

Science

FINDINGS

INSIDE

<i>A Spruce's Formative Years</i>	2
<i>Selecting the Proper Seedlings</i>	3
<i>Managing for Moose and Spruce</i>	4
<i>Spreading the News</i>	4

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"Science affects the way we think together."

Lewis Thomas

CRAFTING A COMPETITIVE EDGE: WHITE SPRUCE REGENERATION IN ALASKA



Bluejoint grass, or Calamagrostis, is an aggressive competitor for rooting space and often fills in the landscape after harvesting white spruce.

"Acts of creation are ordinarily reserved for gods and poets. To plant a pine, one need only own a shovel."

— Aldo Leopold

Big problems can come in little packages. A female spruce bark beetle, for example, is smaller than a grain of rice, yet she is capable of laying more than 150 eggs beneath the bark of a white spruce tree. After they hatch, her offspring will gorge on the tree's nutritious cambium, choking the tree of food and water. As it succumbs, the deep-green needles will turn red and fall.

Patches of red dying spruce are a familiar sight in Alaska. Over the past 10 years the spruce bark beetle has affected almost 4 million acres of spruce trees—an area roughly the size of Connecticut. A big problem indeed.

The beetle is a natural agent of spruce mortality; it has been around for millennia ebbing and falling in number, always affecting a proportion of Alaska's spruce trees. However, the scale of the recent outbreak is unprecedented in modern memory, and although the epidemic peaked in 1996, more trees are killed every year. It is not uncommon for 90 percent of spruce trees in a region to have been killed by beetles. Combine this with increased harvesting and

IN SUMMARY

Over the past two decades, unprecedented levels of disturbance have occurred in the white spruce forests of Alaska. Spruce bark beetles, fires, and timber harvests have left millions of acres of dead spruce with little spruce regeneration. To assist public and private landowners, Pacific Northwest Research (PNW) Station scientists are testing various approaches to white spruce regeneration.

In search of a competitive advantage for spruce seedlings, experimental plots have been designed and replicated on five sites across Alaska. Researchers are testing mechanical and chemical approaches to removing competing plant species. Nursery seedlings of different sizes have been planted on each site and their growth rates are being monitored. Additionally, in an effort to improve wildlife habitat, some sites were planted with a mixture of hardwood species known to be palatable to moose.

Spruce seedlings benefited from both types of site preparation, although survival was highest on the sites pretreated with a common herbicide. The fastest growing seedlings were the ones that were largest when they were planted. Moose were attracted to the mixed species sites and assisted in spruce regeneration by keeping hardwoods from overtopping the spruce which suggests that multiple resource objectives could be approached simultaneously.

several large forest fires and it becomes clear why Alaskans are interested in enhancing white spruce regeneration.

Even before the recent outbreak, Andy Youngblood, a research forester at the Pacific Northwest (PNW) Research Station, was manipulating test plots and experimenting with nursery seedlings in search of optimal spruce growing conditions. “The explosion of bark beetles has certainly increased the importance of our research,” says Youngblood. “Before our studies, there wasn’t much information available with regard to controlling competing vegetation or nursery production of seedlings adapted to local sites in Alaska.”

Youngblood, who is based at the Station’s La Grande, Oregon, laboratory, started looking into spruce regeneration in 1986. Since then, he and collaborators at Oregon State University have been tracking the success of seedlings at experimental sites replicated in four regions of Alaska: the interior uplands near Fairbanks, the Copper River basin, the Susitna basin north of Anchorage, and the Kenai Peninsula south of Soldotna. His

KEY FINDINGS	
• Reestablishment of white spruce is often hindered by competing vegetation, especially grasses and tall shrubs. Seedlings planted on sites immediately after clearing perform better than those planted on sites with well-established competing grasses and tall shrubs.	
• Larger seedlings grow faster and tolerate competing vegetation better than small seedlings. Large, healthy white spruce seedlings planted soon after clearing a site for reforestation will have good survival and moderately good growth without vegetation control provided the competing vegetation remains relatively short and does not overtop seedlings.	
• Planted paper birch and willows respond to vegetation control similarly to white spruce seedlings. Moose may participate in vegetation control by browsing the paper birch and willow and preventing it from completely overtopping white spruce seedlings.	

experiments are designed to resolve problems of reestablishing white spruce by demonstrating a variety of methods for controlling grasses, forbs, and shrubs that compete with trees, and to evaluate methods for enhancing multiple resource values at the same time by considering wildlife habitat.

