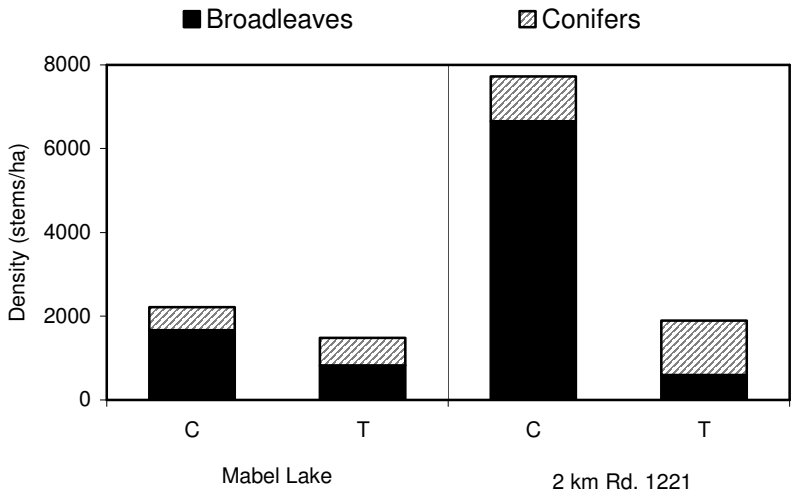

Figure 15. A comparison of conifer and broadleaf density on sites where the *Aspen* complex was girdled in Douglas-fir plantations.

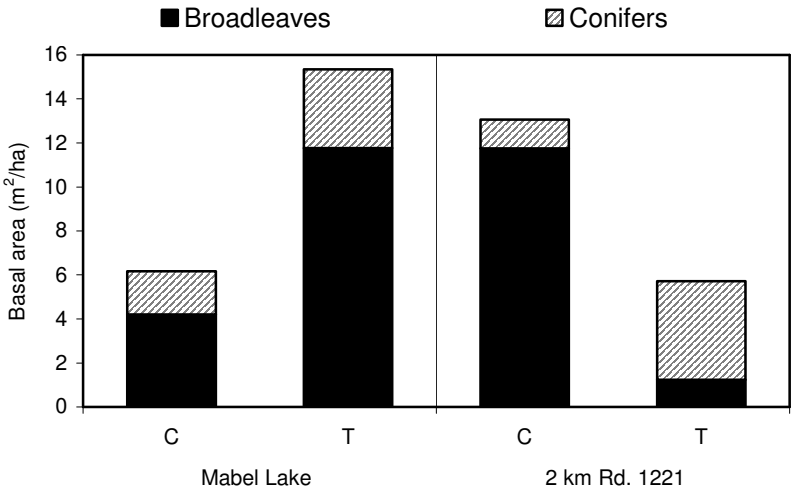

Figure 16. A comparison of conifer and broadleaf basal area on sites where the *Aspen* complex was girdled in Douglas-fir plantations.

9. Manual cutting of the Aspen complex in Douglas-fir plantations

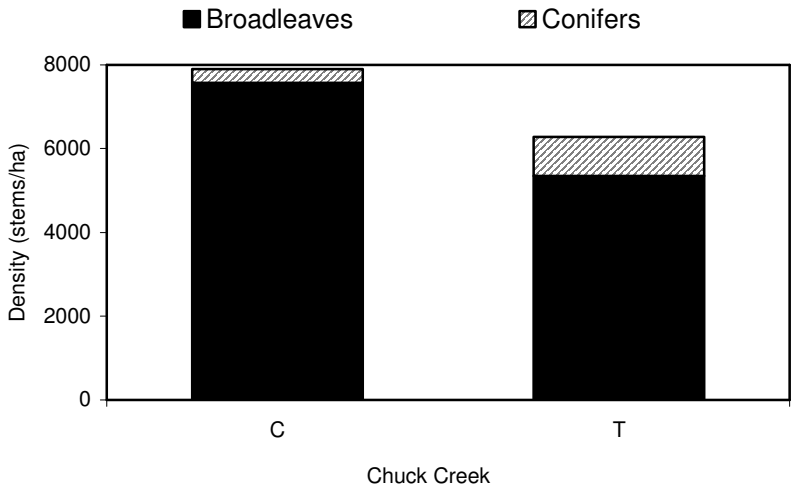

Figure 17. A comparison of conifer and broadleaf density on sites where the *Aspen* complex was manually cut in Douglas-fir plantations.

