REVEGETATION RESEARCH

A PROGRESS REPORT ON WORK ACCOMPLISHED IN 1975

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Project Leader and Editor

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INTRODUCTION

This report outlines the progress made in 1975 in the Revegetation Research Program which is co-ordinated through the Botany Section of the Plant Industry Laboratory. This program is a joint research project co-sponsored by Alberta Agriculture, Alberta Environment, Alberta Highways and the Oil Sands Environmental Research Program.

The program was initiated in 1973. That year a detailed provincial survey was done in regard to revegetative growth on newly disturbed areas. The major conclusion from the work of that year related to revegetation possibilities in unfavourable environments. The study showed that revegetation of moist, well drained areas appeared to be no real problem and could be accomplished using agronomic varieties now on the market. However, it became apparent that areas which are not so favourably endowed by nature would prove more difficult to revegetate. For these areas native species and naturalized landraces[1] seemed to offer greater possibilities of success. This assumption was the initiating factor for the work done in 1974.

In 1974 sites were selected throughout the province in order to test the growth possibilities of native species and naturalized landraces. These sites were selected in different areas of the province in an effort to obtain data on as many different micro-environments as possible. By the fall of 1974 34 test sites had been obtained and on 27 of these at least some planting had taken place. The detailed results of this work done in 1973 and 1974 are available in previous years reports.

The work done in the summer of 1975 is a direct continuation of that of 1974. More small sites (see included map) were obtained and these also were planted with rows of test plants. We believe that by now there are sufficient sites throughout the province so that reasonable conclusions can be drawn for most areas in a few years time. The only areas in which additional sites are needed are the foothill and mountain areas, and very specialized sites such as Forestburg and Round Hills. Hopefully sites will be obtained in these areas and they will be planted in the future along with additional planting of native legumes and shrubs at current sites.

In addition to the small sites larger areas have also been obtained to study the possibilities of seed increase of native ecotypes. These sites have also been outlined in this report.

Included in this report is a short evaluation resume of the growth occurring at each site. In most cases the sites were evaluated twice during the course of the year. Very little growth was expected from those sites which were planted this year and this proved to be the case. Those sites which had substantial growth were evaluated for height and vigour. The height evaluation was done using standard techniques while the vigour rating was a subjective rating from 0 - 5, with 0 representing no growth at all above ground and 5 designating an excellent row. In the interest of brevity these results have not been detailed in full but the highlights for each site have been summarized.

It must be emphasized that these are only first year results and conclusions must not be taken as applying with validity for long term extrapolation. Also each site must be taken as a separate entity and comparisons between sites are risky at best. The first tentative conclusions on these early test sites will be specified in two years time.

In the summer of 1975 we were able, for the first time, to collect a reasonable amount of seed from native legumes and shrubs. This has been used to carry out the winter research in the laboratory and will also be used for limited field work in the spring. We expect that more seed from native legumes and shrubs will be needed to properly evaluate the ecotypic variability of various species and thus this seed will be collected in future years.

Also, in 1975 the Plant Industry Division, Soil and Feed Testing Laboratory, analyzed the soil samples taken from each of the actual test sites. Consequently we are now able to relate the ecotypes involved to the overall environment and also to soil properties.

This report also outlines the laboratory research which is underway at present. This research is being carried out in growth chambers and greenhouses supplied by Alberta Agriculture for this program. This laboratory work is reported in five sections:

III Soil Analysis

IV Seed Technology study.

V Testing of grasses on various soil types.

VI Testing of legumes on various soil types

VII A study of the micro-organisms associated with seeds and seedlings.

A report of the Preliminary vegetation survey of the Alberta Oil Sands Area - Bryophytes and Lichens conducted by Dr. P. W. Stringer is also included in this report. This survey was financed by money allocated for the AOSERP Empirical Revegetation Study.

At this time I would like to thank the authors of this report for their work, both in the field and laboratory, and would also like to acknowledge the work of Messrs. Chin Chu, Don Laverty, Lloyd Hodgins, Gerry Wheeler and Terry Steil for their contribution to the success of the project.

A special thank you to Mrs. Alice Dancey for handling the typing of this report and secretarial work whenever needed for the project.

Herman Vaartnou,
Project Leader.

F I E L D   R E S E A R C H

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Alberta Environment

I N T R O D U C T I O N

The field research part of the Alberta Revegetation Research Program is designed to test the adaptability and survival of native species and naturalized landraces of grasses and legumes. The specific criteria used for the selection of appropriate ecotypes have been fully outlined in previous years' reports, but it must be emphasized that desirable agronomic traits such as forage quality and quantity are secondary in revegetation work when compared to aspects such as cover production, biocompetitiveness and disease resistance.

The small test sites throughout the province have been chosen in as unfavorable conditions as possible. Consequently most are on fairly steep slopes and many are on poor soil. The reason for this is that previous work has shown that there is little difficulty in revegetating areas of fertile soil which are moist and well drained.

With a few exceptions, which are noted throughout the body of this report, the sites have been hand planted in rows 36 inches apart. The space between the plants in each row is also 36 inches. Fertilization of these sites has been minimal or nil based on the reasoning that species which need constant fertilization have little use in revegetation work.

The field research section outlines the pertinent attributes of each of the individual sites. Each site which was planted in 1975 has information on the following:

a) An initial page giving locational data, soil properties, time and method of planting, and moisture conditions at the time of planting.

b) Detailed meteorological information.

c) A list of species planted at that site.

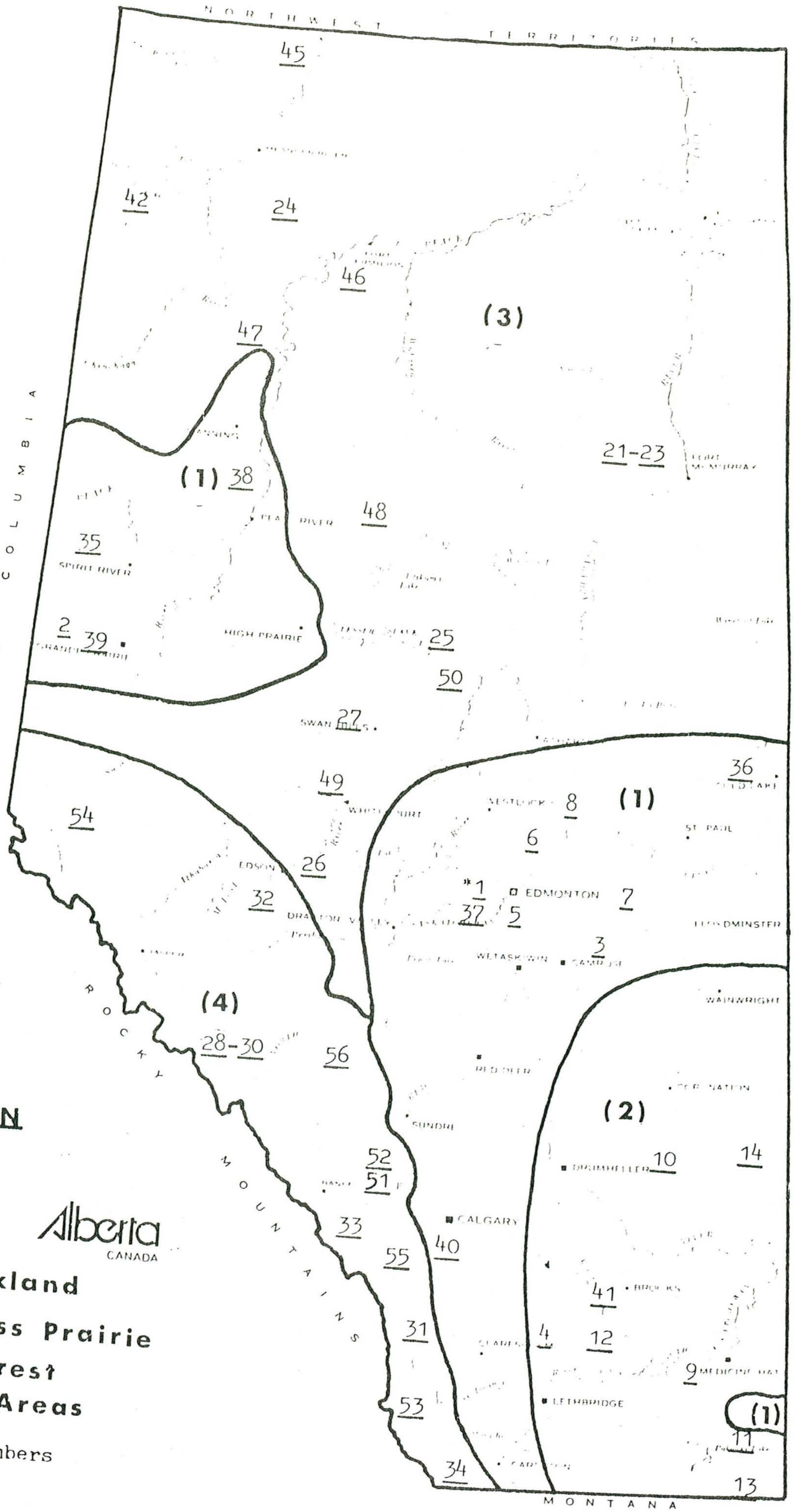
d) A diagram showing the exact location of the site.

e) A short resume of the first year's evaluation of the site.

However, for those sites which were planted in years prior to 1975 sections (b), (c), and (d) of the preceding have been omitted. This has been done to avoid duplication of previous years' reports and, if this information is desired, it can be obtained from the May 1, 1975 report titled "ESTABLISHMENT AND SURVIVAL OF GROUND COVER PLANTINGS ON DISTURBED AREAS IN ALBERTA' by H. Vaartnou and G. Wheeler.

As expected, evaluation after one year's growth proved to be inconclusive and consisted mainly of general observations. The major factors considered this year were height, where differences were discernible; the general health of the plants, quantified into a subjective vigour rating; and analysis of the native ground cover both on and adjacent to the test site.

In future years evaluation will also be able to include important factors such as resistance to winterkill and increase in ground cover through spreading via rhizomes.



REVEGETATION

TEST SITES

Alberta
CANADA

(1) Aspen Parkland

(2) Short Grass Prairie

(3) Boreal Forest

(4) Mountain Areas

* Test Site Numbers

ALBERTA BEACH #1

Location:

Alberta Beach turnoff on Highway 43, junction of Highways 43 and 33, south west corner

Longitude - 114° 50' W.

