SYNCRUDE'S RECLAMATION RESEARCH PROGRAM

by

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ABSTRACT

The objective of Syncrude's land reclamation research program is to identify and develop cost-effective land reclamation strategies and techniques to achieve acceptable reclamation for all combinations of materials surfaces and ecological situations which will be encountered during the Syncrude Project. At the present time Syncrude's land reclamation research program consists of 19 active in-house projects organized into 5 categories as follows: tailings sand reclamation, overburden reclamation, woody plant propagation and performance, soil biology, and small mammal research. Each of the projects is discussed briefly.

INTRODUCTION

Syncrude's land reclamation objective is to establish on all disturbed land surfaces resulting from the Syncrude project, terrestrial ecosystems which are erosion-controlling, self-maintining, compatible with the designated end land use (forestry, recreation, or wildlife), and at least as productive as those existing prior to disturbance. The objective of Syncrude's land reclamation research program is to identify and develop cost-effective land reclamation strategies and techniques to achieve acceptable reclamation (as defined above) for all combinations of materials surfaces and ecological situations which will be encountered during the project. The development of cost-effective land reclamation strategies and techniques must be based on a thorough understanding of the properties of the soil materials which require reclamation and the plant species which are available. An understanding of these materials is derived from a number of sources including the general body of soil and plant science,

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the land reclamation literature, operational experience and controlled experimentation. Since 1975 when a land reclamation research program was initiated by Syncrude, a large number of controlled experiments and field trials have been developed. At the present time Syncrude's land reclamation research program consists of 19 active in-house projects organized into 5 categories (Table 1), as well as a number of cooperative projects organized through the Oil Sands Environmental Study Group (see A. W. Fedkenheuer - this Proceedings).

TAILINGS SAND RECLAMATION

Tailings sand is a relatively homogeneous material. It is essentially an inert, quartzic, alkalai-stripped fine sand, having negligible quantities of organic matter or plant nutrients and with very little ability to retain applied nutrients. There are not believed to be any phyto toxic properties associated with tailings sand, rather, the major reclamation problem with this material appears to be the establishment of an adequate level of soil fertility.

The main thrust of research directed at level tailings sand surfaces is to define the minimum quantity of peat and clay amendment, and the attendant revegetation strategy or strategies, necessary to achieve acceptable reclamation. On sloped tailings sand surfaces, part of the research has focused on the effect of different fertilizer regimes and amendment quantities on the establishment of erosion controlling ground cover; future research will likely involve the development of techniques to minimize the ground cover density in order to promote woody plant establishment while, at the same time, maintaining adequate erosion control.

Suncor Tailings Dyke Projects

In 1975 and 1976, three major experiments were installed on a portion of the Suncor tailings sand dyke. These experiements are described in detail in Syncrude Environmental Research Monographs 1977-1, 1977-4, 1978-5, and 1979-5. Generally, these experiments were designed to study the effect of different fertilizer regimes, different amounts of peat and clay additions, and different peat and clay incorporation depths on the performance of grasses and legumes on a tailings sand dyke. In 1979, fertilizer additions were discontinued on all plots and comprehensive plant and soil analyses were undertaken. These analyses were completed in early 1980.

Table 1

Land Reclamation Research Program*

Tailings Sand Reclamation

1. Suncor Tailings Dyke Project I (1975)
2. Suncor Tailings Dyke Project II (1976)
3. Soil Simulation - Revegetation Project (1977)
4. Drill-seeding Project (1981)
5. Soil Moisture Monitoring Project (1981)
6. Strip-seeding Project (1982)

Overburden Reclamation

7. Woody Plant Establishment Project (1978)
8. Native Plant Reinvasion Project (1979)
9. Post-planting Herbicide Project (1981)
10. Organic Matter Amendment Project (1982)

Woody Plant Propagation and Performance

11. Seed Germination Trials (1977)
12. Vegetative Propagation Trials (1977)
13. Stock-size Project (1981)
14. Planting-time Project (1982)

Soil Biology

15. Legume Project (1978)
16. Buffaloberry Inoculation Project (1979)

Small Mammal Research

17. Population Studies (1977)
18. Physical Protection of Seedlings Project (1982)
19. Effect of Partial Girdling Project (1982)

* all in-house projects.

