

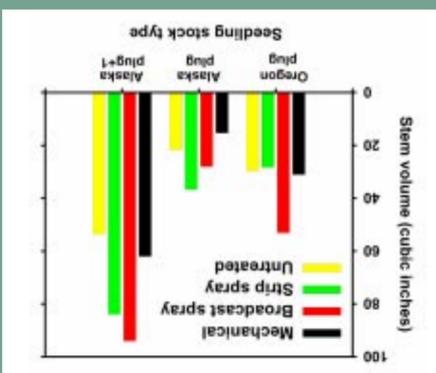
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Figure 8—Stem volume for three stock types 9 years after vegetation control treatment.



etation treatment. The mechanical and spray treatments are different means of removing existing plant cover so that planted seedlings would have reduced competition. All treatments were applied in 1996-97.

On each plot, we planted five stock types of white spruce seedlings. All five stock types were started from the same seed source, collected locally. Each stock type occurs in two rows of about 15 seedlings. Figure 1 shows the initial heights and diameters of the different stock types. The seedling stock types included:

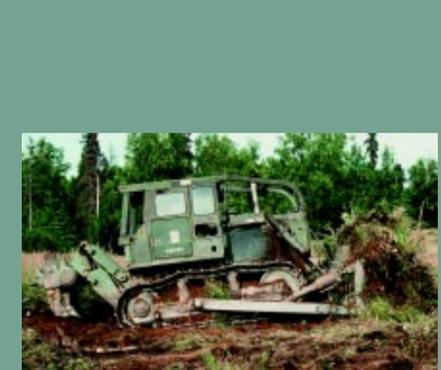
- Alaska plug+1 seedlings (pink flags) were 2 years old when planted. They were grown at Alaska State Nursery as container stock for 1 year, and then transplanted for 1 year in a nursery field. They received little care and tending in their second year and were very small.
- Alaska plug+2 seedlings (red flags) were 3 years old at the time of planting. They were started at Alaska State Nursery as container stock for 1 year and then were transplanted for 2 years in a field nursery. The bare-root seedlings were relatively large when lifted and planted.
- Pelton plug seedlings (orange flags) were 1-year-old container stock grown in a Canadian nursery.



- Silvaseed plug seedlings (yellow flags) were 1-year-old container stock like the Pelton plug seedlings (orange flags). They were grown in Washington state, and initially were taller and more slender than the Pelton plugs.
- Silvaseed plug+1 seedlings (blue flags) were 2-year-old seedlings from a Washington state nursery that were started as container stock for 1 year and then transplanted to a nursery field for 1 year. They received more consistent care and tending before being lifted compared to the Alaska plug+1 seedlings.

After planting, diameter and height for each seedling were measured in years 1, 2, 3, and 5, with observations of surrounding plant cover. Diameter and height measurements were used to calculate a stem volume for each seedling. The five stock types, planted in each vegetation control treatment, will demonstrate how seedlings started under different growing regimes perform under different types and amounts of competition. The three vegetation control treatments will allow evaluation of various approaches in providing each type of planted seedling relief from competition, and how long the benefit, if any, may persist. Assessment of competing plant cover at each seedling will allow us to relate competitive effects on each tree, such as height, diameter, and volume growth, to associated plant cover, and will allow us to systematically follow the development of plant cover through time.

What we have learned:



- Large, healthy seedlings planted soon after clearing a site will have good survival and moderately good growth without vegetation control provided the vegetation remains relatively short. The use of large seedlings alone will at least partly substitute for site preparation treatments designed to temporarily control competing vegetation.
- All stock types, including willows, benefit from Oregon plug seedlings, relatively small white spruce stock types.
- Alaska plug seedlings, slightly larger 1-year-old container seedlings grown in Alaska at Alaska State Nursery.
- Alaska plug+1 seedlings, 2-year-old transplanted into a field nursery at this site for 1 year.
- Alaska plug+2 seedlings, 3-year-old transplanted into a field nursery at this site for 2 years.
- The experiment at this site demonstrates that plant stock grown in containers at Alaska State Nursery for 1 year and then transplanted to a field nursery at this site for 2 years. This stock type was planted a year after the other three stock types were planted.

