REESTABLISHMENT OF WOODY BROWSE SPECIES FOR MINED LAND RECLAMATION YEAR 3 (1991) RESULTS

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Introduction

Many mined lands or other disturbances are being reclaimed to wildlife habitat, especially moose browse. However, little information has been available on expected growth rates of woody plant species used for moose browse on mined land sites, their tolerance ranges for soil physical or chemical properties, and the biological potential of soils for natural regeneration of forbs and grasses, and mycorrhizal fungal inoculum. Mycorrhizae are mutualistic symbioses between plants and fungi in which the fungi increase absorption of soil moisture and nutrients for the plant and, in turn, receive carbon substrates from the plant to produce energy. The potential for natural regeneration and mycorrhizal colonization will depend on vegetation already growing on the soils.

This study was designed to determine:

1. Survival and growth of seven 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.

These data were needed for reclamation planning for the Wishbone Hill Coal Project as well as other mines.

Seven woody species had been selected based on ease of propagation, desirability for moose browse or hiding or thermal cover, and presence on the site prior to disturbance: balsam poplar (*Populus balsamifera*) (easy to propagate, browsed by moose), feltleaf willow (*Salix alaxensis*) (easy to propagate, browsed by moose), Barclay willow (*Salix barclayi*) (easy to propagate, browsed by moose, grows in low pH soils [5.2] on upland sites), Bebb willow (*Salix bebbiana*) (common willow species on site prior to disturbance, but difficult to propagate), paper birch (*Betula papyrifera*) (common tree species, browsed by moose), alder (*Alnus tenuifolia*) (N_2-fixing symbiosis, hiding cover), and white spruce (*Picea glauca*) (thermal and hiding cover) (Helm 1990).

Four soils were selected based on their biological properties which are governed by the predisturbance vegetation: paper birch–white spruce (contain mycorrhizae for white spruce), upland meadow (dominated by bluejoint (*Calamagrostis canadensis*)), lowland meadow (has diversity of herbaceous species), and overburden (has glacial gravels from beneath the developed soil and has negligible biological activity). Bluejoint reedgrass competes strongly with woody plants trying to colonize secondary disturbances and is a significant challenge for forest regeneration in the Matanuska Valley Moose Range. More details on the rationale behind the species and soil selections are described in Helm (1990).

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 could not test the effects of long-term (more than one year) storage on the propagule banks. Cuttings and seedlings were transplanted at the start of the growing season in 1989. All plots except those on the upland meadow site were fenced to control moose browsing.

The plots were observed in the winter shortly after snow or windstorms to determine snow cover patterns, especially whether the plants were covered completely or partially. Plant development was observed during May 1991 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. Vigor and damage caused by disease, insects, or other causes were assessed qualitatively. Plant dimensions were measured at the start of the growing season in late May 1991 and at the end of the growing season in late August. 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 made in August 1991. Six observations were made in each plot with a point frame containing five pins spaced 10 cm (4 in) apart, resulting in cover recording for 30 points in each plot. A pin was dropped at each point and all plant species hit by that pin were recorded. Multiple hits on the same plant spercies were counted as one hit. The number of points hit was converted to a percentage cover for each species and classes of forbs (broad-leaved herbaceous species), grass-likes (grasses, rushes, sedges), shrubs, and trees. Relative cover of species was calculated by dividing the cover percent for each species by the sum of cover for all species. Relative cover is an indicator of relative species composition rather than the amount of ground cover. All species observed in a plot, whether they were hit by a pin or not, were also recorded.

Results

Many patterns observed in the first two years have continued through the third year. Snow has been sufficiently deep during the first two winters (1989–1990, 1990–1991) to cover the plants completely 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 browsing in this heavy snowfall year. Snow has been shallower during the 1991–1992 winter so some mid-winter browsing has occurred on the upland meadow plots. Previous browsing occurred during late winter through summer.

The same patterns that occurred for early-season development of plants during the first two years continued through the third 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 begun to expand leaves before the local colonizers, especially bluejoint, had begun substantial height growth. Hence, the larger woody plants had several weeks of full sunlight before local colonizers were competing aboveground. Root competition has not been evaluated.