Latitude - 53° 45' N.

Legal - 34 - 54 - 14 - W5

Elevation - 750 meters.

Notes:

Ecological Zone - Aspen Parkland

Aspect - 30° E. - N.E. - facing slope

Soil Type - Dark Grey, sandy clay soil

Moisture - good 1/2" down (1.25 cm.)

Disturbance of soil - topsoil scraped off, b and c horizons mixed.

Method/Date of seeding -

cover crop: hydro-seeder; July 3, 1974

test plants: planted by hand; July 4, 1974

Fertilizer - 100 lb/acre of 36-10-0

Average frost-free period - 102 days; May 27- Sept. 6

Soil Properties:

Slightly calcareous soil with a pH of 7.70

Low in plant nutrients.

O B S E R V A T I O N S

This site was planted on June 4, 1974 with both test row plants and a ground cover crop being planted. Growing conditions at this site are excellent and it is one of the two or three best sites throughout the province. The cover crop has come in very well on both the test site and adjacent area. Legumes here are very dominant with the major species being *Medicago sativa, Onobrychis sp., Trifolium pratense* and some *Lotus corniculatus*. The more dominant of the grasses in the cover crop are *Bromus inermis, Phleum pratense* and *Agropyron trachycaulum.*

The test rows were evaluated on August 1, 1975 both for vigour and for height. Nearly all of the species were very strong with the following receiving vigour ratings of 5: *Festuca rubra 22, Poa pratensis 39, Poa palustris 41, Agropyron sp. 54, Agrostis gigantea 59, Poa ample 86,* and *Agropyron smithii 48.* Others, which were only slightly less vigorous and received a 4 rating included *Koeleria cristata 32, Phleum pratense 35, Puccinellia sp. 43, Elymus innovatus 69, Phleum sp. 81, Poa compressa 87,* and *Trifolium medium 119.*

All but three of the other ecotypes received a rating of 2 or 3. The three ecotypes which were not initially successful and received a rating of 1 or 0 were *Agrostis sp. 16, Hedysarum alpinum 107* and *Oxytropis sp. 158.*

From a height standpoint there were no unexpected discrepancies. The taller species such as *Phleum, Elymus, Bromus,* *Deschampsia* and *Agropyron trachycaulum* were all 24" or more. Of the taller varieties only *Agropyron smithii* was shorter than might be expected as it was only 10" high. Of the shorter growing varieties such as *Poa spp.*, *Festuca spp.*, *Koeleria sp.*, and *Puccinellia sp.* only the *Koeleria* and *Puccinellia* were shorter than 12" and even these were extremely vigorous plants. The two successful legumes, *Medicago falcata* and *Trifolium medium* were not as tall as they will be in subsequent years but appeared very healthy.

At this site the most outstanding ecotype was *Poa palustris* 41. This ecotype was extremely healthy and had achieved a height of 20". Also it appeared to be producing seed in large quantities.

In general this site substantiates the conclusions made in the original year of this program that there are few difficulties in revegetating disturbed areas which have good soil, adequate moisture and good drainage patterns. Of significance for future years at this site will be the effects of winterkill and the ability of the test plants to spread via rhizomes so as to obtain greater ground coverage.

B E A V E R L O D G E # 2

Location:

3.5 miles (5.7 km.) east on Secondary Highway 722
from Federal Agricultural Research Station.
Longitude - 119° 20' W.
Latitude - 55° 15' N.
Legal - 34 - 71 - 9 - W6
Elevation - 750 meters

Notes:

Ecological Zone - Aspen Parkland
Aspect - Level
Soil Type - grey wooded
Moisture - fair
Disturbance of Soil - undisturbed except preparation for seeding.
Method/ Date of seeding -
cover crop: not planted
test plants: row seeder, Aug. 1973
Fertilizer - 300 lb./acre of 10 - 20 - 10
Average frost-free period - 113 days; May 19 - Sept. 10

O B S E R V A T I O N S

This site was originally planted in August, 1973 using a row seeder. At the time of planting no cover crop was put in as this site was designed to be a seed increase area. Consequently plots of *Agropyron trachycaulum* 326 and *Agrostis tenuis* 329 were planted. These plots were fertilized and good growth occurred over the last two years. Thus at the end of the 1975 growing season substantial quantities of seed were harvested from both species. (At present exact quantity still unknown).

In 1976 this site will probably be abandoned as the seed increase plots have been transferred to other areas.

CAMROSE #3

Location:

15.9 miles (25.5 km.) east of Camrose on Secondary Highway 926 on north side of road.

Longitude - 112° 30' W.

Latitude - 53° 0' N.

Legal - 3 - 47 - 17 - W4

Elevation - 700 meters

Notes:

Ecological Zone - Aspen Parkland

Aspect - top half level, bottom half 10° S. - facing slope

Soil Type - Black, clay-sandy clay soil

Moisture - good

Disturbance of soil - topsoil raked, scraped off in parts, surface hard, preparation nil

Method/Date of seeding -

cover crop: cyclone seeder; July 25, 1974

test plants: planted by hand; July 25, 1974

Fertilizer - 100 lb/acre of 10 - 30 - 10 and 100 lb/acre of 21 - 0 - 0

Average frost-free period - 102 days: May 27 - Sept. 6

Soil Properties:

Soil samples range between neutral and slightly neutral in reaction. Salinity is a problem but most plants would only be slightly affected by the measured levels. Sulphur and Na levels are high and are the main cause of the high salinity levels. Total mineral, N, P, and K levels are adequate. The samples are calcareous and also low in organic matter.

O B S E R V A T I O N S

This site was one of the first to be put in by this research program as it was originally planted on July 25, 1974. Consequently one might expect more advanced growth here and this proved to be the case when the site was evaluated in June and late July 1975.

When this site was evaluated in June only two ecotypes, *Agropyron trachycaulum 8* and *Agrostis gigantea* 59 were given vigour ratings of 5. At the other end of the scale eight ecotypes were given a rating of 1 and ten ecotypes were rated at two. At this time it appeared that all ecotypes had germinated but many were still extremely weak.

However when the final evaluation of this site was made on July 22, 1975 the situation had changed considerably. At this time the number of ecotypes receiving a 5 rating had doubled to four. In addition to the aforementioned two, both *Medicago sativa* and *Festuca rubra* 24 were now also rated at 5. A greater difference was observed in the amount of weak ecotypes. Of the original eight ecotypes receiving a rating of 1 only two were still rated that low. These were *Glyceria sp. 30* and *Trifolium hybridum 117.* Also only three ecotypes remained with a rating of 2. These were *Festuca scabrella 27, Agropyron subsecundum 4,* and *Poa pratensis 92.* Thus from an original eighteen ecotypes which appeared quite weak only five were still in that category at the time of final evaluation.

The height evaluation disclosed no real surprises. The taller species such as *Elymus spp.*, *Agropyron spp.*, and *Phleum spp.*, ranged anywhere from 12" to 28" tall. Of these the tallest was *Agropyron trachycaulum 8*, which reached a height of 28". The shorter growing species such as *Poa spp.*, and *Festuca spp.* were between 6" and 10". The legumes were still quite small but most were very healthy. The tallest of the legumes was *Medicago sativa 111* which had reached a height of 6".

One point regarding this site which must be noted is the discrepancy in growth between Rep 1 and Reps 2 & 3. More specifically in Rep 1 rows 4 - 25 have no plants on the slope of the site. In other words there is no growth from the location of the third to the sixth plant inclusive. It is very unlikely that the slope of the site has anything to do with this as Reps 2 & 3 have the same slope but have growth throughout the Rep. In order to help ascertain the reason for this six additional soil samples were taken from this Rep and will be analyzed.

The ground cover Rep adjacent to the test plants is growing extremely well. This Rep has close to 95% cover with several of the grasses as high as 42". There is a marked difference between our rep and the ordinary roadside ground cover. Our rep is dominated by *Agropyron trachycaulum*, *Bromus inermis*, *Agropyron cristatum*, *Elymus innovatus* and *Medicago sativa*. Also present are lesser amounts of *Poa spp.*, *Agropyron smithii*, and *Phleum pratense*.

After one year's growth this site is one of the most successful throughout the province.

CHAMPION #4

Location:

Approximately 1 mile (1.6 km.) south of Champion
on east side of Highway 23
Longitude - 113^{o} 5' W.
Latitude - 50^{o} 15' N.
Legal - 30 - 14 - 23 - W4
Elevation - 975 meters.

Notes:

Ecological Zone - Aspen Parkland
Aspect - level
Soil Type - Saline soil, slightly lumpy.
Moisture - fair 2" - 3" down.
Disturbance of Soil - undisturbed.
Method/Date of seeding -
cover crop: broadcast by hand; May 28, 29, 1974
test plants: planted by hand; June 12, 1974
Fertilizer - 200 lb/acre of 34-0-0 and 200 lb/acre of 11-55-0
Average frost-free period - 120 days; May 20 - Sept. 18

Soil Properties:

Mildly alkaline soil adequately supplied with plant nutrients. Due to above average amounts of free soluble sulphate there is a slight salinity problem on the East half of the site.

O B S E R V A T I O N S

This site was originally planted in the spring of 1974. In late May of 1974 a cover crop was put on and then on June 12, 1974 the test plants were put in. Unfortunately this was somewhat poor timing as the cover crop took hold very well and were already 3" tall by July of 1974. Unfortunately when the test plants were put in there was a shortage of moisture and thus between this lack of moisture and the competition from the cover crop the test rows had very little chance to survive. This was already extremely noticeable in the 1974 evaluation of the site.

In 1975 this site was observed on June 18, August 7, and October 25, 1975. The first two evaluations showed an excellent ground cover crop mixed in with extensive weeds. However there was little or no sign of the test plants. These results were expected because the site has been extensively fertilized by the Government Soil Salinity Program and so those plants which managed to germinate should be, and are, thriving. In contrast it appears that the test row plants did not have a chance to germinate.

For the October evaluation the site had been cut to a height of 4" but still very few of the test plants were evident. Consequently an evaluation of this site will be made in early 1976 and if the previous observations are again confirmed it will either be abandoned or replanted.

ELLERSLIE #5

Location:

2 miles (3.2 km.) west from Highway 2 on Ellerslie Road north side of road.

Longitude - 113° 30' W.

Latitude - 53° 0' N.