be produced simultaneously. timber, and productive habitat for moose can



A Forest Regeneration Research and Demonstration Site at Fort Richardson, Alaska

White Spruce and Moose Enhancement Project



Demonstration Stop 1 White Spruce Reforestation

Research activity: This stop in an "old" harvest unit, and stop 3 in a "new" harvest unit, are part of a large study designed to identify the optimum way of establishing white spruce (*Picea glauca* (Moench) Voss) after mature forests are cut. Grasses, forbs such as fireweed (*Epilobium angustifolium* L.), and shrubs rapidly reoccupy clearings on the more productive white spruce sites, resulting in difficult conditions for establishment of white spruce. In this experiment, we are evaluating different ways of controlling the competing vegetation, and we are evaluating different types of nursery seedlings that may be used to reestablish white spruce in Alaska. The site before you supported paper birch (*Betula papyrifera* Marsh.) and scattered, insect-damaged white spruce before it was harvested for fuelwood in 1992. Reforestation did not occur for 3 years, at which time ground cover of grasses, forbs, and shrubs was well established. The site at stop 3 is nearly identical, but was planted immediately after harvest and before ground cover was fully established.

The experiment: Within a short walk, the three treatments can be seen. Individual plots are 150 by 150 feet and were planted with about 150 white spruce seedlings. On this site, one of three vegetation control methods was applied to each plot: (1) mechanical—scrapping with a bulldozer blade to remove most of the plant cover and expose about 85 percent bare mineral soil; (2) spray—a single application of the common herbicides hexazinone (Velpar L®) and glyphosate (Accord®, similar to Roundup®) sprayed the fall before planting; and (3) untreated—no veg-

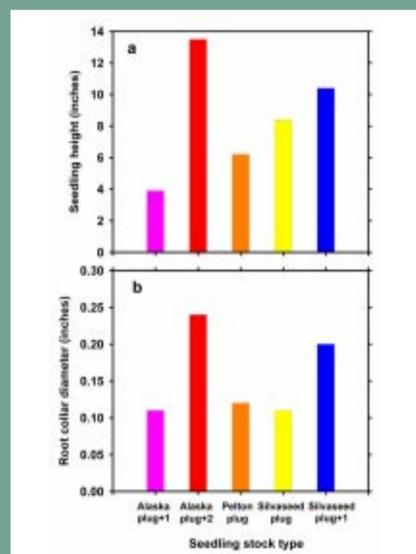


Figure 1—Initial height (a) and root collar diameter (b) of different stock types, averaged over all locations of the study in Alaska.

What we have learned:

- Heavy competition slows seedling growth (fig. 2), and tends to kill small seedlings.
- Both height and diameter growth of seedlings are sensitive to relatively low levels of overtopping cover.
- Large seedlings grow more rapidly than small seedlings (figs. 2 and 3).
- Large seedlings tend to be more rigid and better able to withstand the weight of falling vegetation compared with smaller seedlings.
- Of the three vegetation control treatments at this site, herbicides sprayed in the fall before planting provide a better environment for seedling growth, resulting in the largest seedlings (fig. 3).



Research activity: This stop is in an experiment, started in 1993, that compares various treatments designed to produce multiple resource values at the same time. Note that the uncut, mature paper birch forest that surrounds this site contains few white spruce. Also note that the understory contains little browse, such as highly desirable paper birch saplings or a mixture of willow species, for moose or other large animals. The experiment at this site is designed to evaluate various ways of converting sites with little browse for moose into more productive moose range while providing future crops of paper birch fuelwood and white spruce timber. On this site we made our first evaluation of Alaska seedling stock types.

Demonstration Stop 4 Conversion of Mature Forest to Multiple-Use Forest

- Mechanical removal of plant cover leads to frost heaving for the first few years, after which grasses rapidly develop dense cover.
- Nursery growing regimes have a strong influence on survivability and vigor of seedlings.

