REESTABLISHMENT OF WOODY BROWSE SPECIES FOR MINED LAND RECLAMATION YEAR 1 (1989) RESULTS

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INTRODUCTION

Long-term goals of revegetation include the reestablishment of diverse, self-reproducing plant communities suitable for desired post-mining land uses. In Alaska, these uses include habitat for moose and other wildlife. Current state and federal revegetation regulations affect only coal-mined lands, but some mine operators have been revegetating their lands voluntarily. Regulations requiring revegetation may affect other types of mines in the near future.

Revegetation of mined lands or other disturbed lands helps control soil erosion, which traditionally has been controlled by grass cover. However, vigorous grass growth may interfere with woody plant regeneration needed by wildlife for thermal cover, browse, and hiding cover. Growth of plant species varies in different soils because of the biological, physical, and chemical properties of the individual soils. Biological components of soils are often overlooked even when the physical and chemical properties of soils are considered. The potential advantages and disadvantages of planting certain species in certain types of soils are examined in this study.

SCIENTIFIC BACKGROUND

Biological components of soil include various kinds of plant propagules (seeds, rhizomes) and many of the microorganisms needed for nutrient cycling and plant growth. Regeneration of plants from existing plant propagules may improve the species diversity of revegetated areas and help stabilize the soils. However, this regeneration may also compete with the seeded species and regeneration of browse species. Some microorganisms form mutualistic symbioses (associations between at least two living organisms in which both benefit) with the plant roots.

Mycorrhizae (Greek for "fungus roots") are mutualistic symbioses between certain fungi and roots of plants. In this relationship the fungus assists the plant with the uptake of nutrients and moisture from the soil and in exchange receives carbon (energy) from the plant. Absorption of nutrients assisted by mycorrhizal fungi is particularly important where phosphorus, a nutrient that is relatively immobile in the soil, is in short supply and therefore limits plant growth. Some level of mycorrhizal participation is usually needed for normal growth of most plant species in the field, but plant species vary in their dependence on mycorrhizae.

Although many different species of mycorrhizal fungi may colonize the roots of a single plant, some plants are dependent upon certain forms (endomycorrhizae, ectomycorrhizae) or even certain species of mycorrhizal fungi. Many woody successional species in Alaska [poplar (*Populus balsamifera*), willows (*Salix* spp.), paper birch (*Betula papyrifera*), and alder (*Alnus* spp.)] can be both endo- and ectomycorrhizal. Mycorrhizal fungi may be spread from roots of infected plants to roots of non-infected plants via hyphae or spores. The potential of fungi in the topsoil to colonize the roots of a particular plant varies according to:

1. The vegetation community existing on that topsoil prior to disturbance;
2. The plant species being outplanted;
3. Environmental conditions; and
4. The length of time the topsoil was stockpiled.

Plants in a revegetation project can be inoculated with mycorrhizal fungi by applying fresh topsoil with the desired fungi. Topsoil containing the fungus can either be spread over the entire area or small quantities can be placed into the hole where woody individuals are being planted. In the current study, topsoil was spread as it normally would be after mining. Spreading topsoil supplies the mycorrhizal propagules and also enables the investigator to observe the positive or negative effects of buried plant propagules on soil stabilization and regeneration by woody plants. Existing (or pre-disturbance) vegetation on the soil being used must be matched with the plant species being outplanted to ensure the presence of appropriate microbial species. Spreading the topsoil reduces the effectiveness of the soil microbial communities by diluting and disrupting the communities, but large-scale spreading may be the simplest approach for a large mine with adequate topsoil. In contrast, transferring soil to the hole uses only small quantities of the best portions of the topsoil and may be more efficient and economical for a small operator or for sites where appropriate soils are limited.

OBJECTIVES

The objectives of these studies include:

1. To evaluate the advantages and disadvantages of different soils (based on existing vegetation community) used with different plant species to establish a diverse, self-reproducing plant community with moose browse. Advantages include desirable mycorrhizal species and plant propagules while disadvantages include propagules of undesired plant species.
2. To evaluate the benefits of different grass seed mixes to create a diverse, self-reproducing plant community to reduce soil erosion but not compete with regeneration of browse plants.