“This is a very important resource,” he says. “Throughout much of Alaska, white spruce is the dominant conifer species. And in many areas, it is the only tree of substantial size; therefore, it is important locally for dimension lumber and house logs.”

A SPRUCE’S FORMATIVE YEARS

In a post-disturbance environment, such as the aftermath of a beetle outbreak, competition between plants means kill or be killed. And as in many forms of physical competition, success is often a matter of size and timing.

“There is a window of opportunity for a tree to establish itself, but once that window closes nothing else can get in,” explains Youngblood. His point is underscored by the vast expanses of bluejoint reedgrass that have filled in under the dead spruce trees. The grass, which is often referred to by its scientific name, *Calamagrostis*, is an aggressive competitor for rooting space and it quickly elbows out spruce seedlings. In addition, shrubs and forbs often over-top slow-growing spruce seedlings. This problem is twofold. First, the taller plants cast shade over the spruce seedlings, stealing away a portion of the light, which is in short supply in northern latitudes. Second, come winter, the taller plants crush the white spruce seedlings under the weight of snow, which is in ample supply.

In one of their experiments, he and his colleagues delineated plots 150 by 150 feet to assess different ways of controlling competing vegetation. Each plot received one of three treatments. The first was mechanical scraping done with a bulldozer to remove plant cover and expose bare soil. The second was a single application of a common herbicide, sprayed in the fall before planting. And finally, for comparative purposes, a control was established where no site preparation was conducted. After the sites were prepared, about 150 white spruce seedlings were planted in each testplot. In total, by the time all the replicates were installed, more than 13,500 trees were planted.

“Of these three treatments, the herbicide site prep provided the best environment for seedling growth,” says Youngblood. “Scraping the plots with a bulldozer led to freezing soil temperatures and seedling damage for the first few years and then a dense grass cover took over. Competing vegetation, like grasses, shrubs, and forbs, dominated the control site, which experienced the lowest level of white spruce regeneration.”

In a second study comparing herbicide treatments, researchers continued spot-spraying competing vegetation with herbicides for several years after planting spruce seedlings. This, as it turns out, is the best way to produce large trees fast.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

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“We were surprised at the continued growth on the sites that were kept weed-free for the first 5 years of regeneration. These trees are incredibly large—there is nothing growing naturally that would have shown us comparable growth potential,” explains Youngblood.

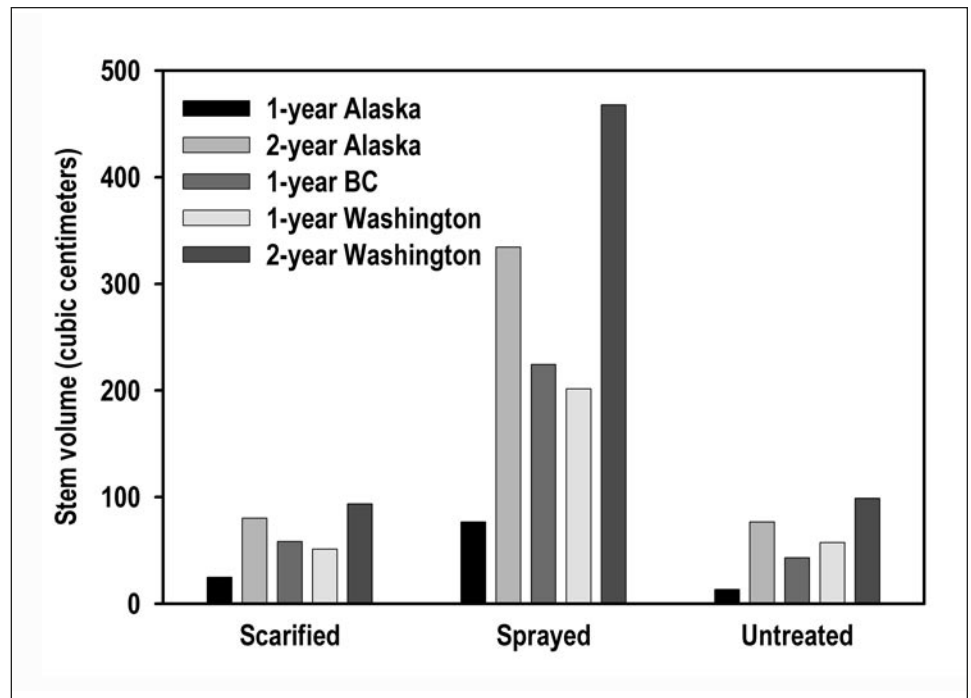
And the differences in growth rates continued long after the herbicide treatments had stopped. It appears that reduced competition early in life leads to increased rates of growth for many years thereafter.