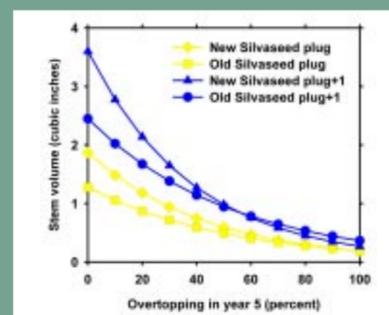


Figure 2—Effect of overtopping plant competition on stem volume for two white spruce stock types 5 years after planting; units were planted the first year after clearing (new), or 3 to 4 years after clearing (old).

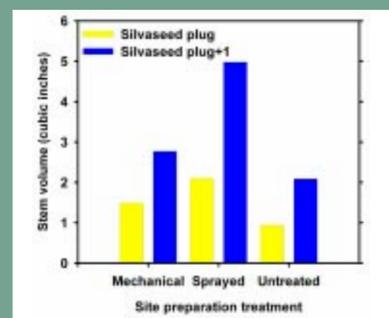
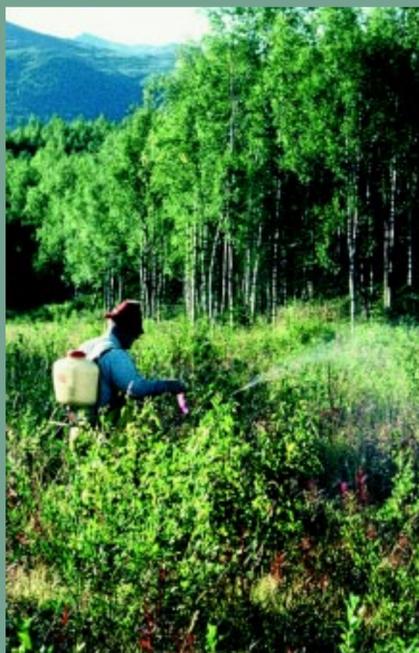


Figure 3—Stem volume 5 years after planting and vegetation control for two stock types planted the first year after clearing (new), averaged over all locations of the study in Alaska.

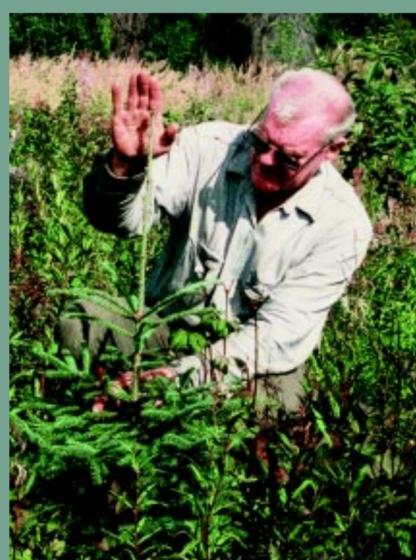
Demonstration Stop 2 Competition and Site Preparation

Research activity: Visible at this stop is part of an experiment designed to determine the ability of white spruce and paper birch seedlings to grow in the absence of plant competition as well as dense cover. This is the oldest reforestation experiment at Fort Richardson Army Base. From the observation point, seedlings planted in plots of untreated dense grass (a control plot) and seedlings planted in plots where the competition was controlled with broadcast applications of herbicides to maintain competition-free conditions (a weed-free plot) are visible. The effect of plant competition on white spruce and paper birch after a decade or more is dramatic. The ability of white spruce and paper birch to grow when competition is completely removed is equally dramatic. By repeat-

ing this experiment at different locations within Fort Richardson Army Base and incorporating levels of partial weed control, we can determine whether the influence of plant competition is the same over a range of site conditions and determine the relative benefit among levels or intensity of vegetation control.



The experiment: At this site and at two more locations nearby on Fort Richardson Army Base, an experiment was installed to evaluate the influence of plant competition on tree growth. This site represents the best growing conditions of the three locations. At all three locations, four vegetation control treatments were applied in plots that are each 50 by 80



feet. The four treatments included (1) a weed-free treatment involving a broadcast application of glyphosate (Accord®, similar to Roundup®) in the fall before planting and then spot spraying of any competitive vegetation for 5 consecutive years so that seedlings established without measurable competition; (2) a release treatment consisting of a single application of granular hexazinone (Velpar L®) applied immediately after planting; (3) a site preparation treatment consisting of a single application of glyphosate and hexazinone applied the fall before planting; and (4) untreated or no vegetation control. Treatments were applied to two replicates at each location. Each plot was planted with 40 paper birch and 40 white spruce seedlings in 1992. There are two plots immediately visible; the first plot received the weed-free treatment, and the second plot was allowed to develop without vegetation control.

