

REESTABLISHMENT OF WOODY BROWSE SPECIES FOR MINED LAND RECLAMATION YEAR 2 (1990) RESULTS

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INTRODUCTION

Revegetation of coal-mined land with plant species suitable for the desired post-mining land use is required by state and federal regulations. The most common post-mining land use in Alaska is wildlife habitat, especially browse production for moose. However, few data are available on growth of woody browse plants on reclaimed sites or effects of different soils on plant species. Another unknown is how much bluejoint reedgrass (*Calamagrostis canadensis*) suppresses the desired woody browse species. Bluejoint reestablishes from seeds and rhizomes (underground stems in the soil) and is a major problem in establishing moose browse on the Matanuska Valley Moose Range near Palmer. Study plots have been established for the Wishbone Hill coal project to investigate plant species and soil relationships for establishing moose browse in this area.

Seven woody species were selected based on ease of propagation, desirability for browse or hiding or thermal cover for moose, and presence on the site prior to disturbance: balsam poplar (*Populus balsamifera*), feltleaf willow (*Salix alaxensis*), barclay willow (*Salix barclayi*), Bebb willow (*Salix bebbiana*), paper birch (*Betula papyrifera*), alder (*Alnus tenuifolia*), and white spruce (*Picea glauca*) (Helm 1990). Four soils were selected based on their biological properties which are governed by the pre-disturbance vegetation: paper birch-white spruce (contained mycorrhizae for white spruce), upland meadow (dominated by bluejoint), lowland meadow (has diversity of herbaceous species), and overburden (had gravels from beneath the developed soil and had negligible biological activity). Hereafter birch-spruce soils or plots will be used to refer to those plots and soils from the paper birch-white spruce vegetation type. Similarly the upland meadow and lowland meadow soils refer to those soils disturbed within those vegetation types. The most important biological properties examined were the propagule bank (seeds, rhizomes, roots) from which native species could regenerate and the

mycorrhizal fungal propagules which are needed to establish mycorrhizae on the roots of plants. Mycorrhizae are symbioses between plants and fungi in which the fungi increase soil moisture and nutrient absorption for the plant and, in turn, receive carbon (energy) from the plant. Most plant species have mycorrhizae when growing under field conditions. This relationship is essential for some species such as the coniferous trees, including white spruce. More details on the rationale behind the species and soil selections are included in Helm (1990).

This study was designed to determine:

1. Survival and growth of woody species on soils from three different vegetation types and overburden.
2. Species of plants which colonize a site from propagule banks in these disturbed soils.

METHODS AND MATERIALS

Methods for starting cuttings and seedlings of the several plant species were previously described in Helm (1990). The sites were prepared in June 1989 by clearing the vegetation and surface soils and temporarily stockpiling the soil at the side of the plots (Helm 1990). Soils were spread over their respective plots the same day that they were cleared. This technique enabled the testing of the usefulness of the plant and fungal propagule banks after a disturbance similar to mining, but would not test the effects of long-term (more than one year) storage on the propagule banks. Most plots were fenced to protect against moose browsing. The upland meadow plots were not fenced to reduce costs.

The plots were observed in the winter to determine whether the plants were completely or partially covered by snow. Observations were made on plant development during May 1990 to determine differences in growth initiation among plant species. Field-season measurements included plant height, crown length and width, basal diameter, twig length, and twig diameter. Categorical observations were also made on vigor and dam-

age caused by disease, insects, or other causes. Measurements at the start of the growing season were made June 1-5, 1990, and those at the end of the growing season were made August 20-24, 1990. Twig lengths were measured on the terminal twigs, which were usually the longest. Hence, these lengths do not represent an average of all twig lengths on a plant. The number of twigs per plant was also counted.

To assess the cover provided by native plant species colonizing the site, cover estimates by plant species were also made in August 1990. Six observations were made in each plot with a point frame containing five pins spaced 20 cm (8 in) apart, resulting in cover recordings for 30 points in each plot. A pin was dropped at each point and all plant species hit by that pin were recorded. The number of points hit was converted to a percentage cover for each species and categories of forbs (broad-leaved herbaceous species), grass-like (grasses, rushes, sedges), shrubs, and trees. All species observed in a plot, whether they were hit by a pin or not, were also recorded.

RESULTS

Snow was sufficiently deep during the winter of 1989-1990 to cover completely the plants most of the time. Some drifting occurred on the upland meadow plots early in the season, but the overall depth of the snow was a more important factor for plant protection from the cold and from moose potential browsing in this heavy snowfall year.

Species in the birch family (paper birch and alder) began growing earlier than members of the willow family (balsam poplar and willows). All transplanted woody species had initiated growth before the local colonizers started growing from the propagule bank.