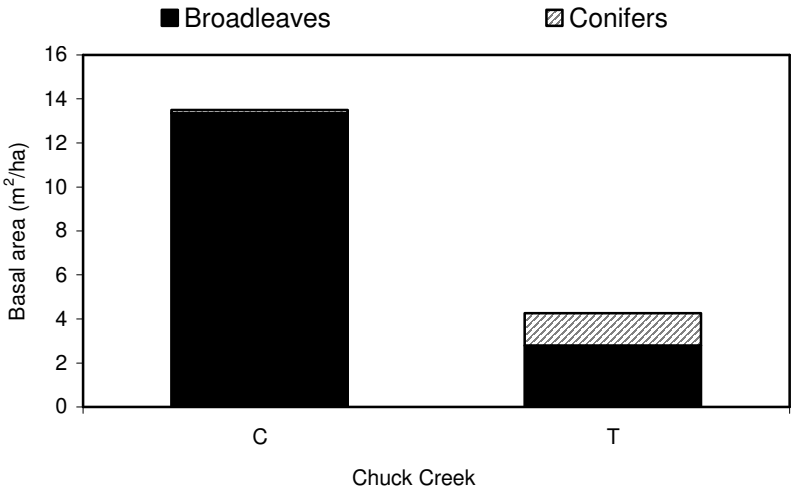

Figure 18. A comparison of conifer and broadleaf basal area on sites where the *Aspen* complex was manually cut in Douglas-fir plantations.

10. Triclopyr application to the Aspen complex in Douglas-fir plantations

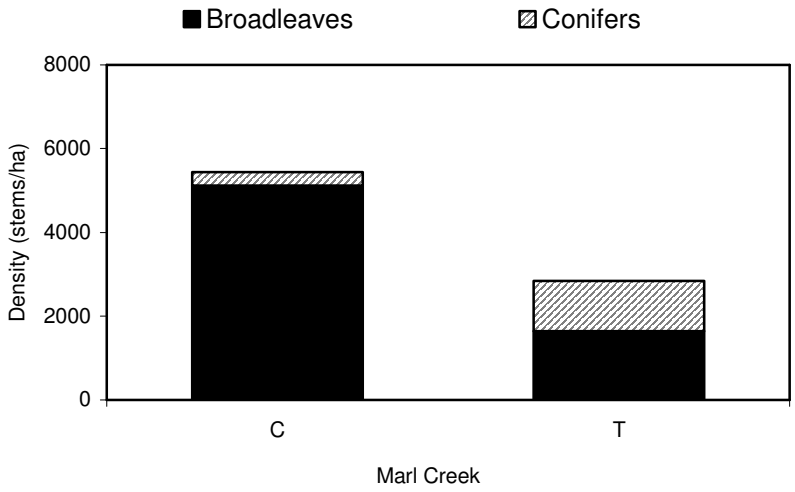

Figure 19. A comparison of conifer and broadleaf density on sites where the *Aspen* complex was treated with triclopyr in Douglas-fir plantations.

