Effects of herbaceous vegetation control and aspen stem density on boreal mixedwood stand development.

Partners Report - 2006 Field Season

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The problem

Mixedwood forests dominated by white spruce (*Picea glauca* [Moench] Voss) and trembling aspen (*Populus tremuloides* Michx.) are prominent in the boreal forests of Canada. These forests contribute significantly to Canada's wood supply and serve important roles in the provision of wildlife habitat, biodiversity, water resources, and aesthetics. Across Canada, demands from both conifer and deciduous users are creating land-use conflicts, particularly where regeneration focuses on a single species. There is a need for practical regeneration strategies that will reproduce the temporal, spatial, compositional, and structural diversity of mixedwood forests and sustain the values they support on our landscape.

The proposed solution

In March 2002, a study was initiated to increase our understanding of the silvicultural regimes necessary to establish a mixture of white spruce and trembling aspen following clear felling on upland boreal sites. The hypothesis being tested is that a relatively low density of white spruce (e.g., 400 stems/ha) can be planted and managed on an individual-tree basis, while aspen are grown to an early technical rotation in the intervening areas between the spruce. The aspen may enhance spruce stem quality and will provide a cash crop midway through the spruce sawlog rotation. A key objective of the study is to explore the relationship between early competition control around the planted spruce and aspen stem density, so that mixed yields of the two species might be optimized. The research sites, situated near Whitecourt Alberta and Timmins Ontario, contain identical experimental installations.

Methods

The study employs a **response-surface** design that combines the effects of ***radial*** vegetation control (0, 2, and 4 years duration) with aspen stem density (400, 800, 1200, 2000 and natural (i.e., unthinned)) (Fig. 1). Five reference ***broadcast*** treatments are also established to represent selected alternative practices: a) untended mixedwood plantation; b) mixedwood plantation with control of grass and herbaceous vegetation only; c) pure spruce plantation with control of all competition; d) pure spruce plantation with control of woody competition only, and e) pure aspen.

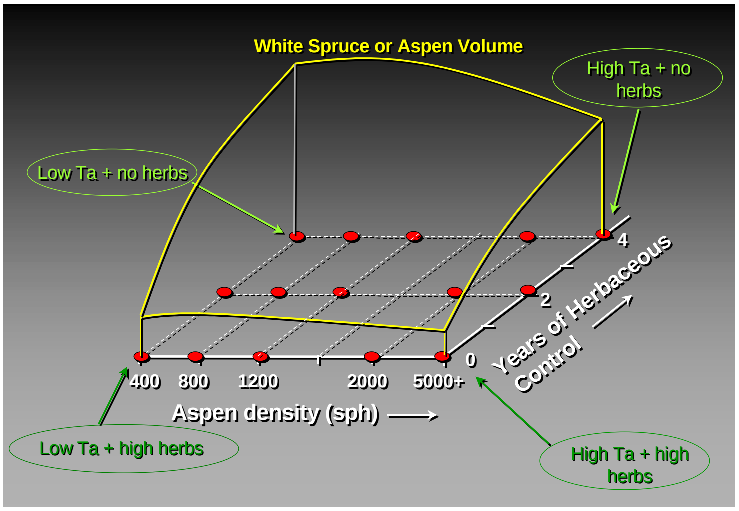

Fig. 1. Theoretical response surface resulting from treatment combinations of aspen stem density and duration of herbaceous vegetation control.

In each response-surface plot, all aspen and other woody competition situated within a 2-m radius of each planted spruce (5-m spacing) are removed at the end of the growing season prior to planting. This site preparation reduces initial aspen densities on the plots by approximately 50%. Herbaceous vegetation control treatments are applied within the 2-m radius of each planting location, at the end of the growing season prior to planting, and maintained for 2 or 4 years, as defined by the assigned treatment. Aspen situated between the spruce will be thinned to the prescribed densities at the end of the 5th growing season, after some natural thinning takes place. Note that the prescribed aspen densities apply to the plot area, inclusive of the radial treatment areas around the spruce. Three replications at each of the four corners and center of the response surface will permit the evaluation of pure error and lack of fit in resulting models; a total of 25 experimental plots (45 x 45 m) comprise this part of the experiment.

