

Responses of hybrid and Engelmann spruce and the *Fireweed* complex to manual cutting, foliar glyphosate, and grazing: A summary of 3-5 year PROBE results

About the *Fireweed* complex

This community is widespread across British Columbia, wherever moisture is sufficient. In the southern interior, it occurs most abundantly in the ICH, ESSF, and MS zones. It is associated with sites where forest floor disturbance has prepared a suitable seedbed, and therefore tends to be more common on summer- than winter-logged sites. Where abundant, the *Fireweed* complex reduces light to understory conifers, and it may also physically damage them through snow- and vegetation-press. However, fireweed is also an important early seral species that contributes to forest floor development through its annual turnover of foliage and nutrients. On some sites, it also reduces the incidence of insect damage to seedling leaders. ([Full complex description](#))

Results

This section summarizes results from four fully replicated PROBE experiments where brushing treatments were applied to the *Fireweed* complex ([Full Methods description](#)):

1. Five year responses of 0-2 year-old¹ Engelmann spruce and vegetation to manual cutting in the ESSF and MS zones. Study sites were mesic to subhygric, gently to steeply sloping (10-50%), with variable aspect. Elevation ranged from 1150-1680 m, and fireweed cover averaged 50% at the time of treatment.
2. Five year responses of 0-4 year-old hybrid spruce and vegetation to manual cutting in the ICH zone. Study sites were mesic to subhygric, moderately sloping (25-45%), with southerly or easterly aspect. Elevation ranged from 1160-1370 m, and fireweed cover averaged 33% at the time of treatment.
3. Five year responses of 1-5 year-old Engelmann spruce and vegetation to foliar glyphosate application (1.4-2.1 kg ai/ha applied in August) in the ESSF and ICH zones. Study sites were mesic, gently sloping (10-25%), with northwest to easterly aspect. Elevation ranged from 1100-1600 m, and fireweed cover averaged 48% at the time of treatment.
4. Three year responses of 0-5 year-old Engelmann spruce and vegetation to grazing in the ESSF zone. Study sites were mesic to subhygric, moderately sloping (20-40%), with variable aspect. Elevation ranged from 1220-1460 m, and fireweed cover averaged 29% at the time of treatment.

¹ Seedling age refers to age since planting, so that “0 years-old” means seedlings were newly planted.

Table 1. A summary of spruce responses

| Was there a significant ^a improvement in conifer performance? | 5 years after manual cutting in the ESSF and MS zones | 5 years after manual cutting in the ICH zone | 5 years after glyphosate treatment in the ESSF and ICH zones | 3 years after grazing in the ESSF zone |
|--|---|--|--|--|
| Survival | No | No | No | No |
| Basal stem diameter | No | No | Yes | No |
| Stem diameter increment | No | No | No | No |
| Height | No | No | No | No |
| Leader length | No | No | No | No |
| Height:diameter ratio | No | No | Yes | No |

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

Spruce responses

- **Survival** - Hybrid and Engelmann spruce survival was not affected by brushing of the *Fireweed* complex in any of the four experiments. In the two manual cutting and the glyphosate experiments, survival was good (average $\geq 83\%$) regardless of whether brushing treatments were applied (Figure 1). Survival was also unaffected by the grazing treatment, but in that experiment, survival averaged only 63% after 3 years.
- **Vigour** - Five years after brushing, the proportion of poor vigour spruce was slightly higher in the treatment than the control of the ESSF/MS manual cutting experiment, but otherwise, proportions of good, moderate, and poor vigour spruce tended to be similar in treatment and control plots (Figure 1). The largest proportion of good vigour seedlings occurred in the ICH zone manual cutting experiment. In all other experiments the majority of spruce were of moderate vigour.
- **Stem diameter** - Spruce stem diameter increased significantly within 5 years of foliar glyphosate application, but did not respond to manual cutting and grazing treatments (Figure 2).
- **Height** - None of the brushing treatments had a statistically significant effect on spruce height (Figure 3). However, after 5 years, spruce in the glyphosate treatment were exhibiting a trend of increase that was only marginally insignificant ($p=0.0794$).
- **Height:diameter ratio** - Spruce height:diameter ratio decreased in the treatment relative to the control within 1 year of foliar glyphosate treatment, and the difference continued to be significant through year 5 (46 in the control versus 42 in the glyphosate treatment). Manual cutting and grazing had no effect on height:diameter ratio.