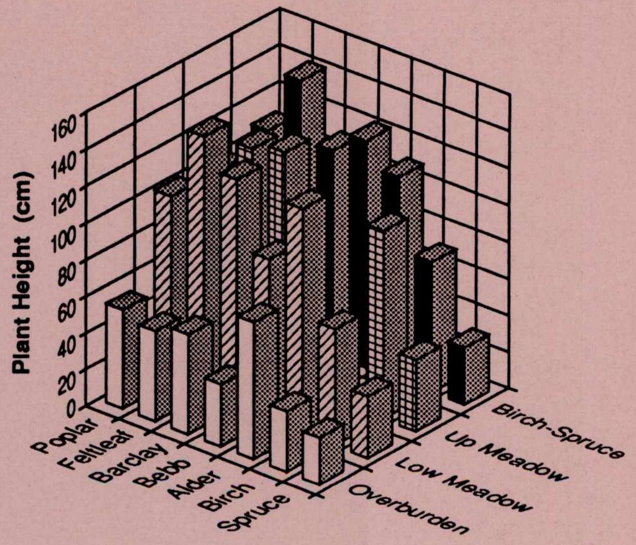

Figure 1. Mean height (cm) of plants for each woody species on each soil at the end of the third growing season, August 1991. (Bebb willow and alder were not planted on the upland meadow soil in 1989.)

Heights of plant species varied when averaged over all plots. Feltleaf willow was the tallest woody plant species tested at the end of Year 3 (Figure 1). Barclay willow and alder were the next tallest. Bebb willow has grown almost as tall as the other willow species, whereas in the past it was much shorter. White spruce was the slowest growing plant species tested on the sites.

Responses of the plant species to different soils varied, but the tallest plants usually occurred on the upland meadow plots for all species planted there (alder and Bebb willow were not planted there because of shortage of plants) (Figure 1). An exception occurred for feltleaf willow which was tallest on lowland meadow and birch-spruce sites. Balsam poplar heights were the same across all topsoils. Barclay willow was the same height on lowland meadow as on upland meadow plots. Least growth for all plant species occurred on overburden plots. The plots with the tallest plants overall contained feltleaf willow on the lowland meadow soil where one plot contained exceptionally large plants ranging up to 7.4 ft (225 cm) height when measured in late August.

Relationships of twig lengths of plant species to soils was different during the third year compared to past years. Longest twigs usually occurred on plants on birch–spruce plots and the shortest on overburden plots (Figure 2). In the past, the longest twigs occurred on the upland meadow plots. Surprisingly, white spruce twigs were longest on the upland meadow plots. Twigs of balsam poplar plants on the lowland meadow plots were similar in size to those on birch–spruce plots. Barclay willow individuals on upland meadow sites had twigs with lengths similar to those on the birch-spruce sites. Paper birch twig lengths were the same on all soils. Similarity of responses on birch-spruce and upland meadow plots appear to have resulted from increased growth on the birch-spruce plots rather than lower production on the upland meadow soil this year (Figure 2, compare with Figure 2 in Helm 1991). Twigs on individuals of most plant species on the birch-spruce plots were substantially longer than last year.

A total of 31 identified native plant species were recorded in August 1991 with the point-frame technique of estimating cover. Total vascular vegetation cover averaged 70% after three years with bluejoint (38%), tall fireweed (*Epilobium angustifolium*) (18%), and horsetails (*Equisetum* spp.) (12%) being the most important species this year as in past years (compare with Helm 1991). Grasses, especially bluejoint, accounted for almost half of the relative cover while forbs averaged near 30% relative cover.

Plots on the birch-spruce soils averaged 84% cover by vascular plants with bluejoint contributing 56%, horsetails 30%, and tall fireweed 13% cover. Fifteen local plant species were sampled on these plots compared with 11 recorded last year. Only 1% bare ground occurred on the birch-spruce plots, down from 24% last year. Plant litter contributed 30% cover and mosses 55% cover, which substantially reduced the bare ground.

Plots on the upland meadow soils had 90% vascular vegetation cover with bluejoint providing 72% cover and only 2% bare ground. Other important local colonizers here were also horsetail (18%) and tall fireweed (28%). Fireweed increased from last year as did moss (30%) and litter (63%) cover. Eighteen local plant species were sampled on these plots.

The lowland meadow plots contained 93% vascular vegetation cover, and no bare ground was recorded. These plots had 21 plant species recorded during the sampling, the same as 1990. Ten species contained more than 5% cover with tall fireweed (28%) and bluejoint (24%) being the most abundant. Bluejoint cover almost doubled from the previous year but is less than half that found on the paper birch-white spruce plots and one-third that on the upland meadow plots. Burnet (*Sanguisorba stipulata*) contributed 18% cover in 1991. Forbs were more important on the lowland meadow plots than on other plots. Forbs provided almost one-half the relative cover while grasses provided only one-third of the relative cover on these plots. Bluejoint provided only 17% relative cover on lowland meadow plots compared with an average of 50% relative cover on birch-spruce and upland meadow plots.