The five reference broadcast treatments will quantify stand composition extremes as well as benchmark some of the operational approaches that are currently taken on mixedwood sites. Each of the plots in this part of the study is 35 x 35 m in size and, with the exception of the pure aspen plots, is planted to white spruce at 2.5-m spacing. Each broadcast treatment is replicated 3 times (15 additional plots, for a total of 40 plots).

All measurements are being conducted within the inner 25 x 25 m of the treatment plots. Individual and combined growth responses of the aspen and spruce are being compared among treatments and the treatment impacts on environmental factors and plant growth resources (e.g., air temperature, soil temperature, soil moisture, and light) measured. Microclimate (light, soil moisture, soil temperature, and air temperature) is being monitored at selected points within selected treatment plots. Light, overtopping leaf area index, and neighboring vegetation cover are being measured at selected spruce in each plot.

Results

Following four growing seasons at the Alberta site (Fig. 2), planted white spruce receiving early woody and herbaceous competition control, either as a broadcast or radial treatment, exhibited greater than 2-fold gains in stem diameter over untended trees, resulting in nearly 7-fold gains in stem volume index (Fig. 3). In contrast, spruce receiving control of only woody or herbaceous competition exhibited little more than 2-fold gains in stem volume index. In general, spruce in the radial treatments had a 23% growth advantage over similar, broadcast-treated trees. Spruce receiving 4 years of radial complete vegetation control had a 41% growth advantage over their counterparts receiving only 2 years of control. Aspen crop trees on the site also exhibited a response to herbaceous weed control (Fig. 3). Broadcast treatment provided an 18% gain in stem volume index over untended aspen; radial treatment provided a 37 to 40% gain, possibly due to the combined thinning effect of the radial treatments, and the adjacent herbaceous weed control. Across the site, aspen growth has still not fully recovered from the July 2005 hail storm, prompting us to delay the planned year-5 aspen thinning.

Through 3 growing seasons at the Ontario site (Fig. 4), plots exhibited similar patterns of vegetation development observed in the west, with the exception that ferns, broad-leaf forbs, and low shrub cover has largely replaced *Calamagrostis* cover. Thus far, spruce and aspen growth responses on this site have closely resembled those observed at the Alberta site. Planted spruce receiving either woody or herbaceous control exhibited 80% gains in stem volume index over untended trees; control of both types of vegetation resulted in 2.5-fold gains (Fig. 5). Aspen gains were 35% to broadcast herbaceous control and 39 to 50% for radial control. Patchy aspen regeneration and moose browsing in some plots may hinder long-term results.