A complete plant cover capable of resisting erosion existed on all of the experimental areas. In the experiment that was started in 1976 where low levels of fertilizer had been added (80 kg-N/ha in 1976 and 1977, none in 1978 and 1979) the proportion of bare ground had increased and greater growth of Alfalfa was noted.

High fertilization (300 kg-N/ha in 1976 and 1977, 150 kg-N/ha in 1978 and none in 1979) produced a pure dense cover of Bromegrass. Medium levels of fertilization (150 kg-N/ha in 1976 and 1977, 75 kg-N/ha in 1978 and none in 1979) produced a mixed grass cover of Bromegrass, Hard Fescue and Canada and Kentucky Bluegrass but only low levels of Alfalfa.

Root biomass has shown a steady decline between 1976 and 1979 in an area seeded with grasses and legumes in 1971. A steady increase in biomass to an almost constant level was noted during the first four years of growth in an area seeded to grasses and legumes in 1976. The depth of root penetration in both areas increased with time with greater rooting being stimulated by deeper incorporation of peat or overburden, and in one experiment by increased addition of fertilizer.

Results indicated that about 40-50% of the weight of the previous year's dead above-ground plant material was decomposed in the next year. However, root tissue was estimated to have a turnover time of about three to three-and-a-half years.

Study of carbon and nitrogen changes during 1976-1979 suggested that considerable decomposition of the peat amendment had occurred and resulted in a significant reduction in the C:N ratio.

Where salinity had been added in the form of mineral overburden, a gradual reduction in surface soluble salts had occurred with a balancing increase in salinity deeper in the soil.

Both pH and soluble salts were well within the range tolerated by plant species.

Organic carbon, total nitrogen and cation exchange capacity all increased noticeably in the 15-45 cm depth due to increased root production and decomposition and possibly to movement of soluble organic decomposition from surface regions of the soil.

Generally these experiments have demonstrated that tailings sand slopes amended with peat, or peat and clay can support vigorous erosion controlling grass swards. Annual additions of fertilizer, particularly nitrogen, tend to promote vigorous Bromegrass growth. If lesser amounts of fertilizer are added the grass swards tend to have a more varied species composition.

If no fertilizer is added for several years the grasses start to thin out and legumes become more prevalent. However, even areas that have not been fertilized in 5 years retain a complete plant cover.

Soil Simulation - Revegetation Project

This project was initiated in 1977 on a 0.2 hectare experimental area of deep, level, coarse tailings sand hauled from Suncor. The primary objectives of the project are to:

a) Evaluate the productivity of a soil engineered from tailings sand, 15 cm of peat, and 10 or 20 cm of mineral soil, all cultivated to a depth of 30 cm;

b) Evaluate the performance of selected grass, legume, shrub, and tree species, in a plant community situation, on tailings sand amended as in (a);

c) Document soil development in deep, level coarse tailings sand amended as in (a);

d) Evaluate the effects on productivity and species performance of an annual maintenance application of fertilizer, compared to an initial fertilizer application with no further maintenance.

In 1977 a deposit of artifically established deep (1 m), level, coarse tailings sand was amended with 15 cm of peat and one of four mineral soil amendments, 10 cm of native sand, 10 cm of lean tar sand, 10 cm of clay or 20 cm of clay.

Each mineral soil amendment was used on 3 replicate plots in each of 2 blocks. Both blocks received an initial fertilizer application but only one of the blocks has received an annual application of fertilizer (1977-1980 inclusive). The other has not been fertilized since the experiment was initiated. Grasses and legumes were drill-seeded uniformly over all of the plots at 11 kg/ha and seven shrub and tree species were planted at 1 m spacing in the same pattern on every plot.