SELECTING THE PROPER SEEDLINGS

White spruce is a sporadic and unpredictable seed producer under the best conditions. This is magnified in the wake of the beetle outbreak or wildfire, which leaves few adult white spruce trees to recolonize the landscape. Therefore, to expedite the return of white spruce forests, seedlings must be reared in a nursery and transplanted into the field.

There are many ways to prepare seedlings, and Youngblood and his colleagues are searching for a balance between the expenses of maintaining seedlings in a nursery with the increased likelihood of survival once they are planted.

The race began with native Alaskan white spruce seeds, collected from healthy adult



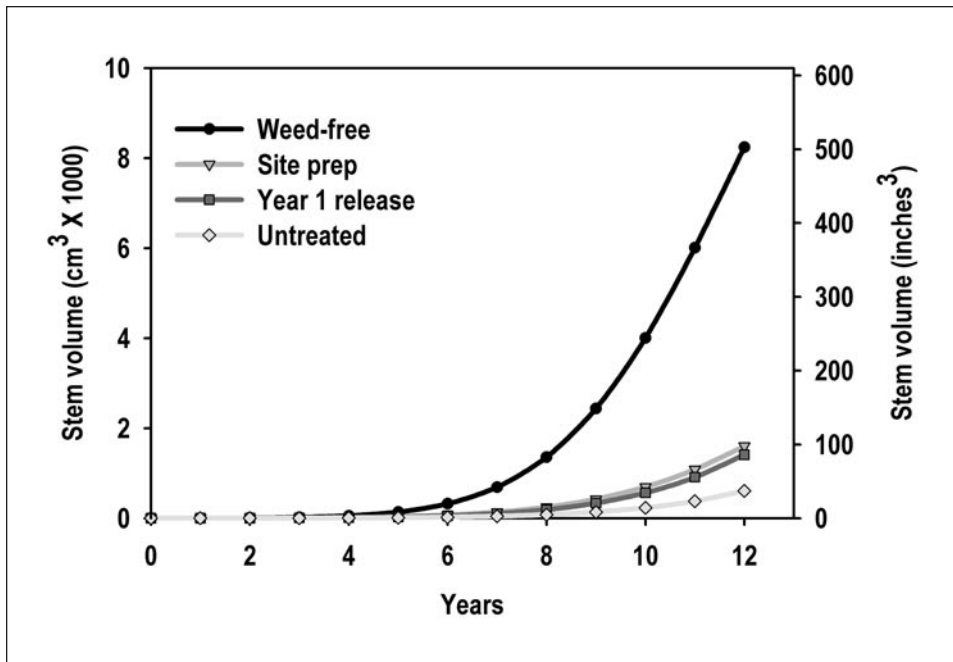
Differences in stem volume 7 years after planting white spruce seedlings at Fort Richardson, Alaska, with three vegetation management treatments and five nursery stock types.

trees and sent to nurseries as far away as Oregon and Washington. After varying amounts of time in a greenhouse and a nursery field, they were shipped back to Alaska, ready to compete. Seedlings ranged in size from 2 to 14 inches and were between 1 and 3 years old when they were put in the ground.

One predictor of seedling success is the amount of leaves and twigs that are directly above a seedling; white spruce seedlings are especially sensitive to overtopping by competing vegetation. Accordingly, results after 5 years indicate that the bigger a seedling is when you put it in the ground, the better its chances for outgrowing its neighbors. The height above the competition, the added resistance to breakage under snow, and the greater number of needles available for photosynthesis all give the larger seedlings an edge.

And the cost of a nursery upbringing is easily offset by the enhanced survival rate.

