

SFM Network
Research Note Series
No. 41

Spruce and aspen regeneration following variable retention harvests at EMEND

Highlights

- Survival of planted spruce was unaffected by the percentage of residual trees, but was higher on mounded and mixed sites compared to scalp or no-treatment sites.
- Planted spruce growth was best in clearcuts for the spruce-dominated sites but was best in the 50% retention in aspen-dominated sites.
- Mounds were warmest and produced the best sites for nutrient release and eventually the best sites for growth of planted spruce – especially on sites that were originally conifer-dominated.
- Across the EMEND experiment, the best growth of spruce seedlings occurred in aspen stands with 50% residuals where mixing or mounding site preparations were used.
- Aspen and balsam poplar regeneration was greater in stands which had high aspen density prior to logging and was inhibited by residual trees, especially aspen and balsam poplar.

The EMEND experiment

The EMEND project provides an experimental template where six levels of dispersed green-tree retention (0-2%, 10%, 20%, 50%, 75% and 100% or uncut) were applied to whole forest stands 10 ha in size. These retention treatments were replicated 3 times over 4 dominant stand types (deciduous-dominated canopy—primarily aspen and balsam poplar, deciduous canopy with developing

The Ecosystem Management Emulating Natural Disturbance (EMEND) Project is a multi-partner, collaborative forest research program. The EMEND project documents the response of ecological processes to experimentally-delivered variable retention and fire treatments. The research site is located in the western boreal forest near Peace River, Alberta, Canada, with monitoring scheduled for an entire forest rotation (i.e. 80 years). Individual research projects evaluate which forest harvest and regenerative practices best maintain biotic communities, spatial patterns of forest structure, and functional ecosystem integrity, compared to mixedwood landscapes created by natural disturbances. Furthermore, economic and social analyses evaluate the long-term viability and acceptability of these practices. This research note, part of a series about the EMEND Project, summarizes results from several studies about forest regeneration.



Figure 1. Overhead view of the EMEND Project.
Photo courtesy of Victor Lieffers.

understory of white spruce, mixed deciduous-conifer canopy and conifer-dominated canopy—primarily white spruce). No vegetation management was applied to this experiment. Some components of this experiment were used for the various studies summarized below.

Environmental response to site preparation and partial harvesting

Temperature, nutrient release and vegetation response were assessed in spruce-dominated stands with 0% and 50% residuals. In the spring following harvest, stands were treated with one of the following:

- mechanical site preparation techniques including mounding (excavator) or mixing (merri crusher); or
- scalping (back-screefing with the excavator); or
- slash burning of small plots using a propane torch (resulting in 2 cm of duff removal).

Conditions were evaluated in the same summer.



Figure 2. Burning of subplots and use of excavator to scalp areas of the site. Photo on left courtesy of Victor Lieffers. Photo on right courtesy of Derek Sidders.

Findings

Site preparation had a larger impact on nutrient release than the percentage of residual trees left after logging. Mounding or burning produced good conditions for nutrient release.

In terms of soil temperature, mounding and scalping resulted in warmer soils than did either mixing or control treatments, while the clearcut had warmer soil than the 50% retention treatments.

Mineralization of nitrogen (the rate of nitrogen release from forest litter) was greatest in mounds while the scalp, and surprisingly, the mixed environments, had lower rates of mineralization.

Nutrient availability for N, P and K (the amount of nutrients captured on ion-exchange resins, June to October) was greatest in the burned treatment. In contrast, the mineral layer of the mound and the scalped zones had the lowest rates of nutrient availability.

The scalp sites produced the greatest re-growth of aspen, while fireweed grew best in the burns and the mounding treatments.

Establishment and growth of planted spruce

Mounding, mixing, scalping or no treatment were applied to the 0%, 50% and 75% residual treatments in both the conifer-dominated and deciduous-dominated forests. Spruce were evaluated after 7 growing seasons.

Findings

Up to the end of year 7 there was no difference in survival for the spruce seedlings across the different levels of overstory retention, but survival was higher in the mixed and mounding treatments. Survival within these site preparations was 83% compared to 74% in sites with scalping or no treatment.

The growth of spruce seedlings was affected by canopy retention. In the conifer-dominated sites, the best growth was in the sites where all the overstory was removed. However, in the deciduous-dominated sites, the best spruce-seedling growth occurred when 50% of the overstory was retained. The mounding or mixing treatments produced the largest seedlings; the scalping treatment was no better than the control treatment.



Figure 3. The worst and the best ways to promote spruce. *Left:* Spruce seedlings with 75% retention in the conifer sites and no site preparation treatment were 30 cm tall at year 7. *Right:* Spruce in 50% retention in the deciduous site with mixing site preparation were greater than 130 cm tall. Photos courtesy of Victor Lieffers.