Vegetation performance and productivity have been monitored by annual spring and fall assessments. Replacement planting of trees and shrubs after the spring assessment was carried out in 1978, 1979 and 1980, but not in 1981. Soil moisture has been monitored biweekly with psychrometers and tensiometers and monthly by soil sampling for gravimetric moisture each year since 1979.

On the whole, woody plant survival and growth has been best on those treatments with the lowest total herbage production and poorest on those with the highest herbage production. From a vegetation management point of view, those factors which promote better herbage production, as for example the use of clay amendments and annual maintenance fertilizer additions, also promote poor woody plant survival. This, and other observations, suggest that one of the major reasons for poor woody plant survival and growth on these plots is moisture competition. It is quite apparent from the results of this field trial that in the Ft. McMurray area, woody plants cannot be successfully established on amended tailings sand in a continuous grass cover.

Drill-seeding Project

A vigorous vegetative cover on tailings dyke slopes is essential for reducing surface erosion, however, it creates problems for the establishment of woody species. The dense root systems of the herbaceous plants compete with woody seedlings for moisture and nutrients and greatly affect woody plant survival and growth. It is apparent that suitable techniques for the establishment of dyke vegetation are required that will not only prevent surface erosion, but will also permit the successful establishment of woody species. Therefore, a dyke slope revegetation study was initiated in summer 1981.

This study was designed to evaluate the use of seeding techniques, seeding rates and fertilizer rates for controlling the density and species composition of ground cover on the tailings sand dyke. Subsequently it will assess the effects of ground vegetation cover density on erosion control and the establishment and performance of woody species.

In May, 1981, an unseeded tailings dyke slope was subdivided into 6 large blocks, each approximately 0.5 ha in size. Each block was then seeded with grasses and legumes by hand broadcast or seed drill at one of three seeding rates in early June. The blocks were then further subdivided into three plots, each of which received a different rate of nitrogen fertilizer in July. Four shrub species, alder, saskatoon, caragana and dogwood were planted in October 1981.

Ground vegetation cover was assessed in late August, 1981 for species composition and percent cover.

Revegetated species had established well in all blocks. The broadcasted blocks had heavier vegetative cover than the drill seeded blocks. However, the drill seeding produced a more uniform vegetative cover with more vigorous seedlings. Among the seeded species, slender and crested wheatgrasses were the dominant grasses, and alfalfa was the dominant legume. Timothy and smooth brome grass were minor components due to the low percentage in the seed mixture.

There were about a dozen native species present in the plots such as lamb's quarters, stinging nettle, smooth hawkesbeard, Canada bluegrass, golden corydalis and fireweed. Most of the native species were introduced with the muskeg peat used for topsoiling.

Soil Moisture Monitoring Project

This study was initiated in 1981. The objectives are to obtain a record of changes in soil moisture at various depths in topsoil and underlying tailings sand on the tailings dyke throughout the growing season, to compare soil moisture profiles of north, south and east-facing dyke slopes and the upper and lower slope positions, to relate soil moisture patterns to climatic conditions, soil physical characteristics and vegetation, and to interpret results in terms of water availability to plants during the growing season.

Soil samples were collected on the tailings dyke from May to October, 1981 and their gravimetric water content determined. Three aspects, north, east and south, and upper and lower slopes were sampled at each of three depths: 0-10 cm, from 10 cm depth to the topsoil/tailings sand junction (about 30 cm deep) and the top 10 cm of tailings sand underlying the topsoil (about 30 to 40 cm). Surface (0-10 cm) samples were collected biweekly and deep samples, monthly. All areas had been topsoiled in November 1980 with about 10 cm clay and 15 cm muskeg, and operationally seeded at low rates with grasses and legumes in spring 1981. Operational planting of shrubs was done in spring and fall on these areas.

Slope aspect had no significant effect on the gravimetric soil moisture for the topsoil (0-10 and 10-30 cm). The top 10 cm of tailings sand did have significantly higher gravimetric soil moisture on the north aspect compared to the south, but only in May, after which there were no significant differences.

