Regeneration Issues in Partial Cutting
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EXTENDED ABSTRACT
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Natural regeneration of Engelmann spruce and subalpine fir 9-years after seedbed treatment in three harvest treatments.

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A silviculture systems trial was established in northern British Columbia to investigate conifer regeneration as it is affected by climatic and ecological processes created by harvest treatments and residual stand structures. One study within this trial is the effects on the natural regeneration of Engelmann spruce (*Picea engelmannii* Parry) and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.). The trial is located on Lucille Mountain outside of McBride, B.C. and more information on this and other trials established by the northern wetbelt forests of BC research team can be found at: http://wetbelt.unbc.ca/index.html. The Lucille Mountain site is northwest-facing in the Engelmann spruce – subalpine fir, moist-mild, variant 1 (ESSFmm1) biogeoclimatic zone. Elevation ranges from 1340-1585 m and slopes range from 15-45%. Pre-harvest, subalpine fir dominated the stand, tree age ranged from 29-455 years, and up to 20% of the trees >17.5 cm dbh were standing dead. The rotational age for timber production at Lucille has been put at 160 years. The trial was established on this site because it is valuable for multiple resource uses including timber production, recreation, wildlife (caribou medium), visual quality, and water supply to the town of McBride.

Harvest treatments included a 32-ha clearcut, 0.2 ha patch cuts, and single-tree selection completed between the summer of 1991 and the winter of 1992. Seedbed treatments of scarification to mineral soil and direct-seeding occurred in the summer and fall of 1993 to create four seedbed treatments of disturbed with (DS) or without seeding (DN), and undisturbed with (US) or without seeding (UN). Cone crop assessments, seed quality, seed abundance, and initial ingress have been reported (Eastham and Jull 1999). Trees continue to be monitored and measured for growth performance.

Germination was increased in the partial harvest systems by disturbance down to mineral soil (Fig. 1). Seedling mortality was the highest in both species following the first winter. The net number (total count that takes in both mortality and ingress) of subalpine fir seedlings has remained stable over time, or increased through ingress (Fig. 1a), while the number of spruce seedlings has decreased (Fig. 1b). The response pattern in the selection harvest system was similar. Direct seeding, not disturbance, increased the number of live seedlings in the clearcut system. Ingress has been mainly subalpine fir, and greatest on the scarified seedbeds in the patch cut and selection harvest treatments. Seventeen germinants were tallied within in all sample plots in 2002. This equals about 700 seedlings/ha. A reduced rate of ingress, five to seven years post-harvest, has been

reported by Greene et al. (1999) for boreal forests as seedbeds suitable for germination decrease with increased vegetation cover.

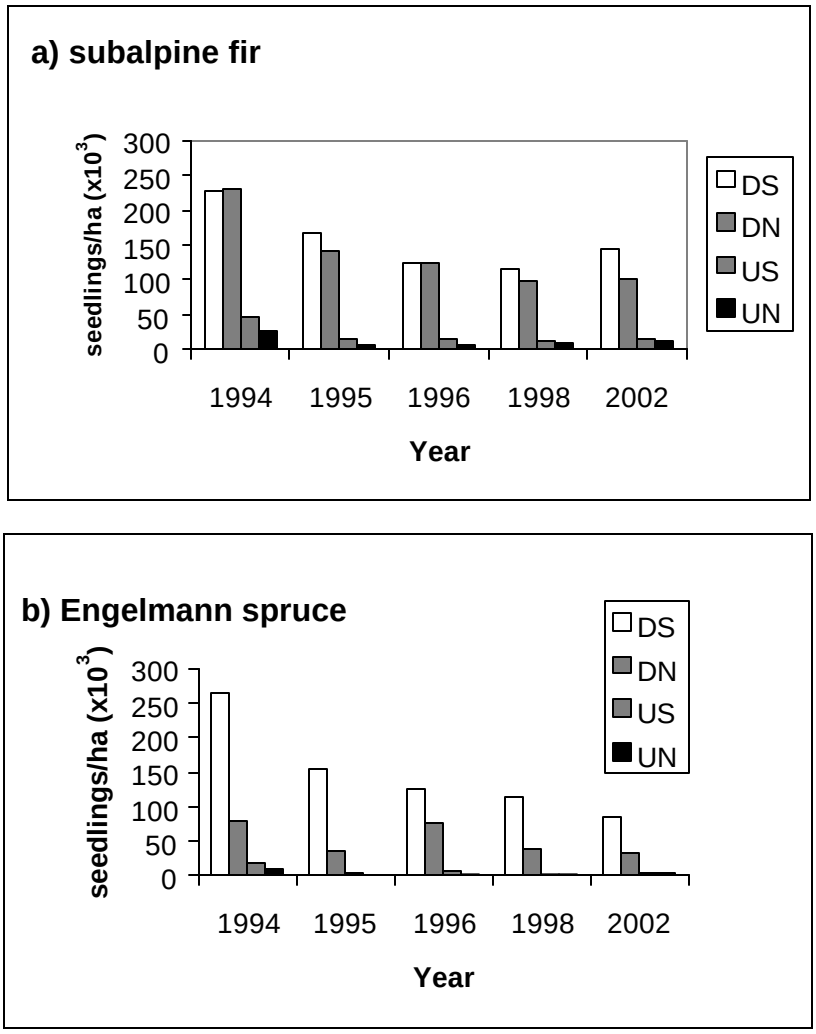

Figure 1. Mean number of subalpine fir (a) and spruce (b) seedlings per hectare by year within a patch cut harvest system and four seedbed treatments: DS = disturbed seeded, DN = disturbed not seeded, US = undisturbed seeded, UN = undisturbed not seeded. Bars represent treatment means and n=3 or 4.