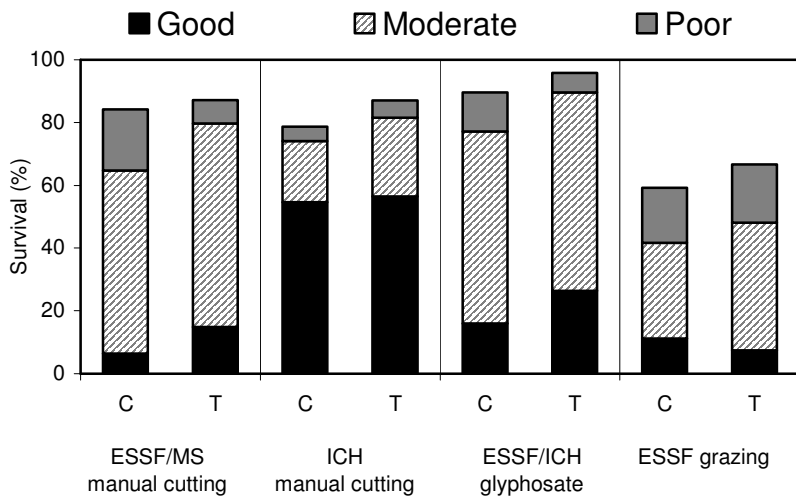


Figure 1. A comparison of spruce survival and vigour in controls (C) and treatments (T) 5 years after manual cutting and glyphosate treatments, and 3 years after grazing

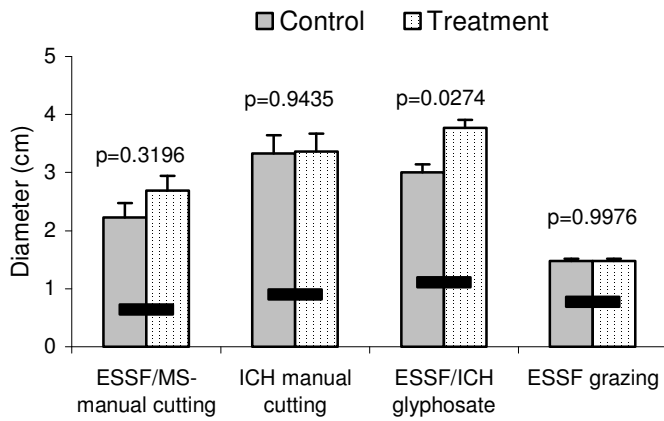


Figure 2. A comparison of spruce basal stem diameter in controls and treatments 5 years after manual cutting and foliar glyphosate treatments, and 3 years after grazing. Horizontal bands represent spruce diameter at the time of treatment. Error bars represent 1 standard error.

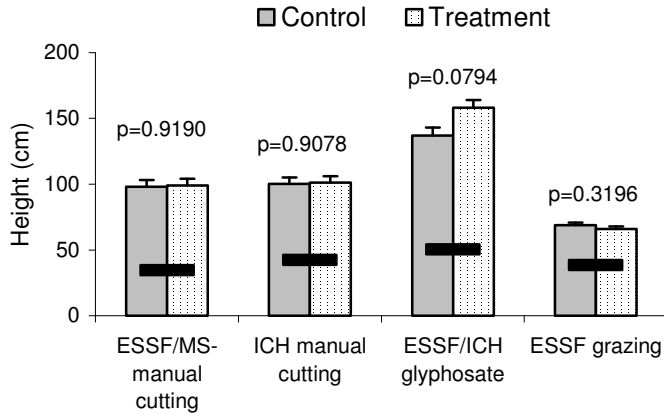


Figure 3. A comparison of spruce height in controls and treatments 5 years after manual cutting and foliar glyphosate treatments, and 3 years after grazing. Horizontal bands represent spruce diameter at the time of treatment. Error bars represent 1 standard error.

