Effects of early herbaceous and woody vegetation control on eastern white pine

Partners Report - 2006 Field Season

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The problem

Eastern white pine (*Pinus strobus* L.) is one of North America's most valuable softwood species. Historically, it thrived in regions characterized by frequent, low-intensity fires that created favorable regeneration conditions. Declining frequency of such fires, coupled with competition, insect, and disease problems, has seriously impeded white pine regeneration efforts. A greater understanding of the vegetation conditions favoring white pine survival, growth, and stem quality is needed to enable more effective management of early stand conditions in the absence of fire.

The proposed solution

In 2000, an experiment with 3 installations was initiated to quantify the temporal and spatial effects of woody and herbaceous vegetation on white pine seedlings. The study aims to determine what types of vegetation constitute competition for white pine and establish when, during the establishment and early growth phase, the effects of competition are greatest. Results from these experiments will support vegetation management prescriptions defined in terms of

- the need for and duration of the suppression of low-growing vegetation, such as grass, ferns, forbs, and low-shrubs;
- the need for and duration of the presence of taller arborescent species for the mitigation of climatic extremes and promotion of white pine height growth and stem form;
- potential interactions with key pests, such as white pine weevil and blister rust; and
- the overall regeneration environment – clearcut vs. shelterwood.

Methods

The research sites, situated near North Bay, Ontario, and Doaktown, New Brunswick, address the clearcut (Fig. 1) and 2 gradients of the shelterwood regeneration systems (Fig. 2). A response-surface design is being used to combine and test different durations of herbaceous vegetation suppression (0, 2, and 4 years) with various timings of woody vegetation release (time of planting, after 2nd growing season, after 5th growing season, and none). Four different hardwood densities are being studied: 0, 5000, 10000, and 15000 stems per ha. Each installation of the study involves 72 18- × 18-m treatment plots. White pine seedlings are planted on these plots at 2-m spacing. Vegetation control treatments are initiated during the first growing season, and continued, as dictated by the design, over a 5-year period (Fig. 3). Microclimate stations and portable sensors are being used to quantify above- and

Fig. 1. ***Clearcut site near North Bay, ON. Each plot is 18 m x 18 m.***

below-ground seedling microenvironment and physiological status at the two Ontario installations. Treatments being monitored are the 4 corners of the response surface (i.e., control of woody vegetation only, herbaceous vegetation only, both types of competition, and no competition control). On 3 replicate plots of each of these 4 treatments, seedling microclimate has been monitored in the clearcut and shelterwood for the first 5 growing seasons after planting. Periodic, diurnal assessments of leaf gas exchange and seedling water status were conducted on these same plots, beginning in the second growing season after planting (growing seasons 2 through 4). White pine needle samples were collected from both sites during July of growing season 5 to examine treatment effects on foliar nutrient content.

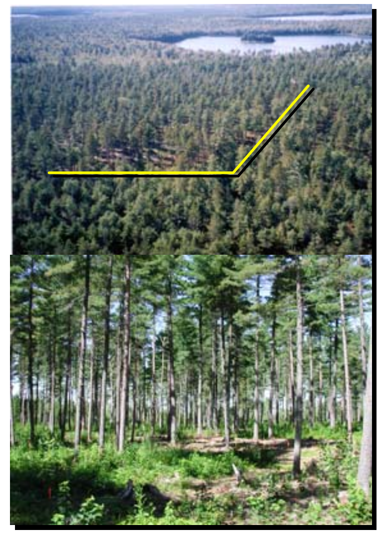

Fig. 2. Shelterwood site near North Bay, ON.

Results

After 6 growing seasons at the clearcut site, white pine subjected to woody-only competition control contained 1.2 to 1.6 times the stem volume of trees left untended, earlier release providing the larger gains (Fig. 3). In contrast, pine receiving 2 growing seasons of herbaceous-only competition control averaged 3.4-fold gains in stem volume over untreated trees. Two seasons of herbaceous control, coupled with woody vegetation control after the 2nd growing season or at the time of planting, more than doubled these gains. Such responses to early vegetation control challenge the current operational strategy of planting, waiting 2 growing seasons, and then broadcast releasing with glyphosate, which provided 4.5-fold volume gains over untended pine. It should be noted that the tallest pine at the clearcut site are currently situated in plots that had early herbaceous-only control. In these plots, the aspen overstorey reduced weevil incidence, allowing the pine to achieve at least 13% greater height growth than their more open-grown counterparts.