Seedbed treatment for subalpine fir was the only source of variation, including interactions, that was statistically significant (α=0.05, p=0.012) when comparing seedling height at year-9. The DN treatment had shorter seedlings with an average height of 12.3 cm compared to 16-17 cm in the other three treatments. This may be a function of more recent, continued ingress in the DN treatment that resulted in greater numbers of younger, shorter trees, although the 17 germinants in 2002 were not included in the growth analysis. Seedlings in the selection treatment were significantly (p<0.001) smaller compared to those in the clearcut and patch cut. The average subalpine fir and spruce seedling height in the selection treatment was 8 and 12 cm, respectively, 9-years after seedbed treatment/10-years after harvest. Seedlings of both species in the patch cut and clearcut averaged 22-25 cm in 2002.

So, what are the regeneration issues in partial cuts that arise given the results from Lucille Mountain? First is the ratio of subalpine fir to spruce in the regenerating layer. Forest companies would prefer more spruce because the subalpine fir warps and twists during kiln drying. The original stand was mostly subalpine fir, more leave trees are subalpine fir, and the regenerating layer is following the same pattern even where the same number of spruce and subalpine fir were direct seeded on small plots. There may be environmental limits to producing spruce on the cold, north-facing slopes even through planting. If planted spruce survival and growth could be achieved, there may be opportunities to use artificial regeneration of spruce coupled with natural regeneration of both species in order to swing the ratio to more spruce and less subalpine fir.

Secondly, the silviculture standards for the ESSFmm1 may, or may not, be achievable. The current free growing target is 700-1200 sph of subalpine fir and spruce with a height of 80 cm and 125% above brush. This target must be meet in 20 years, the latest free growing date. Density (sph) may be a problem in a clearcut situation, but in the partial cut systems studied at Lucille, the patch cut ranged from 16,000 to 130,000 seedlings/ha10-years after harvest, with even higher numbers in the selection system. The current maximum density of 10,000 sph will likely be exceeded at year 20 if only the regeneration layer is assessed, but for selection systems it is the layer 3 trees (1.3 m to <7.5 cm dbh) that are assessed for the free growing target meaning it should easily pass. With regular cone crop assessments to predict seed supply in areas where partial systems are to be used, harvesting could be scheduled to capture the maximum number of initial seedlings just after harvest. This would reduce the risk of having not enough seedlings. Also, the Ministry of Forests recognizes that amendments to the standards that were originally devised for clearcut systems may not be practical to apply to high elevation ESSF sites, and may not be the ecologically appropriate targets in those areas.

The target height of 80 cm could be more challenging within the time frame dictated. Seedling heights have only been measured twice, in 1998 and 2002. Using these two points, and extrapolating out past year 10 using a straight line, none of the average seedling heights will reach 80 cm in 20 years. The best performance we can expect from the data we have now is a 20-year average height of 57 and 50 cm for subalpine fir and spruce, respectively, in the clearcut system. Extrapolated 20-year heights for both species in the patch cut are similar to the clearcut at around 54 cm. Seedlings in the selection treatment may only reach 14 and 27 cm tall by year 20 for subalpine fir and spruce, respectively, using the same extrapolation. Tree growth in the pre-harvest stand was slow with average years to reach 1.3 m of 57 years (Jull and Stevenson 2001). However, the multi-story survey will include the leave trees and advanced regeneration, not just the regeneration layer, making the targets achievable. The allocation of site resources to tree growth differ between silviculture systems. During the first 7 years after harvest at Lucille, the big trees that were left were putting on 0.25-0.6 cm/year and the bigger trees have the largest basal area increment (Jull and Stevenson 2001). Gross growth of the leave-trees at a stand level has been offset by mortality losses from windthrow and other causes, but 7-years into a multiple entry, 160-year rotation is too early to predict the end result in timber production.

The other regeneration issues in partial cuts pertain to the non-timber values of this forest. Partial cut systems are preferred over clearcut systems to specifically accommodate retaining these values such as visual quality and wildlife habitat. Stevenson (Jull and Stevenson 2001) has reported that the amount of forage lichen available 7-years post-harvest in partial cuts at Lucille Mountain was likely below the threshold of suitability to caribou. The regeneration layer is growing slowly and will not provide suitable substrate for arboreal lichens for some time to come. Hydrology issues may also arise due to the long periods of time required to replace the harvested areas. Long-term, regular monitoring of trials such as Lucille is required to fill the gaps in our knowledge of how the regeneration layer established in the first 10 years after harvest will perform over a long rotation.

References:

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