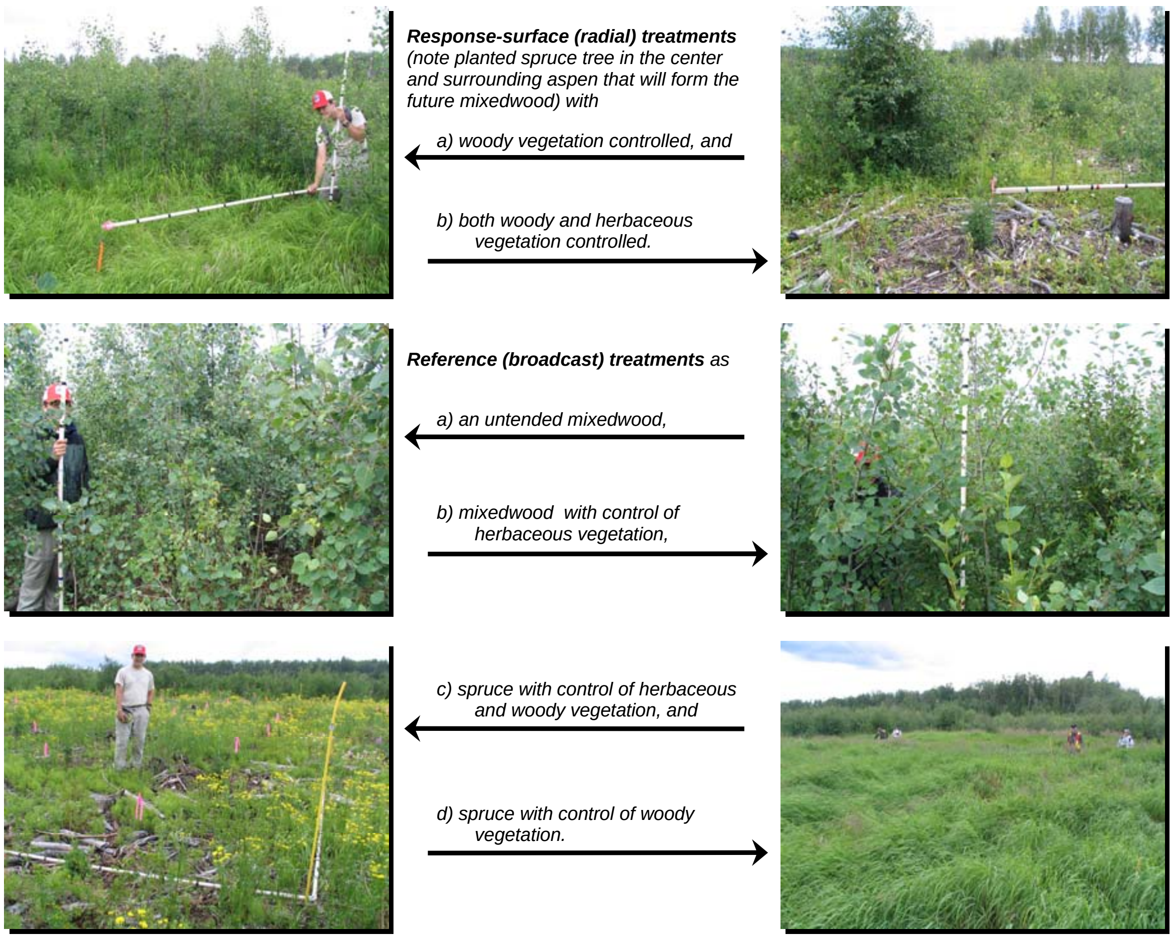

Fig. 2. Key response-surface (radial) and reference (broadcast) treatments illustrated during the 4th growing season at the Alberta site.