After 5 growing seasons at the Ontario shelterwood site, growth patterns suggest that herbaceous and woody competition control may be equally important in the more shaded shelterwood environment (Fig. 4). Herbaceous competition control, coupled with first- or second-season woody control resulted in 7.4-fold stem volume gains over untended pine and 3-fold gains over pine receiving only herbaceous or woody competition control. At the more open-canopied New Brunswick shelterwood site, 5-year growth patterns more closely resembled those observed at the clearcut, with early woody and herbaceous control providing 5.6-fold gains in stem volume over untended pine; more than 1.5 times the gains of herbaceous-only control and 3 times the gains of woody-only control (Fig. 5).

The early growth responses observed were strongly associated with measurements of seedling physiology and microclimate. In general, low photon flux density and soil moisture content in the top 15 cm of mineral soil were associated with reduced photosynthetic potential of white pine seedlings. Herbaceous vegetation appears to be a greater competitor for soil moisture than woody vegetation during the first two growing seasons after planting, explaining the significant positive gains in white pine growth in response to early herbaceous vegetation control at the clearcut site. After the second growing season, woody vegetation, with its rapidly increasing height and leaf area, become greater competitors for both light and soil moisture. Although light levels approached critical levels for white pine growth more rapidly in the shelterwood than in the clearcut, moisture and temperature extremes were moderated in the