Legal - 25 - 51 - 25 - W4

Elevation - 700 meters

Notes:

Ecological Zone - Aspen Parkland

Aspect - level

Soil Type - Dark Grey

Moisture - good

Disturbance of Soil - undisturbed

Method/Date of seeding.

cover crop: not planted

test plants: planted by hand; May - Sept. 1973, 1974 and 1975

Fertilizer - nil

Average frost-free period - 102 days; May 27 - Sept. 6

Soil Properties:

Soil is slightly acid in reaction and is adequately supplied with nutrients. Organic matter levels are high.

O B S E R V A T I O N S

The original plantings at this site were put in in 1973. At that time 26 rows of grasses were planted in continuous rows. In 1974 an additional 48 rows of grasses and legumes were planted in a similar manner. In 1975, 26 additional rows were planted but of these only 14 were additional grasses and legumes. The other rows consist of 4 rows of Salix spp. and 8 rows of individual grass and legume plants which were planted for largely identificational purposes.

The other 88 rows which have been planted over the last three years have been designed for preliminary seed increase work. So far results have been encouraging with seed being harvested in 1975 from nearly all of the ecotypes planted in 1973 and 1974. In fact the only major exceptions to this statement were the two rows of *Agropyron cristatum* (324 & 262) which were struck by ergot and so were not harvested.

As this is only a small site many of these ecotypes may be transferred to a different area in the future so that more intensive seed increase testing can be carried out. If this occurs then this area will again be used to increase the initially small stock of seed of other ecotypes.

REDWATER #6

Location:

North 4 miles (6.4 km.) on Highway 28 from Redwater, after Shell service station turn 3/4 miles (1.2 km) west, then 1/4 mile (0.4 km.) north.

Longitude - 113° 10' W.

Latitude - 54° 0' N.

Legal - 15 - 58 - 22 - W4

Elevation - 600 meters

Notes:

Ecological Zone - Aspen Parkland

Aspect - level

Soil Type - black

Moisture - good

Disturbance of Soil - undisturbed, packed after seeding, oil on certain parts.

Method / Date of seeding -

cover crop: cyclone seeder; Aug. 30, 1974.

test plants: not planted.

Fertilizer - 300 lbs./acre of 34-0-0 and 100 lb./acre of 11-48-0

Average frost-free period - 102 days; May 27 - Sept. 6.

Soil Properties:

At time of sampling, both oil-treated and untreated areas of the fall-seeded plots appear to be adequately supplied with nutrients with the exception of K. Nutrients in the plots to be seeded in spring indicate that fertilizers are required on the oil-treated plots. The oil-free plot to be seeded is moderately supplied with nutrients; however the K level is low.

O B S E R V A T I O N S

The Redwater test site was specifically designed to observe the effects of oil spills on vegetative growth. In August of 1974 six reps were set out and then three of these were flooded with oil by the Department of Soil Sciences of the University of Alberta. Each rep of 1440 sq. ft. received spillage of 540 gallons of oil. In these three reps the oil content of the soil should be around 6.9% by weight.

Each of the six reps was then divided into two with one half of each rep being seeded on August 30, 1974 and the other half on May 28, 1975. These reps were then evaluated on July 2, 1975.

As could be expected the three reps which had the oil spilled onto them showed no growth of any kind. This applied to both the spring and fall seeding portions. In contrast the three reps without the oil were all thriving - with both the spring and fall seeded halves doing well. It appeared that the grasses on these reps were all thriving regardless of when they were seeded. However there was a difference in the growth of the legumes on these reps. The legumes which had been included in the fall planting had failed to germinate but the legumes in the spring planting were starting to emerge with *Medicago sativa* being the strongest.

In subsequent years the oiled plots may be reseeded to test the longevity of the effects of the oil spill.

VEGREVILLE #7

Location:

1000 feet (300 meters) east of weather station on Vegreville Solonetzic Soil Substation.

Longitude - 112° 0' W.

Latitude - 53° 30' N.

Legal - 17 - 52 - 14 - W4

Elevation - 650 meters.

Notes:

Ecological Zone - Aspen Parkland

Aspect - level

Soil Type - Solonetzic Soil

Moisture - poor

Disturbance of Soil - fallow in 1974, ready for planting spring 1975, (shaded area - thin Ap horizon)

Method / Date of seeding - May 20, 1975

cover crop: Cyclone seeder

test plants: Drill seeder

Fertilizer - no fertilizer used.

Average frost-free period - 90 days; June 5 - Sept. 4.

Soil Properties:

In the centre of the site, the sodium and sulphate levels are high, which account for relatively high measured salinity. However the soil itself is slightly acid. Mineral nitrogen level ranges between medium and high.

VEGREVILLE #7

1 *Agropyron riparium* cv. Streambank
2 *Agropyron smithii*
3 *Agropyron sp.*
4 *Agropyron subsecundum*
5 *Agropyron trachycaulum*
6 *Agropyron yukonenses*
7 *Agrostis gigantea 1*
8 *Agrostis gigantea 2*
9 *Agrostis sp.*
10 *Agrostis tenuis*
11 *Alopecurus pratensis*
12 *Astragalus cicer*
13 *Bromus inermis 1*
14 *Bromus inermis 2*
15 *Calamagrostis inexpansa*
16 *Coronilla varia*
17 *Elymus canadensis*
18 *Festuca ovina*
19 *Festuca rubra* cv. Reptans
20 *Festuca scabrella*
21 *Lotus corniculatus*
22 *Medicago sp.*cv. Drylander
23 *Medicago sp.*cv. Kane
24 *Onobrychis sp.* cv. Melrose
25 *Poa ampla*
26 *Poa compressa*
27 *Poa glaucantha*
28 *Poa palustris*

VEGREVILLE # 7 CONT'D

29 *Poa pratensis 1*

30 *Poa pratensis 2*

31 *Puccinellia nuttalliana*

32 *Trifolium pratense*

O B S E R V A T I O N S

This site was planted on May 20, 1975. It differs slightly from the other sites in that one of the reps only had a ground cover planted by cyclone seeder while the other rep only had test row plants put in by hand. Also this was one of the few sites planted in 1975 which were fertilized. The reason for this fertilization was that the site is located on very solonetzic soil, being, in fact, on the Vegreville Solonetzic Soil Substation. However, because of this fertilization and being in a generally favourable growing environment, this site was the most successful of the sites planted in 1975.

Evaluation of the site took place on August 14, 1975 and again on September 27, 1975. Nearly all of the ecotypes in test rows were very successful at both the northern and southern ends of the site. The middle portion of the site is generally weak, although the legumes are not affected as badly as the grasses. The reason for this lack of growth is that the soil in the middle of the site is much more solonetzic than at either end. The August evaluation showed no abnormalities in the heights of the various ecotypes so major emphasis was placed on the vigour evaluation.

Of the thirty-two test rows ten received vigour ratings of 5. These included five legumes; *(Coronilla varia 253, Medicago sp. cv. Kane 251, Trifolium pratense 250, Medicago sp. cv.* Drylander 250, and *Lotus corniculatus 109)* and also five ecotypes of grasses; *(Festuca scabrella 26, Bromus inermis 366, Poa glaucantha 202,* *Agrostis sp. 277,* and *Festuca rubra* cv. Reptans 24). Of the other ecotypes six rows were rated at 4, nine rows at 3 and three rows at 2.

Only four of the rows were so weak as to receive a rating of 1 or 0. These were the grasses *Poa ampla 36, Calamagrostis inexpansa 275, Agropyron yukonense 313,* and *Agrostis tenuis 297.*

The adjacent rep which only received a ground cover seeding also showed excellent growth. Ground cover here was around 90% with the dominant species being *Festuca rubra, Bromus inermis* and *Trifolium hybridum.* One point which should be noted is that both reps were extensively invaded by weeds - this no doubt being an unwanted side effect of the fertilization.

In future years additional ecotypes will be test planted on the third rep which is at present vacant. Also the growth habit of the present plants will be studied with particular emphasis being placed on the middle third of the rep which shows very weak growth in the first year.

WASKATENAU #8

Location:

10 miles (15 km.) north of Highway 28 on Secondary Highway 831. Two test sites.

Longitude - 112° 50' W.

Latitude - 54° 20' N.

Legal - 28 - 60 - 19 - W4

Elevation - 650 meters.

Notes:

Ecological Zone - Aspen Parkland

Aspect - level

Soil Type - thin black

Moisture - good

Disturbance of soil - undisturbed

Method / Date of seeding

cover crop: not planted

test plants: row seeder, some hand planted; Aug. 1974.

Fertilizer - 400 lb./acre of 10-20-10

Average frost-free period - 102 days:

May 27 - Sept. 6

Soil Properties:

Both areas are moderate in their plant nutrient levels; P level in the pig-pen plot, however is low.

OBSERVATIONS

This site was initially planted in 1974 for purposes of seed increase testing. At present there are 53 ecotypes in one row plots which are each 200 feet long, 30 ecotypes in plots of five rows each and six one-half acre plots.

As with Ellerslie, the results so far have been encouraging as seed has been collected from nearly all of the ecotypes planted in 1974. As these plots mature more detailed reports will be available in future years. At present the most successful of the 1/2 acre plots is #5 which has *Festuca rubra*. The other large plots #2,3, & 4, containing *Agropyron smithii*, *Agropyron sp.*, and *Poa pratensis* respectively, were all less than mediocre.

The final two plots, #1 - *Poa ampla* & #6 - *Astragalus cicer* were not doing well and may be destroyed and replanted in 1976. However as was mentioned these plots were planted in late 1974 and so have had only one growing season in which to produce seed. Thus reports of following years will be much more accurate in describing the possibilities for success with these ecotypes.

BOW ISLAND #9

Location:

9 miles (14.4 km.) east of Bow Island on north side of Highway 3.

Longitude - 111° 15'

Latitude - 49° 50'

Legal - 5 - 11 - 9 - W4

Elevation - 825 meters.

Notes:

Ecological zone - Short Grass Prairie

Aspect - 10° N. - facing slope

Soil Type - fine, powder-like brown soil

Moisture - very dry

Disturbance of soil - top 15 cm. of soil replaced.

Method / Date of Seeding:

cover crop - hand planted; Sept. 25/74

test plants - hand planted; Sept. 25/74

Fertilizer - 100 lb./acre of 10-30-10 and

100 lb./acre of 21-0-0

Average frost-free period - 125 days;

May 17 - Sept. 20.