Moisture-tension curves are being prepared for the dyke samples collected to enable the translation of gravimetric soil moisture values into soil moisture tension (water potential). Moisture tnsion can then be interpreted in terms of water availability to plants on this site. This study is to be continued in 1982.

Strip-seeding Project

This project is to be initiated in the summer of 1982. It is intended that strips seeded with agronomic grasses will be alternated with unseeded strips of various widths. Several species of woody plants will be planted in both the seeded and unseeded strips so that a direct comparison of survival and growth can be made.

OVERBURDEN RECLAMATION

Overburden spoil and other drastically disturbed soils contain a great diversity of materials with regard to both texture and chemical and physical properties. The largest percentage of these areas will probably be fine textured material derived from either the Clearwater Formation or glacio-lacustrine till of Pleistocene origin. A much smaller percentage will be coarse textured material derived from glacio-fluvial deposits, also of Pleistocene origin. While the major reclamation problem will be the establishment of adequate levels of soil fertility, there is the potential for some toxicity problems. For example, portions of the Clearwater Formation are known to have high salinity concentrations. Furthermore, bitumen levels may be a problem where lean or rich tar sand derived from the McMurray Formation comes to the surface.

The major problem at present on level spoil surfaces (and other drastically disturbed soils) is to elucidate techniques for establishing woody plants in a pre-established ground cover. In the future, research in these areas will emphasize the development of techniques to promote rapid establishment of the woody plant component and prevent the problems associated with ground cover competition.

Woody Plant Establishment Project

The objective of this study is to evaluate the effectiveness of a chemical herbicide (glyphosate), soil scarification (ploughing) and fire (controlled burning), alone and in combination, for controlling a grass-legume cover and assisting in the establishment of 10 species of woody shrubs and trees. Since the study was established in August of 1978 there have been biannual assessments of tree and shrub survival and rodent populations, and annual assessments of tree and shrub growth and grass and legume cover and productivity. In addition, replacement planting of trees and shrubs was carried out in spring 1979 and 1980 and soil samples were collected and analyzed in 1978 and 1980. Soil moisture (gravimetric) was measured every two weeks from May to September, 1981.

If all woody stock are considered, there are no differences among treatments for percent survival to fall, 1981. The initial survival of woody plants in 1978-1979 was improved by ploughing through mitigation of rodent damage. However, the rapid regrowth of herbaceous vegetation caused competition with woody plants and this had eliminated the difference between treatments by fall, 1981. With regard to the original 1978 stock the ploughed treatments gave only slightly better

results than the unploughed. For the 1979 stock, ploughed treatments were detrimental, and for 1980 stock, survival was not significantly better on any given treatment.

Competition between woody and herbaceous plants for soil moisture was a major factor affecting woody plant survival in 1981. This competition effect was most severe in the period June 15 to July 1, even though soil moisture became lower in August and September. Soil moisture was negatively correlated to herbage production in 1981, while woody plant survival oversummer was negatively correlated to herbage production and positively correlated to soil moisture.

Saskatoon, trembling aspen and jackpine have consistently had the best survival to fall 1981 on this site. Though jackpine is the most susceptible of the conifers to rodent damage, it establishes well within a growing season and competes well for soil moisture subsequently.

Growth of woody plants in 1981 was best for the oldest stock (1978-planted). Trembling aspen, jackpine and black spruce were species with the most growth in 1981.

Rodent damage to deciduous species ranged from 6 to 21% in spring, and 0 to 8% in fall, 1981. Coniferous species had even lower levels of rodent damage in spring (4-9%) and fall (0-2%). The amount of damage was greatest on plots with the most herbaceous cover, regardless of treatment.

Native Plant Reinvasion Project

The survey was initiated in 1979 with the objectives of documenting the rate of colonization of reclaimed areas by native plants and monitoring soil development in these areas. Nine sites were chosen for the 1981 survey, adjacent to native forest on or near the Mildred Lake project site and at the Poplar Creek area. All sites were previously seeded with agronomic species of grasses and legumes and were, for the most part, not planted with trees and shrubs. A transect and mil-acre quadrat method of assessment was used. Observations were made on soil characteristics and degree of development from pits dug at the sites.