Vegetation responses

Table 2. Duration of vegetation responses

| | Years of significant ^a vegetation reduction | | | |
|-----------------------|--|--------------------------------|--------------------------------------|--------------------------|
| | Manual cutting in the ESSF and MS zones | Manual cutting in the ICH zone | Glyphosate in the ESSF and ICH zones | Grazing in the ESSF zone |
| All vegetation cover | None | None | None | None |
| All vegetation height | None | None | None | None |
| Fireweed cover | None | None | >3 but <5 years | None |
| Fireweed height | >1 and <5 years | None | >1 but <3 years | None |
| Shrub cover | None | None | None | None |
| Shrub height | None | None | >1 but <3 years | None |

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

Manual cutting caused a minor and short-lived reduction in fireweed height in the ESSF/MS zones. The magnitude of the reduction was very small (10 cm), but it contributed to the ability of spruce to, on average, grow above vegetation approximately 1 year earlier than occurred in the control. Treated spruce outgrew the fireweed canopy when they were 4-6 years-old, compared to 5-7 years-old for control spruce (Figure 4). Manual cutting in the ESSF/MS zones had no effect on cover of fireweed, or on height and cover of all vegetation, shrubs, or herbs. In the ICH zone, manual cutting had no effect on height or cover of any aspect of the *Fireweed* complex, and did not shorten the length of time it took spruce, on average, to grow taller than vegetation. Spruce naturally outgrew the fireweed canopy when they were 4-8 years-old (Figure 5). Manual cutting had no effect on the richness or diversity of vascular plant species within 3 years (analysis used third year data and grouped ICH and ESSF sites together).

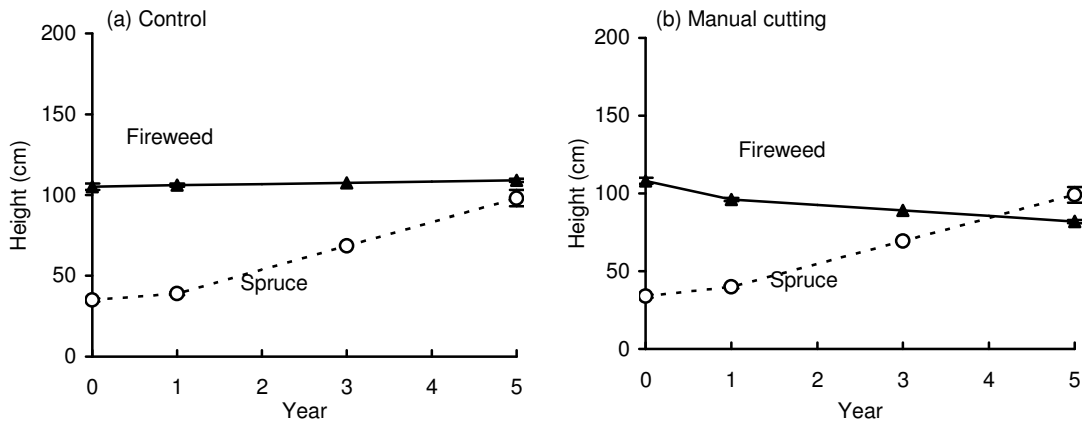


Figure 4. A comparison of average ESSF/MS zone Engelmann spruce and fireweed height profiles in (a) the control and (b) the manual cutting treatment.