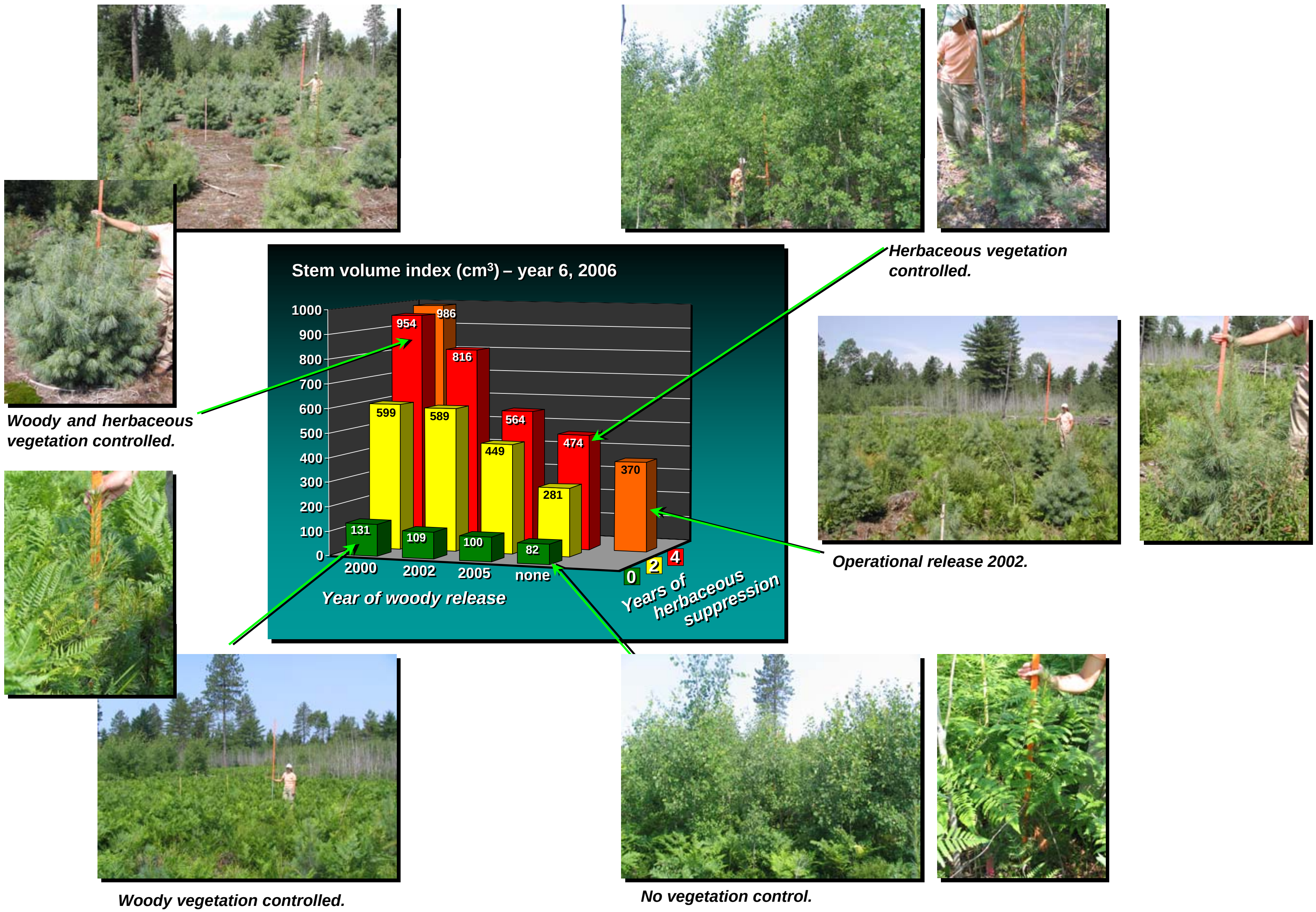

Fig. 3. Response-surface for the stem volume index of 6-year-old white pine at the Ontario clearcut site. Key treatments are illustrated with July 2006 photographs taken on-site.