METHODS AND MATERIALS

The study site is located within the Wishbone Hill Coal District of the Matanuska Coal Field about 8 miles north of Palmer, Alaska. Important vegetation communities include closed deciduous forests with birch, aspen (*Populus tremuloides*), and poplar; mixed paper birch-white spruce (*Picea glauca*) forests; upland meadow; and lowland meadow communities. Experimental plots were placed on freshly-cleared sites in the birch-spruce, upland meadow, lowland meadow communities, and overburden (control). Soil series for the birch - spruce and upland meadow plots is Talkeetna silt loam while that for the lowland meadow is a complex of Lucile and Chulitna Variant. These three topsoils had low levels of available nitrogen (8 ppm), phosphorus (3 to 9 ppm), and potassium (41 to 56 ppm), and low pH values (5.3 to 5.5). The overburden plot was adjacent to the lowland meadow plots, and most topsoil was removed from it.

The birch-spruce vegetation type is dominated by paper birch and white spruce and should contain mycorrhizal fungi for both of these species. The lowland meadow is a diverse community with scattered white spruce, Bebb willow (*Salix bebbiana*), numerous forbs, and several species of grass, including bluejoint (*Calamagrostis canadensis*). This lowland meadow soil was presumed to contain mycorrhizae for spruce and willow. The upland meadow type is dominated by bluejoint and tall fireweed (*Epilobium angustifolium*) which compete with woody regeneration and seeded grasses. It is not known whether the mycorrhizal fungi associated with these herbaceous species (bluejoint, fireweed, and other forbs) can colonize roots of these woody plants. The control plot was overburden, presumably with little or no biological activity.

The seven plant species used in these trials were selected based on ease of propagation, suitability for post-mining land use (moose habitat), and presence in the pre-mining vegetation. Balsam poplar readily colonizes primary successional sites, is browsed by moose, and can have both endo- and ectomycorrhizae. Three species of willow were chosen for their browse production. The most robust is feltleaf willow (*Salix alaxensis*) which is similar to poplar in its ability to produce adventitious roots and to produce moose browse. Barclay willow (*Salix barclayi*) is almost as easy to propagate and may be found on lower pH soils. Bebb willow (*Salix bebbiana*) occurs on the site naturally, grows on low pH soils, but is more difficult to propagate. Birch is heavily browsed in the Wishbone Hill area. Alder can have both forms of mycorrhizae and also is colonized by nitrogen-fixing bacteria. Alder could increase levels of nitrogen in the soil and increase the probability of achieving a self-sustaining plant community. White spruce provides thermal cover for wildlife and is dependent on ectomycorrhizae.

Dormant cuttings for the poplar and willow species were collected locally in April 1989 and started in a sand bed at the Palmer Research Center during May and June. Alder (*Alnus tenuifolia*, 2-mo old), birch (1 and 2-yr old), and spruce (1-yr old) seedlings were obtained from Alaska Division of Forestry's Eagle River Nursery. The study locations were selected in early June based on desired vegetation communities. Trees were cleared, then all topsoil was stripped and temporarily stockpiled (< 1 day) beside the clearing to simulate a mining disturbance. The soil was spread evenly over each site except the overburden control plot on the lowland meadow site. A portion of the topsoil from this area was stockpiled while the remaining portion was added to the one segment of the lowland meadow plot. All plots were disked to loosen the soil except this segment of the lowland meadow plots. Eight-foot high fencing to protect the plots from moose was erected around all but the upland meadow (bluejoint) plots in late June. The upland meadow plots were not fenced so effects of moose browsing on revegetation success could be observed.

Outplanting and initial measurements were completed between June 26 and July 7, 1989. Plants were watered the day they were planted. The upland meadow (bluejoint) plots were the first ones planted and the only ones to receive any rain within the first several weeks after planting. Heat during planting stressed plants in birch-spruce plots more than other plots. The experimental grass plots were seeded and fertilized by hand broadcasting on the birch-spruce soils. Three strips were made in these plots: grass alone, grass + five woody plants (to assess competition with woody species), and grass + fertilizer. Grass cultivars were selected based on earlier trials on other sites and were seeded at different rates in monocultures and mixes.

Several plant dimensions including plant height, basal diameter, twig length, and twig diameter were measured between August 22 and 25, 1989. The number of twigs on each plant was counted and the vigor of each plant was estimated. Species of local plants colonizing each plot were also recorded.

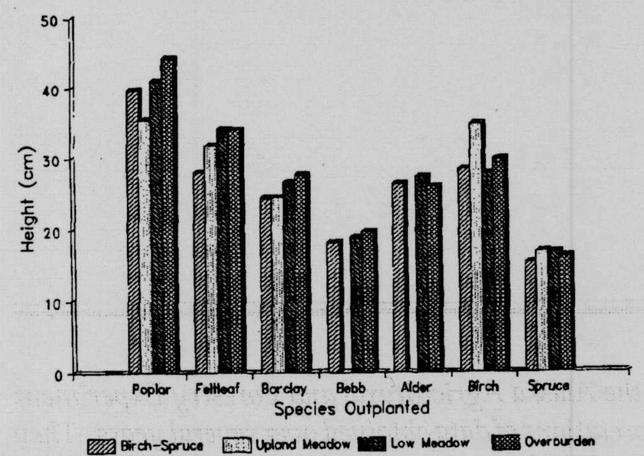

Figure 1. Mean height (cm) of plants for each woody species on each soil at the end of the first growing season, August 1989. (Bebb willow and alder were not planted on the upland meadow soil in 1989.)