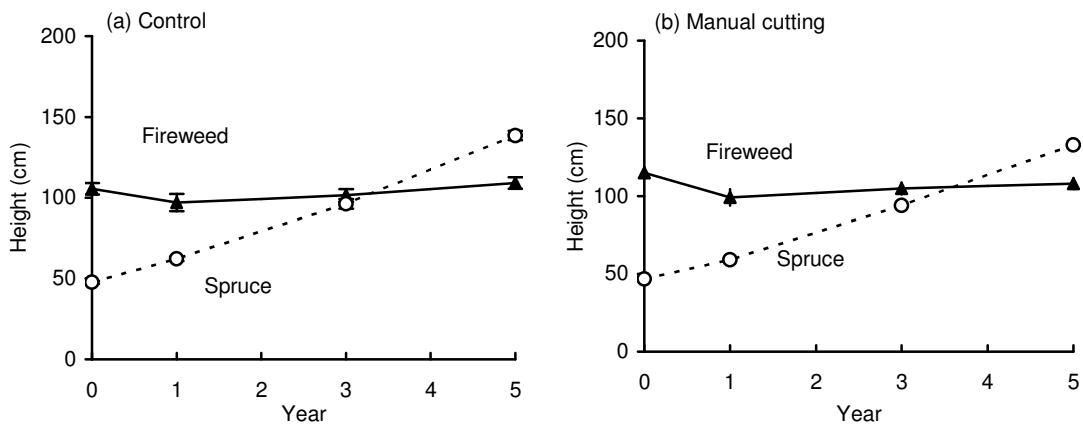


Figure 5. A comparison of average ICH zone hybrid spruce and fireweed height profiles in (a) the control and (b) the manual cutting treatment.

Foliar glyphosate reduced fireweed cover for at least 3 years ($p \leq 0.05$). The difference between the treatment and the control continued to be large in year 5 (14% in the treatment versus 36% in the control), despite the fact that it was no longer statistically significant ($p = 0.1275$). Fireweed height was significantly reduced for 1 year after treatment, but it had recovered to control levels by year 3. Glyphosate treatment immediately reduced fireweed height below that of spruce, and spruce essentially maintained their dominant position after that. Control spruce naturally outgrew the fireweed canopy 4 years later, when they were 5-9 years-old (Figure 6). Foliar glyphosate treatment also reduced cover and height of all vegetation, shrubs, and herbs for at least 1 year. There were no significant effects on the richness or diversity of vascular plant species within 5 years of glyphosate treatment.

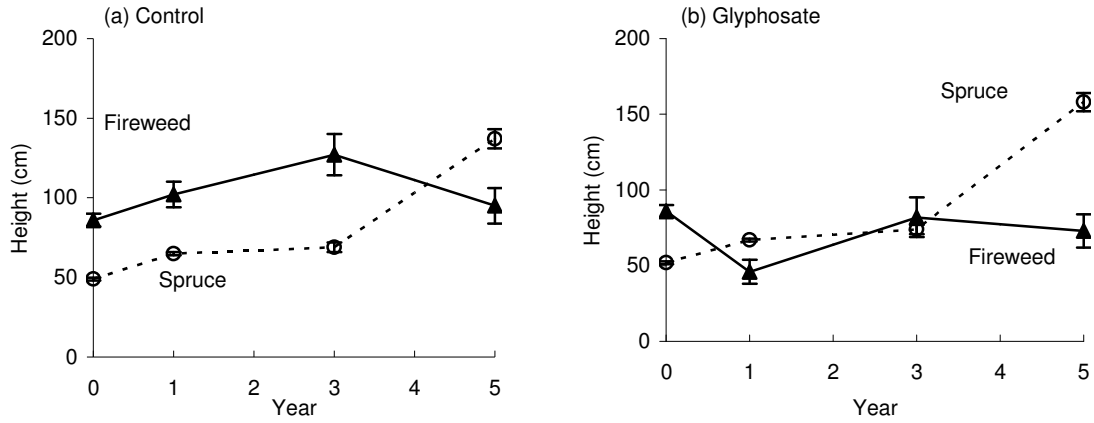


Figure 6. A comparison of average ESSF/ICH zone Engelmann spruce and fireweed height profiles in (a) the control and (b) the foliar glyphosate treatment.