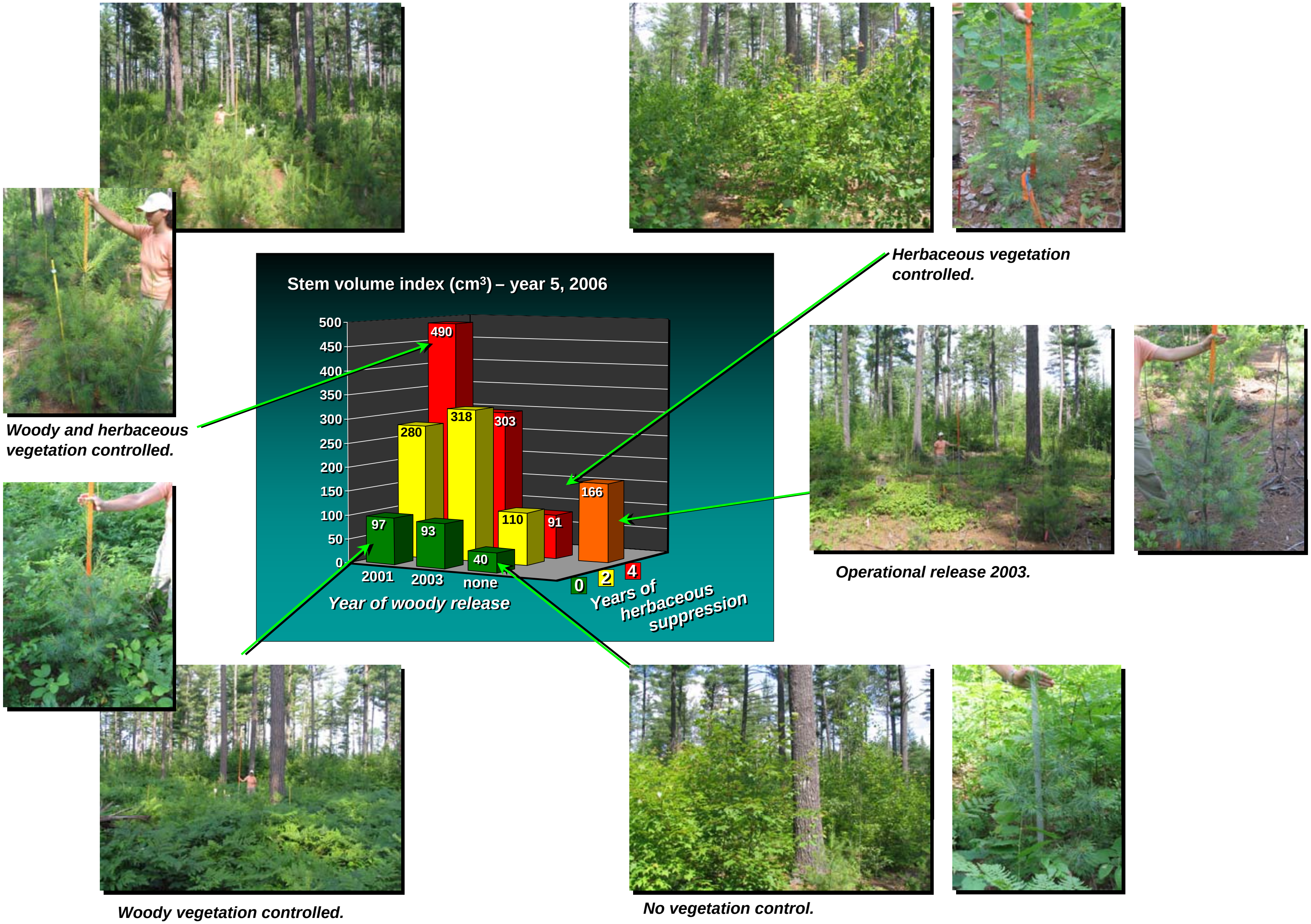

Fig. 4. Response-surface for the stem volume index of 5-year-old white pine at the Ontario shelterwood site. Key treatments are illustrated with July 2006 photographs taken on-site.

shelterwood environment. White pine height growth and weevil avoidance were greatest with either an aspen or a mature pine (shelterwood) overstorey, suggesting that early herbaceous vegetation control and maintenance of a moderate overhead canopy may maximize white pine stem growth and quality. Natural pine regeneration in the shelterwoods was enhanced by early herbaceous vegetation control.

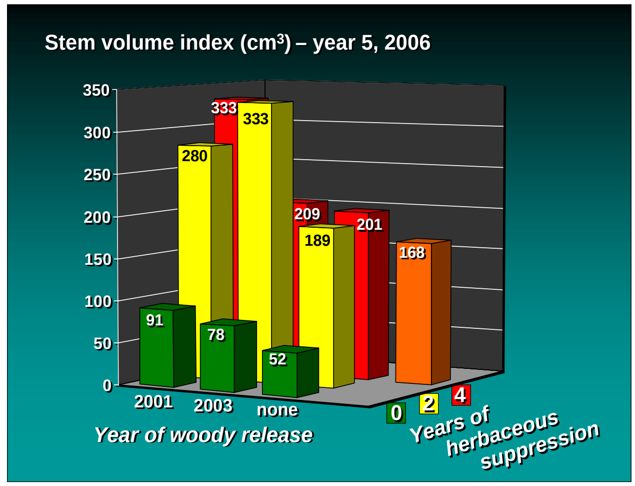

Fig. 5. Response-surface for the stem volume index of 5-year-old white pine at the New Brunswick shelterwood.

Early "take-home messages"

Competition control is important for the regeneration of white pine, regardless of the regeneration strategy being employed. Data from the 3 installations suggest that vegetation management efficiency is maximized through the earliest possible intervention, such that efforts should be undertaken as site preparation, in advance of planting or seeding, whenever possible. The motto "the longer the delay, the more we pay" very likely has significant meaning in terms of increased vegetation management effort and cost, and losses in seedling growth. In clearcut and more open shelterwood scenarios, good pine growth may be achieved through herbaceous weed control alone. On these sites, a partial deciduous overstory may mitigate weevil damage and maximize height growth. In denser shelterwoods, where light penetration is less than 50%, both woody and herbaceous vegetation must be controlled to maintain adequate white pine growth. We are currently in the process of publishing these results.

Research team

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Sponsors

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