On all sites, seeded species, especially sweetclover and alfalfa, were still dominant. Grasses were not as abundant, probably as a result of fertilization being discontinued. The degree of disturbance at the sites seemed to affect the occurrence of native species. On sites where the soil humus was not removed there were more, and a greater variety of, native plants. Where all humus layers were removed native species were scarce.

Moisture conditions at the sites likely affected the presence or absence of native species. Few native plants were found on dry sites with correspondingly little organic matter buildup in the soil. Low-lying wetter areas were more favorable for both native herbaceous species and woody species. Trees and shrubs growing from seed were generally no more than 10-15 cm in height and most were found within a few meters of the forest edge. Willow, aspen and balsam poplar, and prickly rose were the woody species most commonly found during the survey. Very few coniferous species were found.

Post - planting Herbicide Project

The objective of this study is to evaluate the effectiveness of herbicides for releasing woody plant seedlings from competing herbaceous vegetation. The experiment was conducted on an overburden spoil pile at Poplar Creek. The area was aerial seeded with grasses and legumes in 1976. White spruce *(Picea glauca)*, aspen *(Populus tremuloides)* and green alder *(Alnus crispa)* were planted into a dense vegetative ground cover in the fall of 1980.

A randomized block design was used for this experiment. Five treatments were applied on each of the 3 blocks (replicates) for a total of 15 plots. Plots were laid out in strips 2.0 m wide and 51.0 m long with a 2.0 m buffer strip between treatments. On June 15, 1981 Glyphosate was applied at 4.75 L/ha and 9.50 L/ha, and Amitrol-T at 20.0 L/ha and 30.0 L/ha using a hand-operated sprayer. The Glyphosate was mixed with 5 kg/ha of Ammonium Sulphate. During the process of spraying, the seedlings were covered with plastic road cones to protect against the herbicides.

The amount of ground cover killed was assessed 6 weeks after the herbicides were applied. At the rates tested, Glyphosate proved to be far superior to Amitrol-T in killing the ground vegetation. The effect of Glyphosate, however, was more pronounced on the grasses than on the legumes while the reverse was true for Amitrol-T. Seedling growth as affected by the different treatments was insignificant after the first growing season. The effect of reduced ground cover density on seedling performance will be assessed annually for several years. The rate of ground cover reinvasion will also be evaluated periodically and the herbicide treatments repeated if necessary.

Organic Matter Amendment Project

The purpose of this project which is to be initiated this year is to investigate the effect of amending overburden with organic matter on woody plant survival and growth. Generally, the survival and growth of woody plants on spoil materials has been quite poor. Low organic matter levels and the associated poor physical and chemical soil properties as suspected of being important contributing factors.

WOODY PLANT PROPAGATION AND PERFORMANCE

Seed Germination Trials

Since 1977 when this project was initiated, Syncrude has maintained a small but consistent effort in this area. The objective of the project is to improve the seed germination percent of the native woody plant species which Syncrude is propagating or would like to propagate in its on-site greehouses. To date approximately 17 species have received some amount of work. For the most part this has involved the investigation of the effect of rather small variations in germination procedure, on germination percent. For example, studies which have been carried out have concerned the effect of peroxide or acid scarification of Shepherdia canadensis seed, the effect of different stratification times on the germination percent of Amelanchier alnifolia , or the effect of dewinging the seed of Betula papyrifera or Betula pumila . Most likely a small effort will be maintained on this project for at least the next several years as new problems in seed germination become apparent.

Vegetative Propagation Trials

The main objective of this project is to determine the rootability of stem cuttings from six native shrubs that are potentially useful for land reclamation but are difficult to propagate from seeds. As with the above project, a small but consistent effort has been maintained on this project since 1977. However in 1981, a somewhat larger experiment was undertaken. This experiment was designed to simulate the operational production of plantable seedlings from rooted cuttings collected during the dormant period (March, 1981) and semi-hardwood cuttings collected when the actively growing shoots were beginning to become woody (June 1981). The semi-hardwood shoots were sub-divided into two portions (top and bottom). The hardwood cuttings were stored at 4°C for 3 months before planting while the semi-hardwood cuttings were planted immediately after they were collected. The cuttings were treated with either 0, 0.8, or 3.0% of the root

inducing substance (HORMEX) containing Indole 3 Butyric Acid. The basal ends of all the cuttings were dipped in a fungicide solution prior to the hormone treatment.