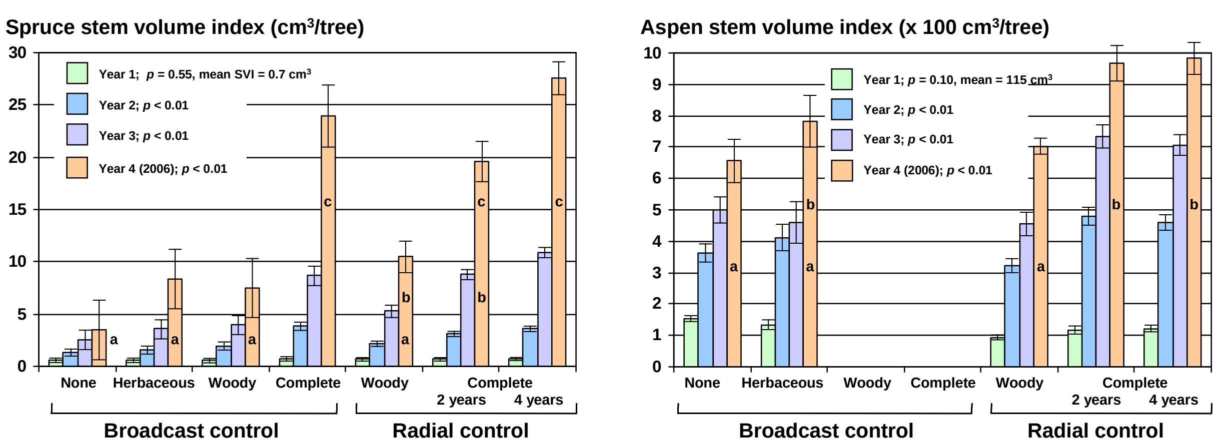

Fig. 3. Stem volume index of spruce and aspen crop trees through 4 growing seasons at the Alberta site. Means with the same letter do not differ in year 4 (α=0.05, Tukey's HSD).

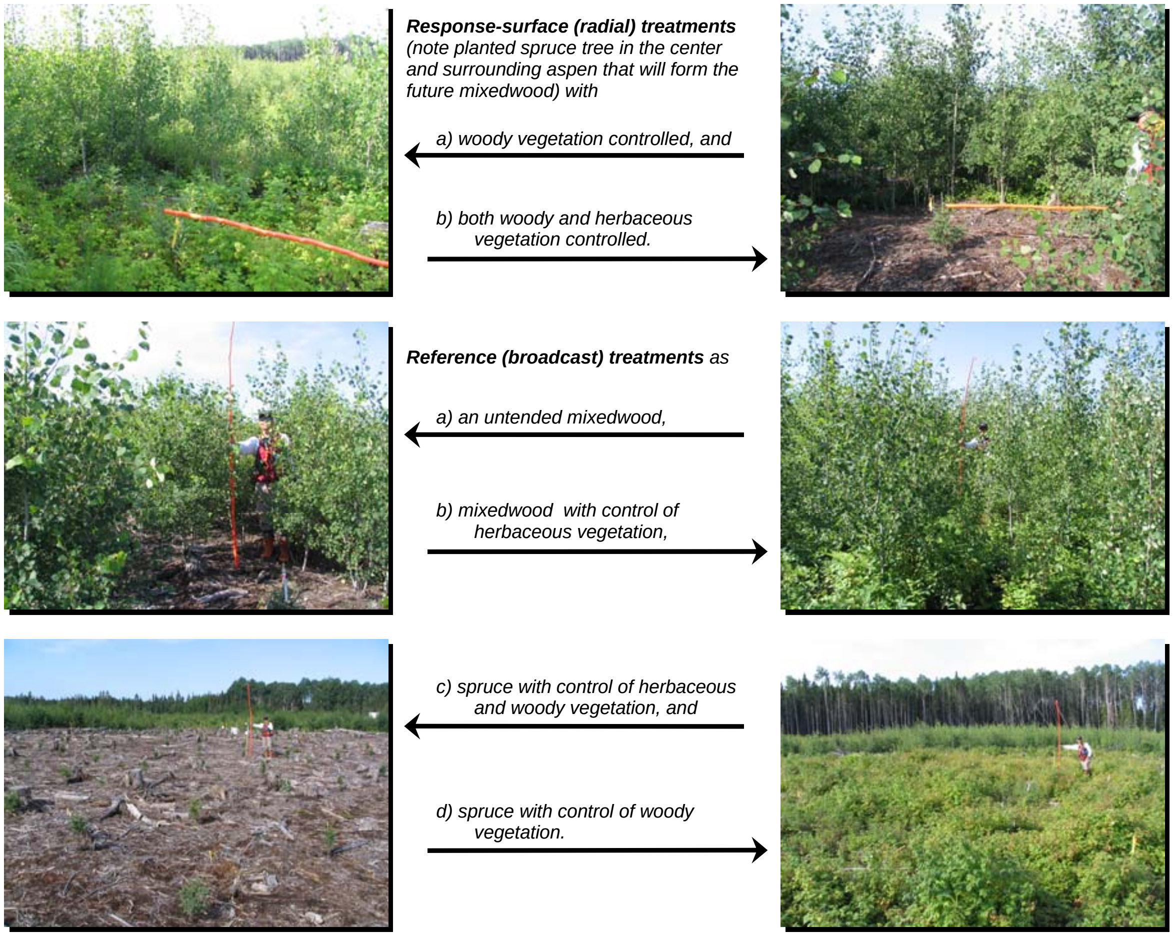

Fig. 4. Key response-surface (radial) and reference (broadcast) treatments illustrated during the 3rd growing season at the Ontario site.