(Velpar L®) and glyphosate (Accord®, similar to Roundup®) sprayed the fall before planting; and (3) untreated—no vegetation treatment. On each plot, we planted five stock types of white spruce seedlings. All five stock types were started from the same seed source, collected locally. Each stock type occurs in two rows of about 15 seedlings. The seedling stock types included:

- Alaska plug+1 seedlings (pink flags) were 2 years old when planted. They were grown at Alaska State Nursery as container stock for 1 year, and then transplanted for 1 year in a nursery field. They received little care and tending in their second year, and were very small.

Demonstration Stop 3 Newly Reforested Cutover

Research activity: This stop is part of the same experiment observed at stop 1. Like the plantation visible at stop 1, this site was planted in 1997. It differs in that seedlings were planted only 1 year after the large paper birch and white spruce growing here were cut and cleared rather than waiting for 3 years before attempting reforestation. Comparing seedling growth and the effects of competing vegetation on recently cleared sites and on sites with competing vegetation already in place will allow us to refine our prescription for seedling stock type and vegetation control.



The experiment: This experiment is identical to the experiment at stop 1 except for the difference in the age of plant cover. Individual plots are 150 by 150 feet and were planted in 1997 with about 150 white spruce seedlings. One of three vegetation control methods was applied to each plot: (1) mechanical—scraping with a bulldozer blade to remove most of the plant cover and expose about 85 percent bare mineral soil; (2) spray—a single application of the common herbicides hexazinone



- Alaska plug+2 seedlings (red flags) were 3 years old at the time of planting. They were started at Alaska State Nursery as container stock for 1 year and then were transplanted for 2 years in a field nursery. The bare-root seedlings were relatively large when lifted and planted.
- Pelton plug seedlings (orange flags) were 1-year-old container stock grown in a Canadian nursery.
- Silvaseed plug seedlings (yellow flags) were 1-year-old container stock like the Pelton plug seedlings (orange flags). They were grown in Washington state, and initially were taller and more slender than the Pelton plugs.
- Silvaseed plug+1 seedlings (blue flags) were 2-year-old seedlings from a Washington state nursery that were started as container stock for 1 year and then transplanted to a nursery field for 1 year. They received more consistent care and tending before being lifted than did the Alaska plug+1 seedlings.

After planting, each seedling was measured in years 1, 2, 3, and 5, with observations of surrounding plant cover on each. This entire experiment is also replicated near Fairbanks, Chitina, and two places on the Kenai Peninsula.

What we have learned

- The influence of cover from competing plants is very strong.
- Competition early in the life of a seedling influences its development for years. Ten years after planting, differences between trees growing with and without competition in earlier years continue to increase (fig. 4).
- Similar reductions in growth occur across sites having different qualities (fig. 5).
- Growth of paper birch increases when competition is reduced. Interpretation of paper birch growth is difficult because of heavy browsing by moose.
- Moose may participate in vegetation control by preventing paper birch and willow from completely overtopping white spruce seedlings.
- Grass is an effective killer of small white spruce seedlings.

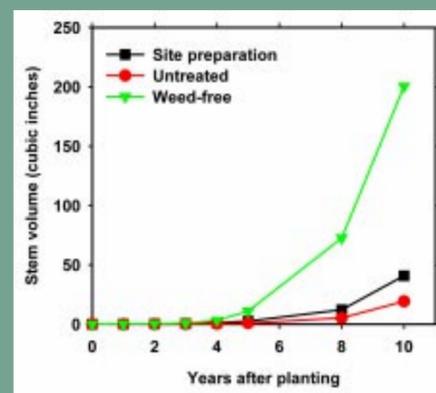


Figure 4—Stem volume by vegetation control treatment over time, averaged for all sites at Fort Richardson Army Base.