All the cuttings were planted in Spencer-Lemaire "Hillson" containers filled with 1:1 mixture of sphagnum peat moss and vermiculite. They were placed in a rooting chamber where the temperature and relative humidity were controlled.

Rooting was assessed 3 months after planting. A large variation in rooting success was seen among all the species and between treatments within each species. Generally hardwood cuttings rooted poorly. This is attributed to deterioration in storage.

Except for choke chery the semi-hardwood bottom cuttings generally rooted better than the top cuttings. Choke cherry, however, rooted exceptionally well under the same conditions as the other species. As high as 75% rooting was obtained from the semi-hardwood bottom cuttings treated with 0.8% rooting hormone. It is now recommended that this species be operationally propagated vegetatively.

Stock-size Project

The objective of this project is to examine the relationship between seedling size and outplanting performance on amended tailings sand. A total of 26 combinations of seedling species and size were planted on May 17, 1981 on a tailings dyke amended with 10 cm clay, 15 cm muskeg peat.

Sizes were differentiated by age class and the size and type of containers used. Individual species were planted in rows of 10 seedlings spaced at 1.5 m apart and 1.0 m between rows. The rows were randomly assigned within each of 3 blocks (replicates). No other treatments were implemented.

Although the plot areas were not seeded, sufficient ground cover (Chenopodium album L. and grasses) had established during the first year to effectively control soil erosion. The ground vegetation was established either from seeds blown over from neighboring experimental plots or from seeds originally present in the muskeg peat.

Seedling survival was excellent (97.8%) after one growing season. The mortality was mainly due to excessively small seedlings being buried by sand blown over from the upper dyke lift and not due to the prolonged summer drought.

This interesting observation could be attributed to the lack of severe competition by the ground vegetation for valuable soil moisture. Seedling hight growth was generally good. Excellent performance was recorded on aspen, jack pine, dogwood and green alder.

Root development of each stock size was examined at the end of the first growing season. Roots that were not completely confined to the shape of the container at the time of planting wereable to egress into the surrounding soil and developed into a normal root system. Roots that had been severely "pot bound" were unable to initiate new roots. Such a root system had not at this time affected the seedling performance.

Root nodules were found in abundance on the green alder and buffaloberry although these were not seen at the time when the seedlings were planted.

Planting-time Project

The success or failure of an individual seedling to survive and grow when it is outplanted depends upon many factors, some related to the environment and some related to the seedling. Many of these factors are seasonally variable. In the Ft. McMurray area, one of the major environmental factors affecting seedling performance is moisture availability. This tends to be highest in the spring and lowest in mid-summer, with some increase again occurring in the fall. A seedling characteristic which is seasonally variable is rate of root growth or root regeneration potential. For seedlings to perform best these factors must be compatible.

There is a continuing question as to what time of year to plant seedlings of different species. In order to answer this question a field trial will be initiated in 1982 in which seedlings of a range of species will be planted at 2 week intervals over the entire growing season. Soil moisture availability and plant performance will be monitored at 2 week intervals.

SOIL BIOLOGY

Legume Project

Legumes are an important component of successful revegetation because of their ability to fix atmospheric nitrogen and therefore improve soil fertility. The purpose of this project, which was initiated in 1978, is to identify and develop ways of improving legume

performance. Most of this work has been carried out for Syncrude by Dr. W. Page of the University of Alberta.

Activities in 1973 were largely exploratory. However, in 1979 a 3-year project to isolate and test locally-isolated Rhizobia was begun. Isolations and preliminary screening were carried out in 1979. In 1980 the project was advanced to the pot trail stage.