Grazing had no effect on height or cover of fireweed, all vegetation, shrubs, or herbs. Spruce had not grown above the fireweed canopy by the time they were 3-8 years-old in either the control or the treatment (Figure 7). Grazing had no effect on the richness and diversity of vascular plant species 1 year after treatment.

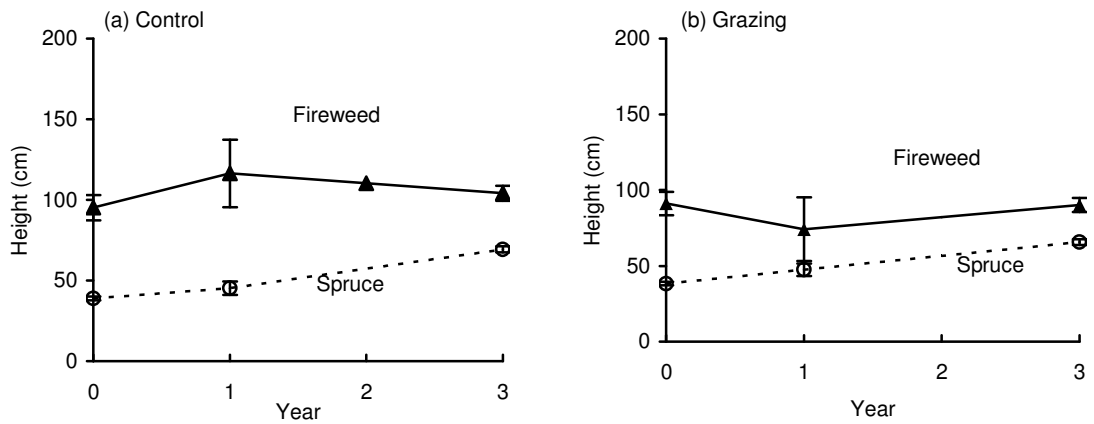


Figure 7. A comparison of average ESSF zone Engelmann spruce and fireweed height profiles in (a) the control and (b) the grazing treatment.

Management interpretations

Survival - In general, competition from the *Fireweed* complex was not severe enough on mesic sites to reduce spruce survival below acceptable levels. We recommend brushing not be done with the objective of improving survival on mesic (or drier) sites, but we do not include subhygric sites in this recommendation. Observations within individual experiments suggest that mortality was higher on subhygric than mesic sites, but we do not have sufficient replication to test this theory. Other studies have recommended brushing the *Fireweed* complex on subhygric sites

(Lindeburgh 1995). Survival was poorer in the grazing experiment than the others, but there is no obvious explanation for this.

Conifer growth - Our results suggest that slight increases in spruce diameter growth can be achieved by treating the *Fireweed* complex with glyphosate, but that single manual cutting and grazing treatments will have no effect. Despite the small growth increases that were achieved with glyphosate, we recommend that brushing the *Fireweed* complex is not necessary on mesic or drier sites for purposes of achieving acceptable spruce growth. Spruce seedlings naturally outgrew the fireweed canopy by the time they were 9 years-old.

Treatment efficacy – Foliar glyphosate reduced abundance of the *Fireweed* complex for at least 3 years, but single manual and grazing treatments had little effect. For all three of these treatments, Boateng and Comeau (1997) report similar efficacy as we report here.

Richness and diversity - None of the brushing treatments applied to the *Fireweed* complex affected species richness or species diversity. Full results are described in [LMH 48 \(Simard et al. 2001\)](#).

References

- Boateng, J.O., and P.G. Comeau. 1997. Operational summary for vegetation management: Fireweed Complex. For. Prac. Br., B.C. Min. For., Victoria, B.C.
- Lindeburgh, S. 1995. Effects of fireweed and associated vegetation on conifer survival and growth in the southern interior- fifth year results. For. Can. and B.C. Min. For., Victoria, B.C. FRDA Memo No. 226.
- 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.

Prepared March 2005