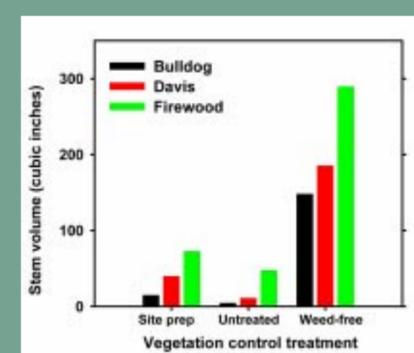
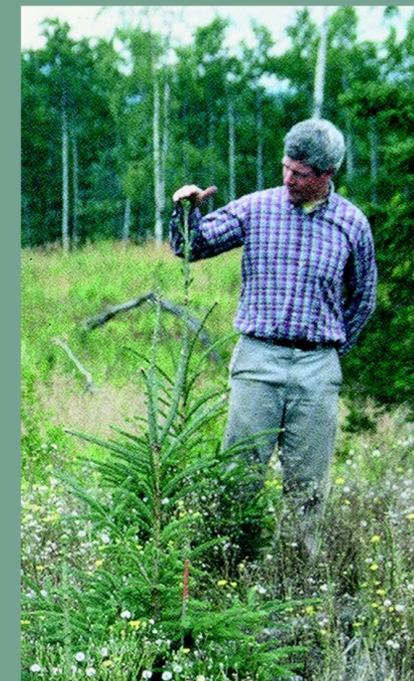


Figure 5—Stem volume after 10 years by vegetation control treatment for the locations at Fort Richardson Army Base.



What we have learned:

- The optimum way to ensure full establishment of white spruce after harvesting or clearing is to plant high-quality, vigorous seedlings before the competing plant cover becomes dense.
- Few natural white spruce seedlings occur in this experiment.
- The spray treatment at this site appears to be more effective in killing roots of competing

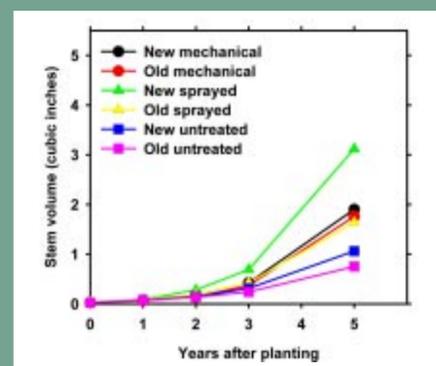


Figure 6—Stem volume by vegetation control treatment over 5 years for Pelton plugs; units were planted the first year after clearing (new), or 3 to 4 years after clearing (old).

grasses and shrubs, making more resources such as growing space, nutrients, and moisture available for white spruce seedlings. The spray treatment appears superior to both untreated and mechanical treatments in decreasing grass cover and providing seedlings a period of relief from plant competition.

- White spruce seedlings will benefit from any vegetation control treatment that results in low levels of competition during the initial years of establishment.
- White spruce seedlings planted on sites immediately after clearing perform better than those planted on sites with well-established competing vegetation. For example, after 5 years, Pelton plug seedlings (orange flags) on this new site are larger than the same Pelton plug stock type on the site with older competing vegetation (stop 1) (fig. 6), and Silvaseed plug+1 seedlings (blue flags) on this site are larger than the same stock type planted at the older site (fig. 7).

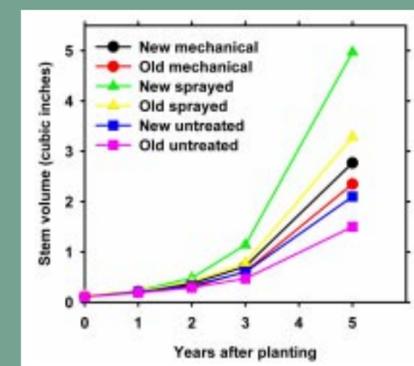


Figure 7—Stem volume by vegetation control treatment over 5 years for Silvaseed plug+1s; units were planted the first year after clearing (new), or 3 to 4 years after clearing (old).