In pot-trial tests, alfalfa, inoculated with one of several locally isolated Rhizobium strains or a commercial strain, was grown either alone or in competition with bromegrass at 6 levels of N fertility. Where alfalfa was grown alone, there was no significant effect of N fertility level or inoculum strain on alfalfa biomass production or nodulation. However, in the presence of bromegrass there were significant changes. At low N levels the alfalfa grew well and was well nodulated, and the bromegrass grew poorly. At high N levels the bromegrass dominated and the alfalfa grew very poorly and was poorly nodulated. All inocualted alfalfa grew better than the uninoculated controls. However, there was no significant effect of inoculum strain on alflafa performance.

In all of these trials, Rhizobium was applied at very high inoculum dosages. A supplementary trial was performed to investigate the effect of inoculum dosage. In this trial, effective nodules were formed by locally isolated strains at much lower inoculum dosage than for commercial strains. This is a significant observation because, in the field, Rhizobium inocula dosages will probably be relatively low. In field situations the locally isolated strain may give better results.

In 1981, the field trial stage of the project was initiated. In the field-trial, alfalfa, inoculated with three types of inoculants and two methods, was grown on plots on the tailings dyke slope at 4 levels of N fertility. The inoculants were two commercial (Nitragin) preparations and a mixture of locally-isolated (SYN) Rhizobium strains. The inoculant was added to the seed separately in powdered peat or this peat material was coated onto the seed. The seed mixture of alfalfa and grasses with or without inoculant was applied to all the dyke slope plots by hydro-seeding. The field trial was evaluated approximately 1 and 2 months after seeding by measuring plant development, biomass, species cover, alfalfa nodulation and nitrogen fixation effectivity.

A number of preliminary observations were made. The uninoculated plants were well nodulated and nitrogen-fixing. This was due to the high numbers of effective Rhizobium meliloti present in the topsoil mixture on the dyke. The seed coated with the Nitragin inoculant did not perform as well as the bare seed plus peat-based inoculant and only marginally better than the uninoculated plots. The locally-isolated (SYN) inoculant did increase the number of effective plants and produced very large nodules on the plants. A more extensive evaluation of these plots will be made in 1982.

Buffaloberry Inoculation Project

Buffaloberry, a promising reclamation species, is one of a limited group of non-leguminous woody shrubs which is capable of forming nitrogen-fixing root nodules when symbiotically infected with the appropriate actinomycetous endophyte. The purpose of this study, which was initiated in 1979, was to examine the effect of artificially inoculating buffaloberry seedlings on their growth in the greenhouse and later performance in the field.

Shepherdia canadensis seedlings were reared in a controlled environment "growth room" for 3.5 months. They were then outplanted onto a simulated reclamation site adjacent to the AOSERP Mildred Lake Camp. Seedlings were supplied with 4 mg , 35 mg , or no nitrogen over the growth room period. The peat rooting medium was injected with a Frankia (Eunlf) solution at 5 or 9 weeks after germination and control seedlings received only nitrogen-free Crone's solution. Nodulation and seedlings growth and survival were observed after the growth room period (3.5 months after germination) and 2.5 months after outplanting (6 months after seedling germination).

In the greenhouse functional nodules developed only on Shepherdia seedlings which were inoculated with Frankia. Fewer plants became nodulated at the second inoculation than at the first, but more nodules were produced per seedling at the second inoculation. The level of nitrogen that seedlings received did not significantly affect whether or not seedlings became nodulated, and inoculated seedlings receiving 35 mg of nitrogen produced the largest total weight of nodules per plant. After out-planting, virtually all seedlings became nodulated but inoculated seedlings produced a largertotal weight of nodules per seedling than uninoculated seedlings. Again, seedlings supplied with 35 mg of nitrogen before outplanting had the greatest weight of nodules per seedling.

Inoculated seedlings produced the greatest shoot and root weights before and after outplanting in all nitrogen treatments although differences between inoculated and uninoculated seedlings receiving 35 mg of nitrogen were not statistically significant.