Soil Properties:

Moderately alkaline soil due to presence of large amounts of free lime. Very low Phosphorus level could cause problems.

BOW ISLAND # 9

1 *Agropyron cristatum* cv. Summit
2 *Agropyron riparium* cv. Sodar
3 *Agropyron smithii*
4 *Agropyron sp.*
5 *Agropyron trachycaulum* cv. Revenue
6 *Agrostis gigantea*
7 *Astragalus cicer*
8 *Bromus inermis* cv. Magna
9 *Coronilla varia*
10 *Elymus canadensis*
11 *Elymus innovatus*
12 *Elymus junceus* cv. Sawki
13 *Festuca ovina*
14 *Festuca rubra* cv. Boreal
15 *Medicago sp.* cv. Kane
16 *Onobrychis sp.* cv. Melrose
17 *Phleum pratense* cv. Climax
18 *Poa ampla*
19 *Poa pratensis*
20 *Puccinellia nuttalliana*
21 *Trifolium hybridum* cv. Dawn

O B S E R V A T I O N S

This site was originally planted in June, 1974. However the June, 1975 evaluation showed that this site had been completely regraded by the Department of Highways and that there was no growth of the previous year's test plants. Thus this site was replanted on June 18, 1975.

When this site was again observed on September 4, 1975 it was apparent that the same thing had happened again. The reason for this is that Highway 3 is currently being made into a four lane highway. Thus no plant growth was evident.

If still no growth is evident at the time of the spring 1976 evaluation this site will have to be abandoned or replanted in an area where highway construction will not disturb it one more time.

BULL POUND #10

Location:

19 miles (30.4 km.) south on Highway 36 from junction with Highway 9. Then 1 mile (1.6 km.) west and 1 mile (1.6 km.) north.

Longitude - 111° 50'

Latitude - 51° 20'

Legal - 6 - 28 - 13 - W4

Elevation - 800 meters.

Notes:

Ecological Zone - Short Grass Prairie

Aspect - level

Soil Type - brown

Moisture - poor

Disturbance of Soil - undisturbed

Method / Date of Seeding -

cover crop - not planted

test plants - hand planted (in native sod) Oct. 25/74 and May 1, 1975.

Fertilizer - none used

Average frost-free period - 114 days; May 22 - Sept. 15.

Soil Properties:

This neutral soil is poorly supplied with nutrients with the exception of K. The sodium level is relatively high.

BULL POUND #10

1 *Agropyron cristatum* cv. Fairway

2 *Agropyron riparium* cv. Sodar

3 *Agropyron smithii*

4 *Agropyron trachycaulum*

5 *Bromus inermis*

6 *Bromus inermis* cv. Magna

7 *Elymus junceus* cv. Sawki

8 *Festuca ovina*

9 *Festuca rubra* cv. Arctared

10 *Festuca scabrella*

11 *Koeleria cristata*

12 *Medicago sp.* cv. Drylander

13 *Medicago sp.* cv. Kane

14 *Poa ampla*

15 *Poa compressa*

16 *Poa pratensis*

17 *Poa pratensis* cv. Fylking

O B S E R V A T I O N S

Test rows were hand planted at this site on two different occasions. The first planting occurred on October 25, 1974 when three small reps containing just three legumes and three different ecotypes of *Elaeagnus commutata* were planted. This spring on May 1, 1975 three additional reps containing seventeen rows of grasses and legumes were also planted.

The site was then evaluated on June 17, 1975 and October 17, 1975. The first evaluation showed that there had been no germination of the reps which were planted in 1974. Also, at this time, the grasses and legumes planted in 1975 had not yet emerged above ground.

On October 17, 1975 there was still no germination of the seeds planted in 1974 and so, if at the time of spring evaluation in 1976 the results are still negative these reps will then be abandoned. However at the time of this second evaluation the grasses planted in 1975 were now slightly visible. They were still too small to evaluate but if they survive the winter some data should be obtainable in 1976.

Ground cover on and adjacent to our reps is around 80%. On the 1974 reps the most prominent grasses are *Stipa spartea* and *Koeleria cristata*. Also in evidence are species such as *Artemesia spp.*, *Saxifraga spp.*, *Solidago sp.*, *Muhlenbergia sp.* and *mosses*. On the 1975 reps the ground cover is similar but also contains *Agrostis scabra*, *Poa canbyi*, and *Agropyron sp.*

ELKWATER #11

Location:

13.4 miles (21.5 km.) south of Elkwater on Highway 48.

Longitude - 110° 10'

Latitude - 49° 30'

Legal - 8 - 6 - 2 W4

Elevation - 1125 meters.

Notes:

Ecological Zone - Short Grass Prairie

Aspect - level

Soil Type - dark brown clay soil

Moisture - poor

Disturbance of Soil - top soil removed

Method / Date of Seeding -

cover crop - cyclone seeder; Sept. 24/74

test plants - hand planted ; Sept. 24/74

Fertilizer - 100 lb./acre of 10-30-10 and
100 lb./acre of 21-0-0

Average frost-free period - 125 days;
May 17 - Sept. 20.

Soil Properties:

Large amounts of free soluble sulphates create a highly saline soil. High sodium levels cause a poor physical structure. Heavy textured soil which is adequately supplied with plant nutrients.

O B S E R V A T I O N S

This site was planted on September 24, 1974 with both a cover crop and test rows being put in. It differs from the other sites in that the rows are continuous, while in other sites the test plants are approximately one yard apart. The 1975 evaluation of this site was done on June 18 and August 6.

The June evaluation showed the cover crop to be coming in well with about one half of the test rows in solidly. At this time the strongest rows were *Festuca rubra cv.* Arcta red 154, *Poa ampla 84, Agrostis gigantea 58, Poa ampla 86, Agropyron subsecundum 4,* and *Festuca ovina 21.* Both the cover crop and the test rows were around 2" tall.

The August evaluation confirmed these results. At this time only two ecotypes, *Festuca scabrella 28* and *Lotus corniculatus* 109 received vigour ratings of less than 2. At the other end of the scale the ecotypes receiving maximum ratings of 5 were *Agropyron smithii 47, Agrostis gigantea 58* and *Festuca ovina 21.* Of the other ecotypes five received a rating of 4, five received a 3 rating and four received a 2 rating.

From the height aspect all ecotypes were still very short as the tallest was *Deschampsia* sp. 66 which was 7" tall. The other grasses were around 3" high but in most cases the plants seemed very healthy.

Prior to planting there was no ground cover on the site as it is in an area which had just been disturbed by highway construction. Even one year later ground cover adjacent to the site is less than 1%. Consequently the cover which is on the site is that which was planted by this research program at the same time as the planting of the test rows. This crop has come in very well and covers 85% of the site. In fact the cover crop is much more dominant than the test rows as the plants are generally from 6" - 10" high. This cover consists largely of *Agropyron cristatum*, *Agropyron trachycaulum*, *Elymus sp.*, *Poa sp.*, and *Medicago sp.*

As mentioned earlier there is literally no ground cover adjacent to the site but vegetation in the vicinity includes *Poa canbyi*, *Agropyron smithii*, *Thermopsis sp.*, and *Lupinus sp.* *Festuca scabrella* is also to be found in the nearby area.

In future years a point worth observing is whether or not the cover crop continues to outperform the test row plants.

ENCHANT #12

Location:

4 miles (6.4 km.) east and 1 mile (1.6 km.) south of Enchant

Longitude - 112° 15'

Latitude - 50° 10'

Legal - 12 - 14 - 18 - W4

Elevation - 800 meters.

Notes:

Ecological Zone - Short Grass Prairie

Aspect - level

Soil Type - lumpy brown solonetzic soil

Moisture - poor

Disturbance of soil - undisturbed

Method / Date of seeding -

cover crop - broadcast by hand; May 29/74

test plants - seeded by hand, June 13/74

Fertilizer - none used

Average frost-free period - 120 days; May 20 to Sept. 18

Soil Properties:

Ranges from strongly alkaline on the North half to slightly acid on the South half. Contains sufficient plant nutrients.

OBSERVATIONS

This site was originally planted in the spring of 1974 with first a ground cover crop put in and then three reps of test plants. This site is similar to the Champion test site in that it is on a government soil salinity project site. Two months after the original planting a preliminary evaluation was done. At this time the ground cover crop was coming in well but less than 10% of the test plants had germinated. Similar to Champion it appeared that the three week head start of the cover crop had placed it in a much stronger bio-competitive position than the test plants.

This site was evaluated on June 18, 1975 and October 16, 1975. These evaluations confirmed the preliminary observations of 1974. Once again the cover crop was coming in well with about 75% success. The most successful species in this cover crop were *Agropyron cristatum, Agropyron trachycaulum, Agropyron smithii and Festuca sp.* On the other hand the rows of test plants were nearly unnoticeable.

Ground cover adjacent to the site was quite extensive - upwards of 75% - with the dominant two species being *Koeleria cristata* and *Stipa spartea.*

This site is still useful for observations on the over-wintering ability of the ground cover crop but if specific native ecotypes are to be tested new reps will have to be planted in 1976.

ONEFOUR #13

Location:

3.2 miles (5.1 km.) southeast of Onefour
Experimental Station
Longitude - 110° 30'
Latitude - 49° 10'
Legal - 15 - 2 - 4 - W4
Elevation - 950 meters

Notes:

Ecological Zone - Short Grass Prairie
Aspect - level
Soil type - fine, light brown soil
Moisture - poor
Disturbance of soil - undisturbed (cultivated although much sod still left)
Method / Date of seeding -
cover crop - cyclone seeder; Oct. 22/74
test plants - hand planted; Oct. 22/74
Fertilizer - 100 lb./acre of 10-30-10 and
100 lb./acre of 21 - 0 - 0.
Average frost-free period - 124 days:
May 20 - Sept. 22.

Soil Properties:

Neutral to slightly alkaline soil with an adequate supply of plant nutrients.

O B S E R V A T I O N S

This site was originally planted on October 22, 1974 and was then evaluated on June 18, 1975 and September 4, 1975. The June evaluation showed that all of the test rows were coming in well but the site also had extensive weed ground cover.

The September evaluation reconfirmed the June observations - in fact by September the growth at this site was better than at any around the province. On a more specific basis there were no rows so weak as to received either a 1 or 0 rating. At this site eight rows were given vigour ratings of 5, two rows received a rating of 4, three rows a rating of 3 and five rows received a 2 rating. Even the rows which received a rating of 2 had germinated but were not as healthy as the others.