In contrast the overburden plots contained only 14% cover by vascular plant species and 63% bare ground. This was similar cover to last year but bare ground decreased because of the increase of moss cover (24%). Volunteers of balsam poplar were quite abundant. Fourteen local species were recorded.

Discussion

Good growth on most woody species has continued through the third growing season. Wet conditions at the end of all three growing seasons and the excellent surface and subsurface soil moisture that was visually observed during the springs of 1990 and 1991 have reduced the effects of June droughts. Once again, 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.

Naturally colonizing plant species, especially on the upland meadow plots, appeared to crowd the desired browse species although overall growth was still good. Barclay willow has continued to be one of the most productive species on the upland meadow plots. It has maintained a fairly bushy growth form and maintained height growth even when crowded by bluejoint.

Bebb willow growth is beginning to improve during the third year after its relatively slow start compared with the other willow species. Root systems of many Bebb willow cuttings were less developed than on other willow cuttings, which may have accounted for their slow growth initially.

The excellent growth on the upland meadow site continued through the third year although plants on the birch-spruce plots produced longer twigs this year. Wherever ground cover is greater (up to a limit), woody

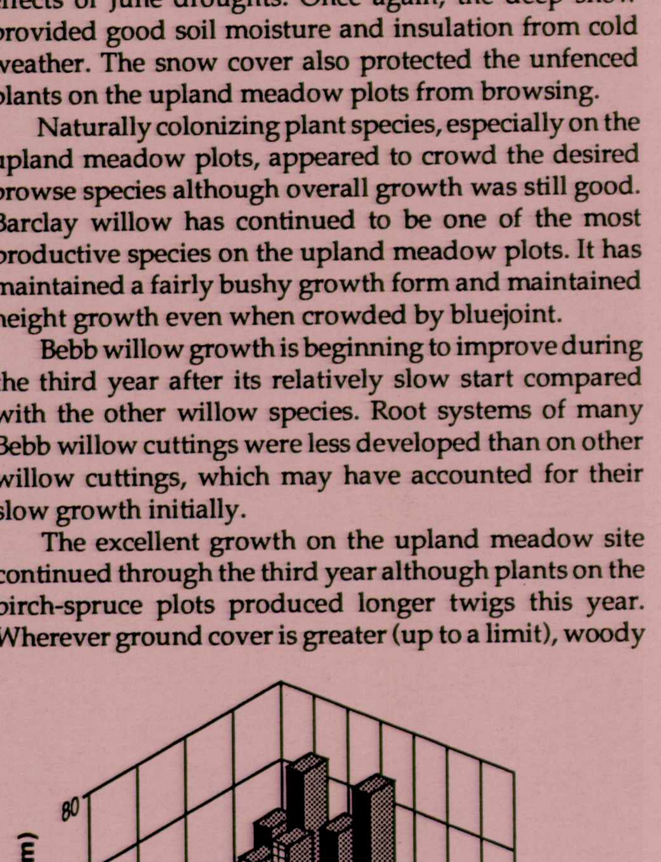

Figure 2. Mean length (cm) of terminal twigs for each woody species on each soil at the end of the third growing season, August 1991. (Bebb willow and alder were not planted on the upland meadow soil in 1989.)

plant growth is usually better, as has been observed in the past. If ground cover and height of other plants become excessive, then negative effects of root and shoot competition would negate positive effects of ground cover. Measurements in this study were not designed to determine if this was a correlation of cause and effect.

Alder was the most productive plant species on the overburden with twigs more than twice as long as all of the other species except Barclay willow. Alder is the only plant species tested that has a mutualistic symbiotic relationship with N-fixing bacteria. Bacteria are wind-borne and can easily infect nearby plants. This may be one reason why alder is outperforming other woody plant species on the overburden plots.

Growth of all plants on overburden is still slow compared with plants on soils. Part of this results from the low soil moisture holding capacities of these gravels and the low levels of natural regeneration.

In conclusion, most plant species, with the possible exception of Bebb willow, grew at least as well as expected on all plots. Most plots covered with local soil produced good growth. Hence, there is no need to segregate special soils for certain species in the Wishbone Hill area. However, use of "live" (not stockpiled) native soils resulted in better growth compared to simulated overburden under these conditions. This overburden is harsher than that on a real mine since it has not been blasted and worked as it normally would. This study demonstrated that moose browse can be produced within three years under the conditions of this study which included excellent snow cover each year.

Use of topsoils on these plots was successful because the native vegetation is mid-successional. Hence, good regeneration was possible in full sunlight on mineral soils. Similar results may not be expected where the vegetation is late successional or climax because many of those plant species may be shade tolerant and unable to regenerate readily in full sunlight on mineral soils.

Literature Cited

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Acknowledgments

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