Seedling survival over the entire growth room and outplanting periods appeared to be enhanced by inoculation in the 0 mg and 4 mg nitrogen treatments.

SMALL MAMMAL RESEARCH

Population Studies

Cricetid rodent populations have been monitored in several locations on the Syncrude Lease since 1977. The objectives of this project are to determine the densities of potentially harmful rodents, and to determine the effects of density and type of ground cover on abundance of cricetid rodents. Undisturbed mixedwood forests have been found to support the highest density of Clethrionomys gapperi while Microtus pennsylvanicu has been the principal species in cleared and revegetated areas. Both species reached peak densities in 1978 before declining to low numbers in 1979. In 1980 populations started to recover.

Populations will continue to be monitored. Severe seedling damage may occur during years of high Microtus abundance. For example, in 1978, at the time of the Microtus peak, severe damage was observed in the Poplar Creek area. Knowledge of the periodicity and current phase of the population cycle obtained from monitoring of Microtus abundance on selected sites may be useful for prediction of peak population years.

Physical Protection of Seedlings Project

Adjacent to, or on, areas with dense vegetational ground cover, protection of vulnerable tree species may be most cost-effectively accomplished by insertion of a physical barrier between animal and seedling. "Vexar" seedling protectors have been used for this purpose to protect Douglas fir against ungulates, snowshoe hare, and pocket gophers. However, ability of "Vexar" protectors to exclude Microtus has not been examined nor has durability in our climate with respect to cold breakage, snow compression, or frost heave. Also in need of examination is the effect of protectors on seedling growth. Possible adverse effects include shading and root constriction. In 1982, a project is planned to examine Vexar protectors with respect to their effectiveness in preventing rodent damage, their durability and their effects on seedling growth.

Effect of Partial Girdling Project

Complete girdling of stems of tree and shrub seedlings is relatively rare; most damage consists of partial girdling. This damage is assumed to reduce growth and resistance to other agents of mortality. However, there is little information available regarding the extent to which a stem must be girdled before there is a significant effect on growth or mortality or the extent to which girdling above this threshold value adversely affects seedling survival and growth. Without the foregoing information the reclamation cost reduction and hence the cost-effectiveness of various potential plant damage control strategies cannot be estimated. A study to examine this aspect of small mammal damage to planted seedlings is also planned for 1982.

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PROCEEDINGS:

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INTRODUCTION

Last Spring the Provincial Government's Reclamation Research Technical Advisory Committee presented a two day Reclamation Research Seminar at the Chateau Lacombe. We were surprised by the large turnout and an overwhelming majority of those in attendance indicated the desirability of an Annual Reclamation Conference for Alberta which would focus on Policy and Practice as well as Research and which would include industry, academic and government participation.

These were very sensible suggestions though their implementation would exceed the mandate and manpower of the Reclamation Research Technical Advisory Committee. So various groups were contacted to sponsor and help organize the Conference. Positive responses where received from the Canada Land Reclamation Association (CLRA) The Alberta Government's Land Conservation and Reclamation Council, The Coal Association of Canada and The Oil Sands Environmental Study Group (OSESG).

The CLRA authorized formation of an Alberta Chapter to serve as the umbrella organization with a Program Committee consisting of representatives of the Government and the two Industry groups. Through this Conference and perhaps other functions the Alberta Chapter of the CLRA can fulfill two important roles:

1. To provide an opportunity for members of the Reclamation community to meet, exchange experiences or argue and otherwise improve communications among its industry, government and academic factions.

2. To provide a public forum for reclamation activities, capabilities, issues and challenges.

This was the first function of its kind in Alberta. Special thanks are due the Sponsors, Speakers and the other Members of the organizing Committee: Jennifer Hansen, Malcolm Ross and Al Fedkenheuer. Their talents and efforts made the Conference a success.

One final word on the Speakers: they were given very short notice of the Conference and not only responded enthusiastically but prepared presentations which were of remarkable quality and consistency. We are fortunate to have individuals of this caliber working in the Field of Reclamation in Alberta.

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