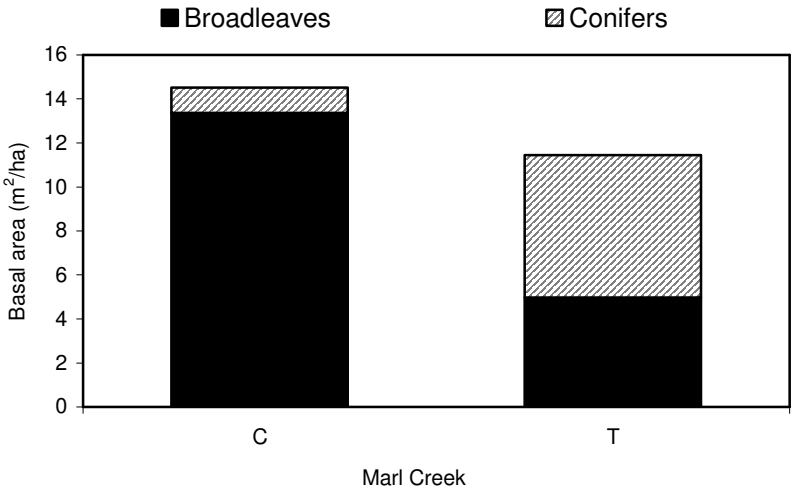

Figure 20. A comparison of conifer and broadleaf basal area on sites where the *Aspen* complex was treated with triclopyr in Douglas-fir plantations.

11. Manual cutting of the Dry Alder complex in lodgepole pine plantations

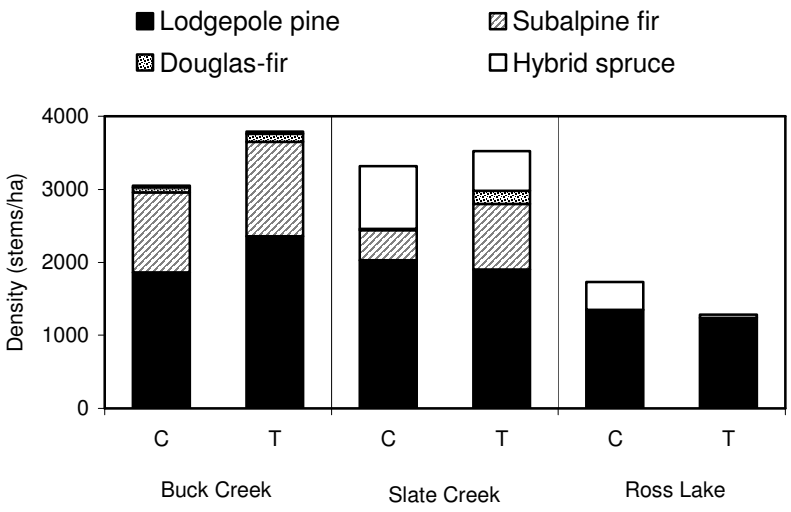

Figure 21. A comparison of the density of tree species on sites where the *Dry Alder* complex was manually cut in lodgepole pine plantations. Minor amounts of western white pine, western hemlock, and trembling aspen were also present in some plots.

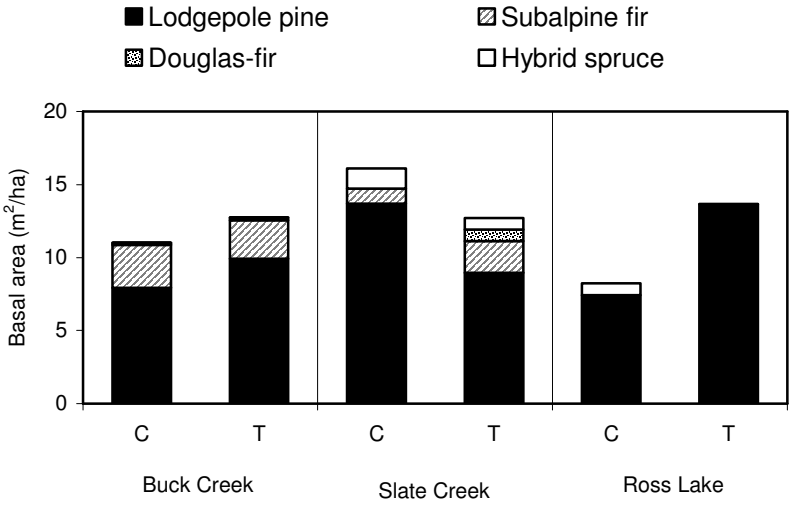

Figure 22. A comparison of the basal area of tree species on sites where the *Dry Alder* complex was manually cut in lodgepole pine plantations. Minor amounts of western white pine, western hemlock, and trembling aspen were also present in some plots.

References

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Prepared by J. Heineman Forestry Consulting
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