As a group the weakest genus at this site was the five ecotypes of *Poa sp*. They all received a rating of 2 or 3. In comparison, of the rows of *Agropyron spp.*, five of seven received a rating of 5. One *Festuca* (240), one *Bromus* (242) and the *Elymus* (249) also received a rating of 5. In subsequent years this will be an important point to observe as some of the *Poas* may well surpass the *Agropyrons*.

From a height standpoint there were no discrepancies but all of the ecotypes were rather short as compared to the adjacent ground cover. Ground cover on the site was around 90% consisting very largely of weeds. Major grasses in this cover were *Agropyron cristatum* and *Agropyron smithii*. Ground cover adjacent to the site was similar with the addition of some *Festuca sp.*, *Poa sp.*, and *Elymus sp*.

SOUNDING CREEK #14

Location:

12.5 miles (20.0 km.) north of Excel, then 4.5 miles (7.2 km.) west and 0.7 miles (1.1 km.) north

Longitude - 110 ° 40'

Latitude - 51° 40'

Legal - 20 - 30 - 5 - W4

Elevation - 725 meters

Notes:

Ecological Zone - Short Grass Prairie

Aspect - level

Soil type - brown

Moisture - dry

Disturbance of soil - undisturbed

Method / Date of seeding -

cover crop - not planted

test plants - hand planted; Oct. 25/74 and May 2, 1975.

Fertilizer - none used

Average frost-free period - 111 days;

May 25 - Sept. 13

Soil Properties:

Neutral to slightly acid soil containing sufficient plant nutrients.

SOUNDING CREEK #14

1 *Agropyron cristatum* cv. Fairway
2 *Agropyron riparium* cv. Sodar
3 *Agropyron smithii*
4 *Agropyron trachycaulum*
5 *Bromus inermis*
6 *Bromus inermis* cv. Magna
7 *Elymus junceus* cv. Sawki
8 *Festuca ovina*
9 *Festuca rubra* cv. Arctared
10 *Festuca scabrella*
11 *Koeleria cristata*
12 *Medicago sp.* cv. Drylander
13 *Medicago sp.* cv. Kane
14 *Poa ampla*
15 *Poa compressa*
16 *Poa pratensis*
17 *Poa pratensis* cv. Fylking

O B S E R V A T I O N S

This site is similar to Bull Pound Creek in that test rows were planted here at two separate times. The original planting of three legumes and two ecotypes of *Elaeagnus commutata* took place on October 25, 1974 while on May 2, 1975 an additional seventeen rows of grasses and legumes were hand planted.

Evaluation of this site took place on June 17, 1975 and on October 19, 1975. The June evaluation showed no growth in either the 1974 or the 1975 plantings. The October evaluation showed a similar situation to that of Bull Pound Creek. In other words, the seeds planted in 1974 have not emerged at all, but those planted in 1975 are now slightly visible. However as they were less than 1/4" high they were too small to really evaluate. The reps planted in 1974 will be abandoned unless there is evidence of growth at the time of the spring 1976 evaluation.

This site is on native rangeland and has a ground cover around 85 - 90%. It consists almost exclusively of mosses and *Saxifraga spp*. The only grass of significance is *Koeleria cristata*. Adjacent ground cover is also very thick and includes the grasses *Poa pratensis*, *Stipa spartea*, and *Agrostis scabra* while nearby are clumps of *Rosa acicularis* and *Symphoricarpos occidentalis*.

SYNCRUDE #15-20

OBSERVATIONS

In 1974 six test sites were selected on Syncrude property for planting in 1975. Soil samples were taken and analyzed as detailed in the May, 1975 progress report. However when the time came to plant these sites it was no longer possible.

The reason for this is that over the winter of 1974-75 Syncrude construction activities had made these sites unusable because of grader activities. Thus these six sites (#15-20 in the May, 1975 report) have had to be abandoned as possible test areas.

Future test sites in this area will depend upon the availability of new test sites which will not be subject to construction activity for a period of several years.

G. C. O. S. # 21

Location:

Located in Waste Dump #5 on G.C.O.S. plant site

Longitude - 111° 30' W.

Latitude - 57° 0' N.

Legal - 13 - 92 - 10 - W4

Elevation - 250 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - 25° - 30° S. - facing slope

Soil Type - mixture of lean tar sand, glacial till, overburden.

Moisture - good

Disturbance of soil - disturbed in that soil is deposited waste material

Method / Date of seeding:

cover crop: cyclone seeder; June 5, 6, 1974.

test plants: planted by hand; June 26, 1974.

Fertilizer - 50 lb./site of 21-0-0- and
50 lb./site of 10-20-10

Average frost-free period - 69 days;
June 15 - Aug. 24

Soil Properties:

Both fertilized and unfertilized sites are slightly alkaline and also have the highest salt levels tested. The electrical conductivity of the unfertilized site would restrict the yield of crops which are salt-sensitive; the level at the fertilized site

G.C.O.S. # 21 continued -

has been raised to a level that would restrict the yield of many crops. Both sites contain some crude oil, the level of which is up to 1.0 percent at the fertilized site. Mineral and total N levels tested low at both sites; mineral nitrogen level was slightly higher on the fertilized site. Cation exchange capacities are low; the sample taken from the unfertilized site is highly calcareous. Levels of organic carbon are medium at both sites; phosphorus level was high, however, only on the fertilized site.

FORT MCMURRAY #21

1 *Agropyron repens*
2 *Amelanchier alnifolia*
3 *Arctostaphylos rubra*
4 *Arctostaphylos uva-ursi*
5 *Calamagrostis inexpansa*
6 *Calamagrostis sp.*
7 *Cornus stolonifera*
8 *Elaeagnus commutata* 1
9 *Elaeagnus commutata* 2
10 *Elymus cinereus*
11 *Empetrum nigrum*
12 *Festuca saximontana*
13 *Glyceria sp.*
14 *Hierochloe odorata*
15 *Juniperus horizontalis*
16 *Medicago sp.* cv. Kane
17 *Oryzopsis hymenoides*
18 *Poa glaucantha*
19 *Potentilla fruticosa*
20 *Prunus virginiana* 1
21 *Prunus virginiana* 2
22 *Rosa acicularis*
23 *Shepherdia canadensis*
24 *Symphoricarpos alba*
25 *Symphoricarpos occidentalis*
26 *Trifolium pratense*
27 *Vaccinium myrtilloides*
28 *Vaccinium vitis-idaea*
29 *Viburnum edule*

G. C. O. S. # 22

Location:

On tailings sand dyke at south end of former Tar Island, G.C.O.S. plant site.

Longitude - 111° 30' W.

Latitude - 57° 0' N.

Legal - 13 - 92 - 10 - W4

Elevation - 250 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - 25° - 30° S.E. - facing slope

Soil Type - pure tailing sand

Moisture - poor

Disturbance of soil - disturbed in that soil is deposited waste material

Method / Date of seeding:

cover crop: cyclone seeder; June 5,6, 1974

test plants: planted by hand; June 26, 1974

Fertilizer - 50 lb./site of 21 - 0 - 0 and 50 lb./site of 10-20-10

Average frost-free period - 69 days; June 15 - Aug. 24

Soil Properties:

The reaction of the sands is about neutral and their conductivity suggests negligible salinity effects on plants.

G. C. O. S. #23

Location:

On tailings sand dyke at south end of former Tar Island, G.C.O.S. plant site.

Longitude - 111° 30'W.

Latitude - 57° 0' N.

Legal - 13 - 92 - 10 - W4

Elevation - 250 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - 25° - 30° S.E. - facing slope

Soil type - tailing sand plus peat

Moisture - poor

Disturbance of soil - disturbed in that soil is deposited waste material

Method / Date of seeding:

cover crop: cyclone seeder; June 5,6, 1974

test plants: planted by hand, June 26, 1974

Fertilizer - 50 lb./site of 21-0-0 and
50 lb./site of 10-20-10

Average frost-free period - 69 days;
June 15 - Aug. 24

Soil Properties:

The reaction of the sands is about neutral and their conductivity suggests negligible salinity effects on plants. No free carbonates are present, and only a very slight trace of oil (about 0.2 percent by weight, oven-dry basis) is present. The addition of peat

G.C.O.S. # 23 continued -

appears to lower the level of exchangeable Na, increase the cation exchange capacity slightly and increase the exchangeable Mg. The higher mineral nitrogen on the sown area suggests that it was added as a fertilizer. Total nitrogen and percent organic carbon levels are low; the addition of peat considerably increased their levels.

FORT MCMURRAY #23

1 *Agropyron repens*
2 *Amelanchier alnifolia*
3 *Arctostaphylos rubra*
4 *Arctostaphylos uva-ursi*
5 *Calamagrostis inexpansa*
6 *Cornus stolonifera*
7 *Coronilla varia*
8 *Elaeagnus commutata* 1
9 *Elaeagnus commutata* 2
10 *Elymus cinereus*
11 *Empetrum nigrum*
12 *Festuca saximontana*
13 *Glyceria sp.*
14 *Hierochloe odorata*
15 *Juniperus horizontalis*
16 *Medicago sp.* cv. Kane
17 *Oryzopsis hymenoides*
18 *Poa glaucantha*
19 *Potentilla fruticosa*
20 *Prunus virginiana* 1
21 *Prunus virginiana* 2
22 *Rosa acicularis*
23 *Shepherdia canadensis*
24 *Symphoricarpos alba*
25 *Symphoricarpos occidentalis*
26 *Trifolium pratense*
27 *Vaccinium myrtilloides*
28 *Vaccinium vitis-idaea*

O B S E R V A T I O N S

In 1974 three test sites were selected and planted with test plants and a cover crop. In the spring of 1975 additional reps were planted adjacent to these sites and also willow cuttings were planted throughout the original reps.

Unfortunately during the summer of 1975 the GCOS environmental staff was forced to destroy these sites to prevent major erosion damage which was in danger of occurring because of inadequate slope stabilization procedures in the initial contouring of these sites. Of the three sites only a portion of one (#23 in the May 1975 progress report) was still intact. However by the time of the writing of this report, we were informed that this site would also be destroyed for the same reason.

The quick evaluation done of this one site on October 15, 1975 showed generally good ground cover of around 85% in the area planted in 1974. The ground cover of the area planted in 1975 was somewhat less, being only 35%. Major species in this ground cover were *Agropyron trachycaulum, Agropyron riparium, Agropyron trichophorum, Agropyron cristatum, Bromus inermis, Onobrychis sp.,* and *Phleum pratense*.