Feltleaf willow stems were the tallest plants when averaged across all sites (Figure 1). The next tallest plants were barclay willow and balsam poplar. Alder and birch were similar heights although alder was slightly taller. Bebb willow was the shortest of the willow family. White spruce was the slowest growing plant species planted on the sites.

The tallest plants and longest terminal twigs occurred on the upland meadow plots for all species planted there (alder and Bebb willow were not planted there) (Figures 1, 2). In some cases, the lowland meadow produced plants that were not significantly shorter than those on the upland meadow plots. The plots with the tallest plants overall contained feltleaf willow on the lowland meadow soil where one block produced exceptionally large plants ranging in height from 109 cm (about 3.6 ft) to 153 cm (5 ft) when measured in late August. Heights and twig lengths of plants on birch-spruce soils were almost always significantly less than those on the upland or lowland meadow soils. Plants growing on the overburden were smaller and less vigorous than plants growing on the other developed, but

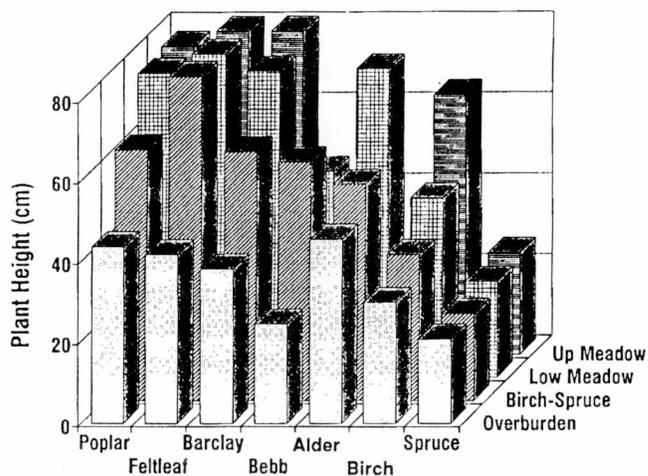


Figure 1. Mean height (cm) of plants for each woody species on each soil at the end of the second growing season, August 1990. (Bebb willow and alder were not planted on the upland meadow soil in 1989.)

disturbed, soils.

A total of 27 identified native plant species were recorded with the point-frame technique of estimating cover. Another few were sampled but not yet identified, and a few others were recorded on the species list but not hit with the point frame. Total vascular vegetation cover averaged 63% after two years with bluejoint (28%), tall fireweed (*Epilobium angustifolium*) (15%), and horsetails (*Equisetum* spp.) (10%) being the most important species. Plots on the birch-spruce soils averaged 72% cover by vascular plants with bluejoint contributing 36%, horsetails 22%, and tall fireweed 15%. Eleven plant species were sampled on these plots. About 24% of the area on the birch-spruce plots was bare. Plots on the upland meadow soils had 87% vascular vegetation cover with bluejoint providing 63% cover and only 11% bare ground. Other important local colonizers here were also horsetail (17%) and tall fireweed (16%). Eleven plant species were also sampled here.

The lowland meadow plots contained 78% vascular vegetation cover with 18% bare ground. These plots were the most diverse and had 20 plant species recorded during the sampling. Eight species contained more than 3% cover with tall fireweed (26%) and bluejoint (12%) being the most abundant. In contrast the overburden plots contained only 15% cover by vascular plant species and 82% bare ground. Fireweed was the most important species, but provided only 4% cover.

DISCUSSION

Most of the plant species have grown surprisingly well considering the dry conditions during the early part of both growing seasons (1989, 1990). Wet conditions at the end of both growing seasons and the excellent sub-

surface soil moisture during the spring of 1990 ameliorated the effect of drought. Interactions between native plant species and the desired browse species were more positive than anticipated. Benefits, such as moisture, associated with site conditions and native species regrowth overcame any differential response expected from mycorrhizae or other factors.

The deep snow provided good soil moisture and insulation from cold weather. The snow cover also protected the unfenced plants on the upland meadow plots from browsing. Meltwater from this snow pack combined with the ground cover from the propagule bank improved soil moisture conditions in an otherwise very dry growing season. Soils were visibly drier under open areas compared with those under patches of vegetation.

Barclay willow was a productive species under most conditions and had a very desirable growth form. Its terminal twigs were almost as long as the terminal twigs of feltleaf willow, but barclay willow had more twigs and a bushier shape. The bushy crown provides a windbreak and increases deposition of snow, organics, and propagules in the neighborhood of the plant.