Growth of aspen

Nine growing seasons after establishment of the experiment, the aspen and poplar regeneration were assessed in all of the different levels of canopy retention in the deciduous, mixed and conifer stands.

Findings

The number of aspen and balsam poplar sucker regeneration declined steeply with increasing density of residual stems of both aspen and white spruce.

Density of aspen regeneration was suppressed more by residual aspen than by spruce, likely because of the hormonal suppression of root suckering from the residual trees. Leaving 20% residuals suppressed the density of regenerating stems by nearly 50%. Leaving 75% residuals resulted in negligible redevelopment of the aspen and balsam poplar.

The size of aspen suckers was suppressed by both residual aspen and spruce.



Figure 4. Clearcuts had the highest density and the largest suckers 9 years after logging (>20,000 stems/ha). Photo courtesy of Victor Liefers.

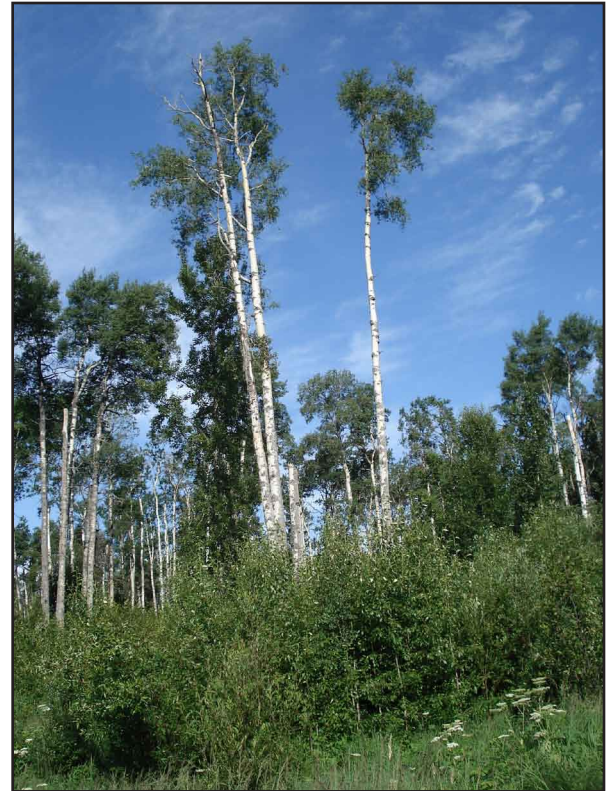


Figure 5. In the deciduous stands, 50% residual aspen resulted in >80% reduction in density of suckers compared to clearcuts. Photo courtesy of Victor Liefers.



Figure 6. The coniferous stands with 50% residuals had a lower density of suckers, both because of the more intense shading of the spruce and because of the reduced density of aspen roots in the stand prior to logging. Growth of aspen stems was also suppressed relative to clearcuts. Photo courtesy of Victor Liefers.

Overall, the partial harvesting was more beneficial to the regeneration of the planted spruce compared to the natural regeneration of the shade-intolerant aspen. In the future, we will need to assess the natural regeneration of the spruce on these sites and secondly, assess the regeneration of aspen in variable-retention cuts which have undergone site preparation.

Further reading

Frey, B. Lieffers, V.J., Munson, A. and Blenis, P.V. 2002. *Nutrient and vegetation dynamics in boreal mixedwoods following partial cut harvesting and forest floor disturbance*. Can. J. For. Res. 33: 1180-1188.

Gradowski, T., Sidders, D., Keddy, T., Lieffers, V.J. and Landhäusser S.M. 2008. *Effects of overstory retention and site preparation on growth of planted white spruce seedlings in deciduous and coniferous dominated boreal plains mixedwoods*. Forest Ecol. Manage. 255: 3744-3749.

EMEND : www.emend.rr.ualberta.ca

Management Implications

- The absence of tending treatments appears to have little impact on spruce seedling survival.
- Mounding and mixing site treatments may result in better spruce seedling establishment and survival compared to scalping or no site preparation.
- Given the dense canopy of spruce in conifer-dominated sites, limited retention of mature spruce (perhaps in the order of 25-30%) may result in the greatest improvements in spruce seedling establishment.
- For a deciduous-dominated site, which has a more porous canopy than a conifer site, spruce establishment will be better under conditions of increased retention, (50% retention in the experiments) likely due to protection from frost and the reduced suckering of the aspen.
- In variable retention systems, regeneration of aspen and balsam poplar will be suppressed by leaving residual trees of these species. Even 20% residual retention will suppress the density of regenerating stems by nearly 50%. Retention levels around 75% will result in negligible redevelopment of the aspen and balsam poplar.



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Ecosystem Management Emulating Natural Disturbance



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