RESULTS AND DISCUSSION

Mean plant height and twig lengths for each species on each soil type are reported in Figures 1 and 2. These first year results were affected by drought and may not indicate long-term trends. In particular, plants on the upland meadow site may have developed more relative to other plots because of benefits from the initial rain. Plants in the plots on birch-spruce soils may not have grown as well as normal because of moisture stress during planting. Twig lengths were measured as an indicator of moose browse. Bluejoint competition with woody plants was minimal this year because of low cover.

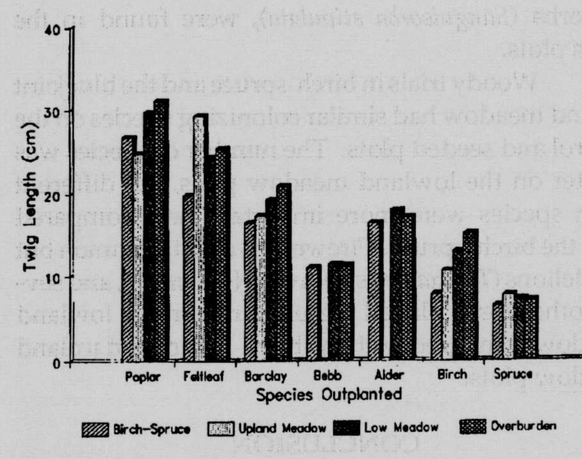

Figure 2. Mean length (cm) of terminal twig for each woody species on each soil at end of first growing season, August 1989. (Bebb willow and alder were not planted on the upland meadow soil in 1989.)

Most grass plots had little cover during this establishment year, possibly because of the dry conditions at the time of planting. However, 'Arctared' red fescue (*Festuca rubra*), 'Nortran' tufted hairgrass (*Deschampsia caespitosa*), and 'Gruening' alpine bluegrass (*Poa alpina*) provided the best cover. Arctared produced over 40 per cent cover while Nortran produced 50 per cent cover in the fertilized portion of the plot. An Arctared:Nortran mix produced 75 per cent cover where fertilized; Arctared:Gruening bluegrass produced 44 per cent, and a mix of Arctared, Nugget, Alyeska , and Norcoast produced 69 per cent. Some species grow slowly during the seedling year but may be very vigorous in the long term. However, establishment of vegetative cover for erosion control during the first year is important to any reclamation effort. All grasses were short and did not compete significantly with woody transplants this first year.

Plants regenerating from the buried seed bank may play an important role in erosion control, community diversity, and competition with planted species. Tall fireweed was present in every plot testing grass species mixes on the birch-spruce soil and produced up to 67 per cent cover of the fertilized part of the control plot. Fertilizer increased fireweed growth in about half the grass-mix plots. Fireweed developing from seeds and rhizomes in the soil suppressed some of the seeded species, but the more successful grasses suppressed some fireweed. A total of 15 local vascular plant species, including rose (*Rosa acicularis*) and sanguisorba (*Sanguisorba stipulata*), were found in the grass plots.

Woody trials in birch-spruce and the bluejoint upland meadow had similar colonizing species on the control and seeded plots. The number of species was greater on the lowland meadow plots, but different plant species were more important here compared with the birch-spruce. Fireweed was still common but dandelions (*Taraxacum* sp.), avens (*Geum* sp.), and several other forbs played a greater role in the lowland meadow compared with the birch-spruce and upland meadow plots.

CONCLUSION

Survival of woody plants transplanted onto various soils was greater than 97 per cent in all cases except Bebb willow in the birch-spruce site (90 per cent survival). Height and twig lengths varied among soils with no consistent pattern. The establishment year is usually too early to determine long-term trends.

Buried plant propagules were an important source of both additional species and competition with seeded grasses during the first year. 'Arctared' red fescue, 'Nortran' tufted hairgrass, and 'Gruening' alpine bluegrass provided the best grass cover during this first dry year. First year results are important for short term soil stabilization but longer term results are needed to determine progress toward a diverse, self-reproducing plant community with moose browse.

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