The test row plants were starting to come up well and the success rate of the willows varied from 50% to 85% going from the lower to the upper half of the site.

However new sites are needed in this area and will be arranged for in the winter of 1975-76 through consultation with the GCOS environmental staff.

HIGH LEVEL #24 ✓

Location:

10 miles (15 km.) east of Highway 35 along Highway 58, then 2 miles (3.2 km.) south, 2 miles (3.2 km.) east, 1 1/2 miles (2.4 km.) south, 1 1/2 miles (2.4 km.) east, site is on south side of road.

Longititude - 117° 0' W.

Latitude - 58° 30' N.

Legal - 21 - 109 - 18 - W5

Elevation - 300 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - level

Soil Type - degraded black

Moisture - good

Disturbance of Soil - undisturbed

Method / Date of Seeding:

cover crop - not planted

test plants - 1 row seeder:

Sept. 1,2,10, 1974.

Fertilizer - none used

Average frost-free period - 91 days,

June 6 - Sept. 6

OBSERVATIONS

This site was planted in September, 1974 with eighteen ecotypes of grasses and legumes being put in continuous rows. This site has a twofold purpose, being both a check on species adaptability and also a trial for possible seed production. After one year's growth there was, as expected, very little seed production. In fact, only one of the ecotypes, *Poa palustris 89*, produced seed in a significant quantity.

However when the site was evaluated on August 30, 1975 nearly all of the ecotypes were showing good growth with excellent seed possibilities for 1976. From a vigour aspect the following ecotypes were given a rating of 5: *Phleum sp. 81*, *Poa palustris 89*, *Poa ampla 85*, *Poa compressa 87*, and *Poa pratensis 39*. Of the other ecotypes all received a rating of 3 or 4 except four. Of these four, two, *Elymus innovatus 71* and *Hedysarum alpinum 107* were given a rating of 2. The other two ecotypes *Oxytropis splendens 114* and *Agrostis sp. 13* were not in at all. The reason for this is that they were inadverdently destroyed by summer hoeing. Thus, on the whole, all ecotypes showed success after one year and resistance to winter-kill will be very significant in future years.

From the height standpoint the major point of interest was the fact that all species with the exception of *Bromus pumpellianus*, *Poa palustris*, and *Poa compressa* were somewhat shorter than normally expected after one year. However this is not a major concern as the short species were very sturdy in most cases.

The four species planted in 1973 for seed production purposes were all very successful with seed being harvested from each of *Bromus pumpellianus*, *Bromus inermis*, *Agrostis sp.*, and *Agropyron trachycaulum*.

From observations based on these trial areas and also from the first year growth of the row plantings it would appear that seed production of northern ecotypes in the High Level area is very promising. In subsequent years more of the same will be done with a greater variety of ecotypes being tested.

LESSER SLAVE LAKE #25

Location:

6 miles (10 km.) north of Slave Lake on old road

Longitude - 113° 45' W.

Latitude - 55° 20' N.

Legal - 6 - 74 - 5 - W5

Elevation - 575 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - 15° E. and W. - facing slope

Soil type - sand

Moisture - good

Disturbance of soil - wind-blown sand dune

Method / Date of seeding:

cover crop: none planted

test plants: hand planted; Oct. 18, 1974, and May 14, 1975.

Fertilizer - none used

Average frost-free period - 91 days; June 4 - Sept. 4.

Soil Properties:

Very sandy coarse textured soil showing acid soil reaction and a low Potassium and Nitrogen supply.

LESSER SLAVE LAKE #25

1 *Agropyron cristatum* cv. Summit
2 *Agropyron riparium* cv. Sodar
3 *Agropyron subsecundum*
4 *Agropyron trachycaulum* cv. Revenue
5 *Agropyron trachycaulum*
6 *Agropyron trichophorum* cv. Greenleaf
7 *Agrostis gigantea*
8 *Agrostis sp.*
9 *Alopecurus sp.*
10 *Astragalus cicer*
11 *Bromus inermis* cv. Magna
12 *Bromus pumpellianus*
13 *Coronilla varia*
14 *Elymus canadensis*
15 *Elymus innovatus*
16 *Elymus junceus* cv. Sawki
17 *Festuca ovina*
18 *Festuca rubra* cv. Arctared
19 *Festuca rubra* cv. Boreal
20 *Festuca rubra* cv. Reptans
21 *Lotus corniculatus* cv. Leo
22 *Medicago sp.* cv. Kane
23 *Onobrychis sp.* cv. Melrose
24 *Phleum pratense* cv. Champ
25 *Poa ampla*
26 *Poa compressa*
27 *Poa palustris*
28 *Poa pratensis* cv. Fylking

LESSER SLAVE LAKE # 25 CONT'D

29 *Puccinellia nuttalliana*

30 *Trifolium hybridum* cv. Aurora

31 *Trifolium hybridum* cv. Dawn

32 *Trifolium pratense*

33 *Trifolium repens*

O B S E R V A T I O N S

This site was planted on two different occasions. On October 18, 1974 three Reps were planted. The seed planted at this time consisted entirely of shrubs and legumes. This was left over seed which had received neither stratification nor vernalization treatment. Consequently little or no germination was really expected and this proved to be the case as shown by the 1975 evaluations.

On May 14, 1975 three additional reps were planted with grass and some legume seed. Also at this time 100 *Salix* rooted cuttings were planted. The evaluation of these new reps took place on July 29, 1975 and September 29, 1975. The results of these evaluations showed very little germination of the seed planted. This is not entirely unexpected when one considers the dry sand soil conditions. Also a major consideration here is the depth of planting. The seed here was planted much deeper than at other sites (1" - 2") and this undoubtedly has contributed to preventing or delaying germination. The only plants showing any germination were the two varieties of *Festuca rubra* (24 & 154).

The *Salix* were planted here to investigate the possibilities of using them in soil conditions to which they are not normally adapted. Results after one summer were extremely poor. On Rep 1 only 3 of 50 (6%) took root while on Rep 2 only 20 of 50 (40%) were growing. The discrepancy between the two reps could be attributable to the fact that Rep 1 is on an east facing slope while Rep 2 is a west facing slope. If a conclusion can be based on one summer's results it is a confirmation of previous ideas that *Salix* can not be used for slope stabilization purposes on dry, sandy soil. (In moist areas the success rate with *Salix* from the same stock was from 65% upward.)

The ground cover on this site fluctuated, as on Reps 1 & 2 it was around 50% while on Rep 3 it dropped to less than 15%. Seperate soil samples were taken and are currently being analyzed to see if there is a difference in soil properties. The ground cover on these Reps consists largely of *Festuca spp.* and *Agropyron cristatum.* Also present in lesser amounts were *Agropyron trachycaulum, Elymus spp.*, and *Oryzopsis sp.* The ground cover on the abandoned Reps and adjacent land is very similar to that of Reps 1 & 2. It should be noted that this ground cover is not native but was planted as a test program in 1972 by Western Erosion Control. Prior to planting of this cover, native vegetation on the site was less than 1%.

PEERS #26

Location:

6 miles (10 km.) north of Peers on farmland
adjacent to McLeod River
Longitude - 116° 0' W.
Latitude - 53° 45' N.
Legal - 34 - 54 - 14 - W5
Elevation - 850 meters

Notes:

Ecological Zone - Boreal Forest
Aspect - level ground (flat river valley)
Soil type - grey wooded, sandy loam soil
Moisture - good
Disturbance of soil - cultivated farmland, undisturbed
Method / Date of seeding:
cover crop: not planted
test plants: belt seeder, some planted by hand; 1973, 1974 and 1975.
Fertilizer - 100 lb./acre of 10-30-10 and 100 lb./acre of 21-0-0
Average frost-free period - 67 days; June 18 - Aug. 25

Soil Properties:

This calcareous sandy loam soil is low in all nutrients with the exception of K.

PEERS #26

1 *Agropyron cristatum*

2 *Agropyron gmelini* 1

3 *Agropyron gmelini* 2

4 *Agropyron smithii* 1

5 *Agropyron smithii* 2

6 *Agropyron smithii* 3

7 *Agropyron smithii* 4

8 *Agropyron smithii* 5

9 *Agropyron smithii* 6

10 *Agropyron sp.* 1

11 *Agropyron sp.* 2

12 *Agropyron sp.* 3

13 *Agropyron sp.* 4

14 *Agropyron sp.* 5

15 *Agropyron sp.* 6

16 *Agropyron sp.* 7

17 *Agropyron sp.* 8

18 *Agropyron subsecundum*

19 *Agropyron trachycaulum*

20 *Agropyron tsukusiense* 1

21 *Agropyron tsukusiense* 2

22 *Arctagrostis sp.*

23 *Bromus pumpellianus*

24 *Bromus sp.* 1

25 *Bromus sp.* 2

26 *Bromus sp.* 3

27 *Calamagrostis canadensis*

28 *Calamagrostis inexpansa*

29 *Elymus cinereus*

PEERS # 26 CONT'D

30	*Elymus giganteus*	
31	*Elymus innovatus*	
32	*Elymus sp.*	
33	*Festuca arundinacea*	
34	*Festuca myuros*	
35	*Festuca rubra*	1
36	*Festuca rubra*	2
37	*Festuca saximontana*	1
38	*Festuca saximontana*	2
39	*Festuca saximontana*	3
40	*Festuca saximontana*	4
41	*Festuca sp.*	1
42	*Festuca sp.*	2
43	*Festuca sp.*	3
44	*Hierochloe sp.*	1
45	*Hierochloe sp.*	2
46	*Koeleria cristata*	
47	*Poa alpina*	1
48	*Poa alpina*	2
49	*Poa macrocalyx*	
50	*Poa palustris*	1
51	*Poa palustris*	2
52	*Poa palustris*	3
53	*Poa palustris*	4
54	*Poa palustris*	5
55	*Poa pratensis*	1
56	*Poa pratensis*	2
57	*Poa pratensis*	3
58	*Poa pratensis*	4

PEERS # 26 CONT'D

59	*Poa pratensis*	*5*
60	*Poa pratensis*	*6*
61	*Poa pratensis*	*7*
62	*Poa pratensis*	*8*
63	*Poa sp.*	
64	*Puccinellia sp.*	
65	*Spartina gracilis*	

O B S E R V A T I O N S

This is one of the seed increase sites throughout the province. The original planting took place in 1973 and again in 1974. At these times only five ecotypes were planted. There were *Agropyron smithii* 261, *Poa pratensis* 39 and three different ecotypes of *Agrostis tenuis* (#'s 13, 15 & 16). These early plantings have all grown well and seed was harvested from each in the fall of 1975. Seed was plentiful but unfortunately exact figures are unavailable at the time of writing of this report.