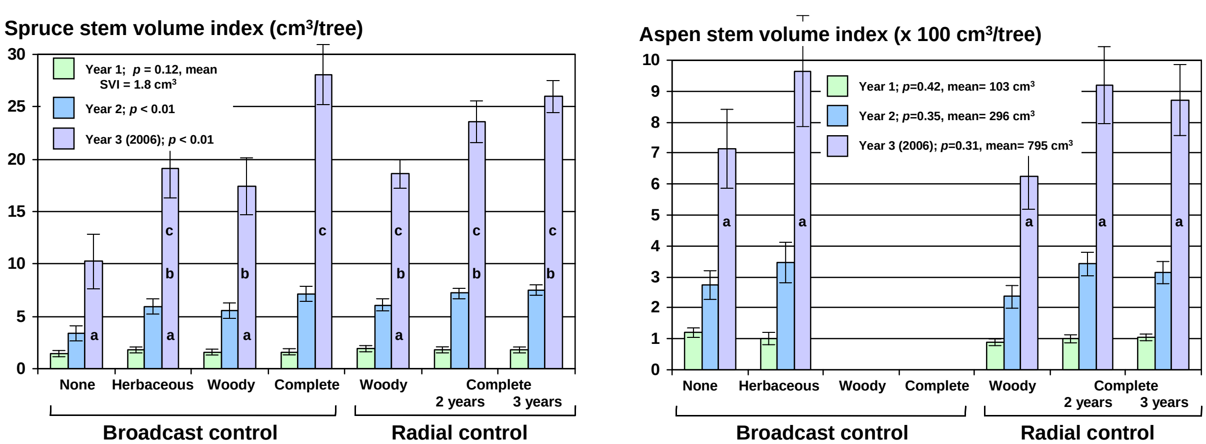

Fig. 5. Stem volume index of spruce and aspen crop trees through 3 growing seasons at the Ontario site. Means with the same letter do not differ in year 3 (α=0.05, Tukey's HSD).

Growth of the spruce was related to increased resources made available by the treatments. Although moisture was generally not limiting during the 2005 or 2006 growing seasons, radial complete control treatments resulted in the fewest hours with soil moisture below 30%. Soil nitrogen availability in 2005 was higher in the complete-control than in the woody-control treatments and higher in the broadcast than in the radial treatments. Complete vegetation control resulted in higher light availability than woody-only control and untreated, with the latter consistently having the lowest light availability. Results from Alberta indicate that, although woody and herbaceous vegetation appear to have similar impact on spruce growth, control of only the woody vegetation results substantial increases in the total leaf area of competitors, largely due to increases in the abundance of grass.

Early "take-home messages"

Effective control of both woody and herbaceous competition is beneficial to the early growth of white spruce. Treatments that control only woody competition generally result in increased herbaceous vegetation and reduced seedling survival. Two-meter radius, individual-tree treatments that control both woody and herbaceous competition appear to have potential for the establishment of spruce and aspen as intimate mixtures. Through 4 growing seasons, adjacent aspen have not hindered the growth of planted spruce and appear to be offering some benefit in mitigating climatic extremes and reducing exposure injuries. Long-term monitoring is needed to document the dynamic interactions between these two species, as established, and formulate practical regeneration strategies and crop plans for spruce-aspen mixedwoods. We will begin publishing the early results of these studies shortly.

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Sponsors

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