Barclay willow twigs appeared to have a greater surface:volume ratio than those of feltleaf willow. This might result in moose browse of greater nutritional value than the twigs of feltleaf willow which had greater diameters. Nutrients in twigs are concentrated in the cambium inside the bark. Hence, twigs with larger surface area:volume ratios may be more nutritious.

Bebb willow growth was less on the lowland meadow plots than might be expected since it grows naturally on that site. Its survival was also the lowest of any species. The outplanted individuals of Bebb willow had less well-developed root systems compared to the other willow species. This probably resulted from greater difficulties in rooting Bebb willow in the greenhouse where it required a heated root zone. If this is the problem, then it may attain the same size as the other plant species over time. Hence, other factors may also be important for the poor growth of Bebb willow.

The longest twigs for plants on overburden during the second year of growth occurred for alder. The nitrogen-fixing bacteria in root nodules of alder improve the nitrogen availability for this plant species. This might also account for alder growth being greater than paper birch growth on all sites. These plant species are in the same family and had similar dimensions when planted.

The excellent growth on the upland meadow site was unexpected. This site was expected to have some of the lowest growth and survival because of competition from the bluejoint reedgrass which dominated the site prior to disturbance. Even though this site was cleared of vegetation and soil, when the soil was replaced, numerous rhizomes of bluejoint and other species were present and could regenerate. Several factors may ac-

count for the lower levels of competition from bluejoint. Growth and recovery of bluejoint after the disturbance in June 1989 may have been slowed by the dry weather until August. Most woody cuttings and seedlings were very healthy when outplanted. (Bebb willow and alder were not planted in this site because of insufficient plants and the belief that the site was going to be overrun by bluejoint.) The woody species initiated growth before the bluejoint had grown substantially during the second growing season (1990). Hence, these woody plants had a head start on the grass. Where the bluejoint cover was thickest, the grass competition has forced the woody plants to grow up into the canopy so height growth was favored over lateral growth. The grass cover also may have helped conserve moisture. Positive effects of bluejoint have outweighed its potential negative effects under these growing conditions through the first two years. Additional unidentified interactions may also be present.

The birch-spruce soils were less productive than either the upland meadow or lowland meadow soils, possibly because of lower moisture even though they were close to the upland meadow plots. The propagule bank here produced less plant cover. Without surface cover, the subsurface moisture appears to have been reduced. The bluejoint on upland meadow plots may have helped conserve moisture on these plots. The lowland meadow plots were in a low-lying area and contained many plant species that helped conserve moisture. In most cases, the bluejoint was not large enough yet to suppress significantly woody plant growth. A few plots on the birch-spruce soils had excellent regeneration of birch seedlings, probably from wind-dispersed

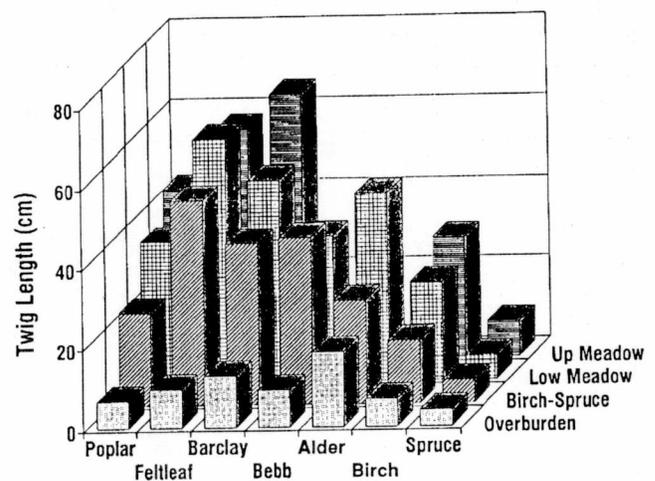


Figure 2. Mean length (cm) of terminal twigs for each woody species on each soil at the end of the second growing season, August 1990. (Bebb willow and alder were not planted on the upland meadow soil in 1989.)

seed. A few volunteers that were dug up had almost complete mycorrhizal infection of the seedling's root system.

Growth of all plants on overburden has been extremely slow. Part of this results from the low soil moisture holding capacity of these gravels and the lack of colonizers to conserve moisture.

Most plant species, except perhaps Bebb willow, grew at least as well as expected on all sites. Most sites covered with local soil produced good growth. However, the upland meadow and lowland meadow sites had the best growth by outplanted woody species at the end of year 2. Soil moisture appears to be an overriding factor affecting plant growth during this same time period based on visual observations of the soil. Other unidentified factors may have affected the results.

LITERATURE CITED

Helm, D.J. 1990. Reestablishment of woody browse species for mined land reclamation year 1 (1989) results. Agricultural and Forestry Experiment Station Research Progress Report 12.

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