In 1975 there was extensive additional planting done at Peers. This consisted of 70 rows of grass plants which were transplanted from growth chambers and greenhouses. Should this transplanting be successful then these rows will also be used for seed increase purposes.

SWAN HILLS #27

Location:

8 miles (12.2 km.) north-west of Swan Hills on site of Home Oil Battery #9.

Longitude - 115° 30' W.

Latitude - 54° 45' N.

Legal - 8 - 67 - 10 - W5

Elevation - 1225 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - level ground (muskeg in a hollow)

Soil type - organic (peat)

Moisture - very wet

Disturbance of soil - treatment areas were rototilled; checks were left undisturbed

Method / Date of seeding:

cover crop: cyclone seeder; July 4, 1974

test plants: not planted

Fertilizer - 300 lb./acre of 34-0-0

100 lb./acre of 11-55-0

100 lb./acre of K_2SO_4 and 5 tons/acre of lime. Applied only to treatment area.

Average frost-free period - 67 days;

June 18 - 24

O B S E R V A T I O N S

The Swan Hills site was put in on July 4, 1974. This site is designed to check the effect that rototilling and fertilization have on plants grown on an oilspill area. Three reps were put in and one half of each rep was rototilled and received an application of fertilizer. The site was evaluated on August 20, 1975 and the following observations were made.

The major point noted was that there was no difference in ground cover between the treated and untreated areas. Also there was no difference in the colour of the plants throughout the site. The percentage of ground cover provided was patchy and varied from 0% to 100%. Of the cover crop planted the most prominent species were *Phleum pratense, Poa compressa, Festuca rubra, Trifolium repens,* and *Trifolium hybridum.* Of these the largest % cover provided was by the *Phleum* and *Poa,* both of which provided around 10% cover.

Native ground cover was the same throughout the site. The major components here were *Epilobium palustre, Beckmania syzigachne, Agrostis scabra, Hordeum jubatum, Salix sp.,* and *Senecio congestus.* However none of these provided more than 2% ground cover overall.

The only other observation which can be made at present is that the variation in ground cover throughout the site is due to some factor other than the treatment applied.

BIG HORN #28

Location:

5 miles (8.0 km.) down damsite road from David Thompson Highway. Below observation point.

Longitude - 116° 15'

Latitude - 52° 20'

Legal - (30's) - 39 - 17 - W5

Elevation - 1,275 meters

Notes:

Ecological Zone - Mountain Area

Aspect - level ground

Soil type - grey wooded, packed sandy clay soil

Moisture - dry

Disturbance of soil - trees cleared, topsoil scraped off

Method / Date of seeding:

cover crop: cyclone seeder; Sept. 11/74

Test plants - hand planted May 6, 1975.

Fertilizer - 100 lb./acre of 10-30-10 and 100 lb./acre of 21-0-0

Average frost-free period - 84 days; June 7 - Aug. 31

Soil Properties:

Strongly alkaline soil with a high level of free carbonates and low levels of both Potassium and Phosphorous.

BIG HORN # 28

1 *Agropyron smithii*
2 *Agropyron sp.*
3 *Agropyron trachycaulum*
4 *Agrostis gigantea*
5 *Agrostis sp.*
6 *Bromus inermis*
7 *Coronilla varia*
8 *Elymus canadensis*
9 *Elymus innovatus*
10 *Festuca rubra* cv. Reptans
11 *Festuca scabrella*
12 *Lotus corniculatus* cv. Leo
13 *Medicago sp.* cv. Rambler
14 *Onobrychis sp.* cv. Melrose
15 *Phleum pratense* cv. Climax
16 *Phleum sp.*
17 *Poa ampla*
18 *Poa compressa*
19 *Poa palustris*
20 *Poa pratensis*
21 *Puccinellia nuttalliana*
22 *Trifolium pratense* *1*
23 *Trifolium pratense* *2*

O B S E R V A T I O N S

This site was planted on May 6, 1975 and then evaluated twice during the year. These evaluations took place on July 7, 1975 and October 11, 1975. The first very noticeable observation on this site was that the ground cover crop which had been planted by cyclone seeder in October, 1974 did not come in at all. This was not unexpected as it was spread on ground which has had the top soil removed.

The July observation showed very little growth in any of the grasses with only spots of *Medicago* and *Trifolium* above ground in the legumes. However both the rooted cuttings of *Salix* sp. and *Elaeagnus commutata* were doing well. 80% of both species had taken hold.

The October evaluation basically reconfirmed that of July. However there was a significant difference in that approximately 85% of the grasses planted were now above ground. As they were only between 1/4 and 1/2 inch high no detailed evaluation was done. However if these can overwinter successfully next year's observations should prove more beneficial. The legumes, on the other hand, with the exception of the earlier mentioned *Medicago* and *Trifolium* were all doing poorly as less than 40% were above ground. The *Salix* and *Elaeagnus* were still doing well with the final figures being 39 of 45 *Salix* growing and 16 of 20 *Elaeagnus* growing.

The ground cover on and adjacent to the site is less than 1% as it is currently part of a reclamation project to restore the Big Horn Dam area.

BIG HORN #29

Location:

5 miles (8.0 km.) down damsite road of David
Thompson Highway: 1/2 mile (.8 km.) east from dam.
Longitude - 116° 15'
Latitude - 52° 20'
Legal - (30's) - 38 - 17 - W5
Elevation - 1,275 meters

Notes:

Ecological Zone - Mountain Area
Aspect - 20° south facing slope
Soil type - Grey wooded sandy soil (extremely rocky)
Moisture - dry
Disturbance of soil - undisturbed
Method / Date of seeding:
cover crop - cyclone seeder; Sept. 11/74
test plants - hand planted May 7, 1975.
Fertilizer - 100 lb./acre of 10-30-10 and
100 lb./acre of 21-0-0
Average frost-free period - 84 days;
June 7 - Aug. 31

Soil Properties:

Strongly alkaline soil with a high level of free carbonates and low levels of both Potassium and Phosphorus.

BIG HORN #29

1 *Agropyron smithii*
2 *Agropyron sp.*
3 *Agropyron trachycaulum*
4 *Agrostis gigantea*
5 *Agrostis sp.*
6 *Bromus inermis*
7 *Coronilla varia*
8 *Elymus canadensis*
9 *Elymus innovatus*
10 *Festuca rubra* cv. Reptans
11 *Festuca scabrella*
12 *Juniperus horizontalis*
13 *Lotus corniculatus* cv. Leo
14 *Medicago sp.* cv. Rambler
15 *Onobrychis sp.* cv. Melrose
16 *Phleum pratense* cv. Climax
17 *Phleum sp.*
18 *Poa ampla*
19 *Poa compressa*
20 *Poa palustris*
21 *Poa pratensis*
22 *Puccinellia nuttalliana*
23 *Trifolium pratense* *1*
24 *Trifolium pratense* *2*

O B S E R V A T I O N S

This site is similar to Big Horn #28 in that it is in an area which has had the top soil removed. However it is bordered on one side by the river and on the other by a steep slope. It was planted on May 7, 1975 and then evaluated twice during the summer.

The July 7 observation showed that the ground cover planted in late 1974 had failed to germinate at all. At this time a few of the test plants in rows were starting to emerge but not to any significant degree. However, as in Big Horn #28 around 75% of the *Salix* sp. and *Elaeagnus commutata* appeared to have taken root.

At the time of the October 11 evaluation the row test plants were still too small for extensive evaluation. However between 55% and 65% of the plants had now emerged. At this time there was no difference between the performance of the grasses and legumes. Of the rooted shrub cuttings planted, 65% of the *Salix* sp. were successful while 80% of the *Elaeagnus commutata* were growing.

The ground cover on this site is less than 5%, consisting entirely of *Oxytropis* sp. and *Astragalus* spp. Ground cover on the adjacent level area is similar with the addition of sporadic *Hedysarum* sp. However on the slope north of the site there is ground cover of 80% on the lowest 20 ft. This consists largely of *Rosa acicularis* and *Symphoricarpos occidentalis*. Other species which provided lesser amounts of ground cover here included *Agropyron riparium*, *Juniperus horizontalis* and small *Populus tremuloides*.

BIG HORN #30

Location:

4 miles (6.4 km.) down damsite road from David Thompson Highway. 1500 feet (450 meters) east along powerline from damsite road.

Longitude - 116° 15'

Latitude - 52° 20'

Legal - (30's) 38 - 17 - W5

Elevation - 1,274 meters

Notes:

Ecological Zone - Mountain Area

Aspect - 30° North facing slope

Soil type - Grey wooded powdery soil

Moisture - dry

Disturbance of Soil - brush cleared; topsoil undisturbed

Method / Date of seeding:

cover crop: cyclone seeder; Sept. 11/74

test plants; hand planted May 7, 1975

Fertilizer - 100 lb./acre of 10-30-10 and

100 lb./acre of 21-0-0

Average frost-free period - 84 days;

June 7 - Aug. 31

Soil Properties:

Strongly alkaline soil with a high level of free carbonates and low levels of both Potassium and Phosphorus.

BIG HORN #30

1	*Agropyron smithii*
2	*Agropyron sp.*
3	*Agropyron trachycaulum*
4	*Agrostis gigantea*
5	*Agrostis sp.*
6	*Bromus inermis*
7	*Coronilla varia*
8	*Elymus canadensis*
9	*Elymus innovatus*
10	*Festuca rubra* cv. Reptans
11	*Festuca scabrella*
12	*Lotus corniculatus* cv. Leo
13	*Medicago sp.* cv. Rambler
14	*Onobrychis sp.* cv. Melrose
15	*Phleum pratense* cv. Climax
16	*Phleum sp.*
17	*Poa ampla*
18	*Poa compressa*
19	*Poa palustris*
20	*Poa pratensis*
21	*Puccinellia nuttalliana*
22	*Trifolium pratense 1*
23	*Trifolium pratense 2*

O B S E R V A T I O N S

As with the other Big Horn plots this site was planted on May 7, 1975 and was then evaluated twice during the summer. The major difference between this site and the other two Big Horn sites is that the top soil on this site is still in place as it is under a power line and not in an area disturbed by the actual dam construction.