“In the absence of heavy grass or brush, planting any nursery stock within the first few years postclearing should give at least 80 percent survival. This exceeds the typical success rate expected during natural regeneration,” explains Youngblood. His findings have suggested a relatively inexpensive option to resource managers for regenerating sites after disturbance.



Differences in stem volume 12 years after planting white spruce seedlings at Fort Richardson, Alaska, with four vegetation control treatments.

MANAGING FOR MOOSE AND SPRUCE

Beetle outbreaks, fires, and timber harvests, as noted, have changed forest structure across vast landscapes in Alaska. Regions that were once a mosaic of hardwoods and conifers are now seas of grass. This has had cascading effects through the ecosystem, and moose populations, in particular, have dwindled in the aftermath.

Moose are the only species of their kind, a group called ungulates, throughout large areas of Alaska. Therefore, without any deer, elk, or caribou to share the responsibility, they play a critical functional role in the ecosystem—both through what they eat and what eats them. In addition, they are a primary source of protein and are central to the culture of many Alaskans.

“There is an increasing desire to incorporate maintenance of wildlife habitat into silvicultural prescriptions in interior Alaska,” explains Youngblood. In response, he and his research team have been developing new strategies for managing multiple resources simultaneously.

Moose prefer certain species of willows and young paper birch trees for food and cover—they generally ignore white spruce. These facts led Youngblood to an interesting question: Can moose participate in vegetation control to benefit spruce seedlings?

To find out, Youngblood and his colleagues initiated a third study and began planting paper birch seedlings and willow cuttings mixed with the spruce seedlings. “The ultimate goal of these prescriptions is to provide fuelwood from paper birch, produce white spruce timber, and create productive habitat for moose,” says Youngblood. “Although white spruce is a slow grower, it does have some advantages over the willow and paper



Silvicultural prescriptions are being designed to produce wood products and wildlife habitat.

birch. For example, because it is a conifer species it can begin growing earlier in the year when competing hardwood trees are still expending all their energy putting on new leaves. Likewise, spruce can continue growing late into the season after the hardwoods have dropped their leaves.”

Results from the multiple resource experiment offer good news for moose, spruce, and the Alaskans who rely on them. As expected, moose were attracted to the plots containing willow and paper birch, suggesting the habitat had improved. Furthermore, spruce regeneration followed a similar growth pattern, albeit slower than that seen in the single species plots: larger seedlings had high survival

rates, and sites with vegetation control, either scraping or herbicides, had faster growing seedlings than sites without.

It is a cooperative relationship whereby moose browse back the willow and paper birch, preventing them from overtaking the site. The white spruce seedlings are then able to grow beneath and eventually overtop the hardwoods.

“This project provided the first evidence that management strategies designed for providing both browse and wood products may differ from strategies designed to provide either browse or wood products alone,” explains Youngblood.

SPREADING THE NEWS

With so many acres in need of regeneration for multiple reasons, Youngblood’s research can have a direct and positive influence on a variety of Alaskan landowners. Indigenous Alaskans such as the Athabascans are one such group. Collectively, they own and manage through various native corporations a large component of the region’s white spruce forests, much of which have been affected by the beetle outbreak.

“Our work has probably benefited the native corporations the most,” says Youngblood.

“Their foresters are dealing with many of the same problems we are addressing on our research plots. They’re seeking the most efficient and successful ways to control competing vegetation, and they plant millions of nursery seedlings every year.”

Due in part to Youngblood’s findings, new standards for seedling production and strategies for outplanting were adopted by the Tanana Chiefs’ Conference in interior Alaska and several other native corporations on the Kenai Peninsula.

Other private landowners and public agencies, such as the USDA Forest Service, the Canadian Forest Service and the Bureau of Land Management, can also benefit from the regeneration study. To ensure their results were available broadly, Youngblood’s research team created a cooperative research and demonstration project at Fort Richardson Army Base. The site is managed and used for public education by the State and Private Forestry staff of the USDA Forest Service in Anchorage.

It is referred to as the Fort Richardson Vegetation Management Demonstration

Area and consists of guided field stops, signs, and printed brochures detailing various plantations managed under different site preparation and vegetation control regimes. It is a unique example of broad collaboration between the Department of Defense, the Forest Service, and Oregon State University.

“Since we built it, several groups—from visiting vegetation management specialists from across the nation to Alaska resource managers and decision makers—have seen the effects of different growing stocks and site treatments on white spruce seedlings. They have also seen a working example of collaboration across multiple public agencies to benefit local people,” explains Youngblood.

Whether the objective is moose, spruce, or both, the study has showcased many options for reforestation. “We have tried to provide to managers and landowners a suite of knowledge-based tools and guides to aid in restoring the health and integrity of white spruce-hardwood ecosystems,” says Youngblood. And although site-specific solutions will always be needed, the demonstration sites, as well as the rest of the research plots, can offer lessons taught by more than 17,000 seedlings.

“The best friend on earth of man is the tree: When we use the tree respectfully and economically, we have one of the greatest resources on the earth.”

—Frank Lloyd Wright

FOR FURTHER READING

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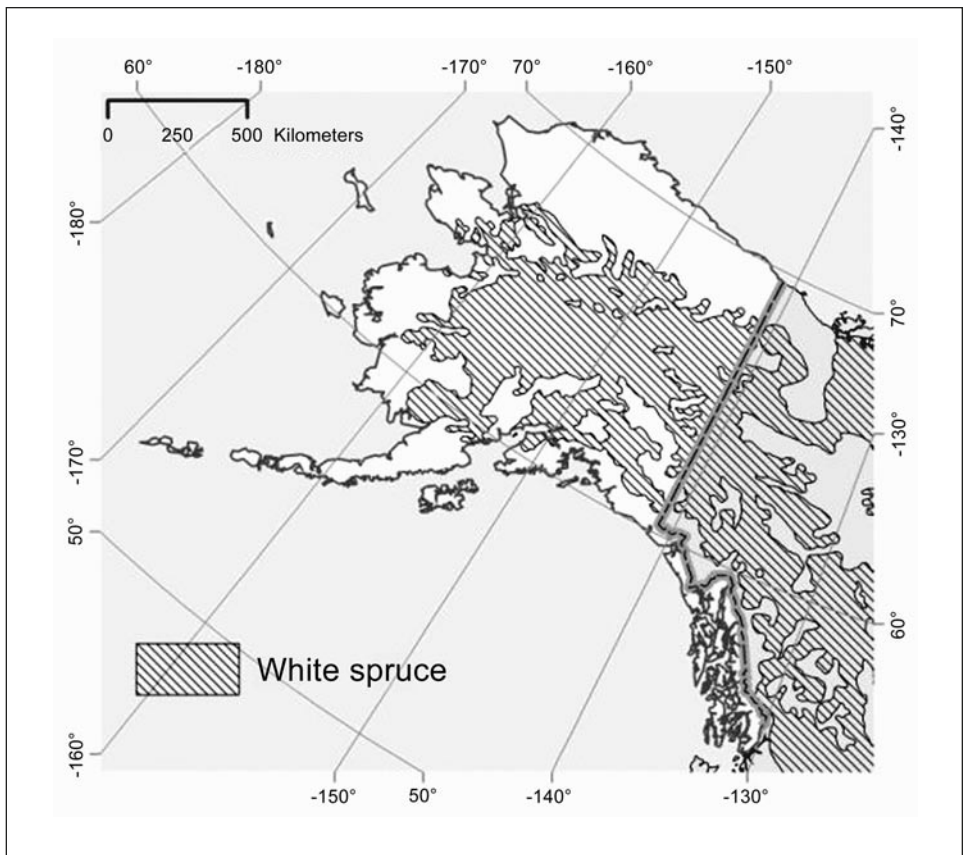
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🏠 **LAND MANAGEMENT IMPLICATIONS** 🏠

- Vegetation competition significantly influences seedling establishment and early growth; therefore, early prevention of competition will influence growth rates and may result in better growth and future yield.

- Work with relatively large planting stock, reared in a nursery, showed that larger seedlings are more resistant to plant competition, thus providing resource managers a relatively inexpensive option for regenerating white spruce after a disturbance.

- Results suggest it is possible to manage for high-value mixed white spruce and hardwood forests for timber, at the same time as providing browse habitat for moose.



White spruce is distributed broadly throughout higher latitudes in Alaska.

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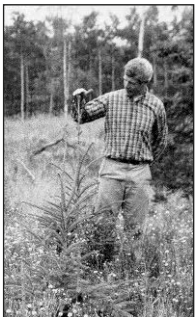


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