The July observation showed this site to be largely infested by native weeds which provided over 50% ground cover. The rows of test plants were minute but it appeared that some were starting to emerge.

The October 11 evaluation disclosed much more favourable results. At this time the test plants were still too small to be evaluated for vigour or height. However it appeared that about 90% of the plants on the north half of the site had germinated. This figure of apparent germination declined to around 30% approaching the southern edge of the site. In general the most successful of the individual rows were the legumes - in particular *Trifolium pratense* 260 and 122.

Final ground cover on this site was around 60% consisting largely of weeds. However at this time some *Oxytropis spp.*, *Astragalus spp.*, *Bromus inermis* and *Phleum pratense* had started to invade.

Ground cover adjacent to the site was similar but cover along the road leading to the site included some additional species.

Among these were *Calamagrostis canadensis*, *Agropyron subsecundum*, *Arctostaphylos uva-ursi*, *Hordeum sp.*, and *Festuca sp.*

In future years this site will provide a good indication of the bio-competitive ability of the ecotypes planted as compared to native weed ground cover.

CHAIN LAKES #31

Location:

.8 miles (1.3 km.) south of Chain Lakes Provincial Park on east side of road.

Longitude - 114° 10'

Latitude - 50° 10'

Legal - 27 - 14 - 2 - W5

Elevation - 1,375 meters

Notes:

Ecological Zone - Mountain Areas

Aspect - 20° West facing slope

Soil type - dark grey wooded clay loam soil

Moisture - fairly good (2.5 cm. - 5 cm. down)

Disturbance of Soil - topsoil removed

Method / Date of Seeding:

cover crop - none planted

test plants - hand planted; July 16/74

Fertilizer - 100 lb./acre of 10-30-10 and
100 lb./acre of 21-0-0

Average frost-free period - 101 days
May 30 - Sept. 9

Soil Properties:

Moderately alkaline heavy clay soil with a high level of free carbonates. The Phosphorus content is extremely low.

O B S E R V A T I O N S

This test site was evaluated on three occasions in 1975. Initial observations were made in early spring, again in July and the year end evaluation was done on October 5, 1975. The spring observation showed that most species had survived the winter and were starting to come in quite well. The July evaluation confirmed this but also disclosed a major problem. Specifically, sometime between May and July the Department of Highways ran a grader over the test site tearing up the middle of the site. This has caused a situation where some plants are missing from each row but the number missing fluctuates from row to row. Consequently it is not possible to determine if the missing plants are missing because of the activity of the grader or because they did not germinate. Two rows which well illustrate the problem are the *Koeleria (32)* and the *Elymus canadensis (20)*. In both cases less than half of the plants are growing but those that are there are extremely healthy.

On this site four of the rows were given the maximum vigour rating of 5. These were *Festuca rubra (22), Phleum pratense (35), Puccinellia sp. (43)*, and *Poa pratensis (92)*. Two other rows received a rating of 4. These were the *Poa ampla (86)* and *Medicago sativa (111)*. Of the remaining rows six received a rating of 3 while four received a 2 rating. Also on this site four rows were very weak and received a rating of 1. These were *Festuca scabrella (25), Poa pratensis (39), Oxytropis sp. (158)*, and *Trifolium repens (20)*.

One interesting aspect of the plants at this site was the lack of height in many of the taller species. For instance *Bromus inermis* (61) was only 5 inches tall and *Agropyron smithii* only 6 inches. This contrasted greatly with normally shorter species such as *Festuca rubra* (22) which was 13 inches high and *Poa pratensis* (92) which was 16 inches high.

The other observation worth noting was the difference in growth habit between the two ecotypes of *Poa pratensis*. One ecotype (92) received a vigour rating of 5 and was generally excellent while the other ecotype (39) received a vigour rating of 1 and had very little germination. There is no definite conclusion to explain this but possibilities include ecotypic adaptability, extremely poor seed of ecotype 39 or perhaps overly severe grader damage.

There has been no ground cover planted on this site either by the research program or the Department of Highways. The ground cover which is there is only between 5 and 10%, and consists largely of oats, barley and *Phleum* sp. Ground cover adjacent to the site is similar but also has a fairly large amount of *Trifolium hybridum*.

In general, if the grader damage is discounted, this is a good test site. In future years it will be interesting to see if the aforementioned taller species and others such as *Deschampsia sp. (66)* and *Elymus innovatus* (69) will equal or outperform the current top species.

EDSON # 32

Location:

15 miles (24.0 km.) southwest on Highway #47
from junction with Highway #16
Longitude - 116° 50'
Latitude - 53° 20'
Legal - 6 - 51 - 19 - W5
Elevation - 975 meters.

Notes:

Ecological Zone - Mountain Area
Aspect - 15° south facing slope
Soil Type - Grey wooded, sandy clay soil
Moisture - fair (5.0 cm. to 7.5 cm. down)
Disturbance of Soil - topsoil removed
Method / Date of Seeding:
cover crop - (Central and Northern cover crop seeded by Highways); July 15/74
test plants - hand planted; July 23/74
Fertilizer - 100 lb./acre of 10-30-10 and
100 lb./acre of 21-0-0
Average frost-free period - 67 days -
June 18 - Aug. 25

Soil Properties - Soil samples taken at both levels are high in free carbonates and pH's are also high. Salinity levels are, however, low; thus they would not affect growth of plants. Mineral nitrogen (NH_4^+ and NO_3^-) levels are low as are organic matter and P.

O B S E R V A T I O N S

This site was originally planted on July 23, 1974 and was evaluated twice during 1975. These evaluations took place on July 17, 1975 and September 24, 1975. The July evaluation showed most of the test plants to be coming in very well, especially considering the fact that the Department of Highways had planted a cover crop on the site a week prior to our planting.

In September detailed height and vigour ratings were taken. From a vigour aspect seven of the twenty-two ecotypes received a rating of 5. The ecotypes receiving a 5 rating were *Poa compressa 87*, *Poa ampla 85*, *Phleum pratense 35*, *Agropyron smithii 48*, *Agrostis gigantea 59*, *Poa palustris 41* and *Festuca rubra 24*. One other ecotype, *Elymus canadensis 20* received a rating of 5 on rep 3 but was very weak in reps 1 & 2, receiving a rating of 2 on these reps.

Of the other ecotypes nine received a 4 rating and two received a 3 rating. The only ecotypes which were consistently weak were *Trifolium pratense 120*, which received a 2 rating and the grasses *Elymus innovatus 69(A)* and *Deschampsia sp. 66*, which both received 1 ratings.

From the height standpoint there were few surprises. The two ecotypes of *Phleum sp.* were the tallest, being between 24"-30" while the *Bromus* and various *Agropyrons* were all between 14" and 18" tall. The shorter grasses such as *Poa spp.*, *Agrostis spp.*, *Festuca spp.*, *Koeleria sp. and Puccinellia sp.* were between 5" and

12" depending upon the ecotype.

In general the plants were healthy but a bit shorter than might be expected. The probable explanation for this lies in the excessive competition from the cover crop planted by the Department of Highways.

The ground cover on the site is from 40% to 60% going from rep 1 to rep 3. The dominant species in this cover include *Agropyron trachycaulum*, *Festuca rubra*, *Phleum pratense* and *Medicago sativa* while rep 3 also has a significant amount of *Trifolium hybridum*. Adjacent to the site the major species is *Agrostis scabra* along with smaller amounts of *Calamagrostis canadensis* and *Elymus innovatus*.

KANANASKIS # 33 - A

Location:

11.2 miles (17.9 km.) down Kananaskis Road
from junction with Highway 1. East side of road.
Longitude - 115° 5'
Latitude - 50° 55'
Legal - 23 - 8 - W5
Elevation - 1,525 meters

Notes:

Ecological Zone - Mountain Area
Aspect - 5° east facing slope
Soil Type - Grey wooded soil
Moisture - fair
Disturbance of Soil - topsoil removed
Method / Date of Seeding - cover crop
broadcast seeded; June 13/74
Fertilizer - 100 lb./acre of 36-10-0
Average frost-free period - 101 days;
May 30 - Sept. 9

Soil Properties:

Moderately alkaline soil with a high level of free carbonates. The Phosphorus content is extremely low.

KANANASKIS #33 - B

Location:

8.6 miles (13.9 km.) down Kananaskis Road
from junction with Highway 1.
Longitude - 115° 5'
Latitude - 51° 0'
Legal - 23 - 8 - W5
Elevation - 1,525 meters

Notes:

Ecological Zone - Mountain Area
Aspect - 25° west facing slope
Soil Type - Grey wooded soil
Moisture - fair
Disturbance of Soil - topsoil removed
Method / Date of Seeding -
test plants - hand planted; June 13/74
Fertilizer - 100 lb./acre of 36-10-0
Average frost-free period - 101 days,
May 30 - Sept. 9

O B S E R V A T I O N S

This site was planted on June 13, 1974 immediately after the Department of Highways had applied their ground cover mix. This has resulted in a site which will prove excellent for evaluation of bio-competitiveness but the first year growth of the test plants has been retarded. Consequently no height evaluation was made as all plants were under 3" high except for *Trifolium pratense* 122.

The ground cover on the site is over 90% consisting largely of *Trifolium hybridum* and *Festuca rubra*. Lesser amounts of *Bromus inermis* and *Agropyron cristatum* are observable. The test plants themselves are coming in well but at present are short with better growth on the upper half of the site.

From a vigour aspect the two most successful ecotypes were *Trifolium pratense* 122 and *Festuca rubra* 24 which both received a rating of 5. Ecotypes which received a rating of 4 included the following: *Poa pratensis 38*, *Medicago falcata 110*, *Poa glaucantha 157*, *Festuca scabrella 26*, *Puccinellia sp. 43*, *Stipa spartea 44*, *Agrostis gigantea 59*, *Poa alpina 82* and *Vicia cracca 124*.

Of the other ecotypes most were given ratings of 2 or 3. However the following were very poor in some cases and received a rating of 0 or 1 on at least one of the Reps. These were *Koeleria cristata*, *Elymus canadensis 20*, *Poa pratensis 39*, *Agropyron smithii 47*, *Lotus corniculatus 109*, *Poa ampla 36*, and *Oxytropis sp. 112*.

Two ecotypes which varied greatly from rep to rep were *Phleum pratense 80* and *Elymus innovatus 69*. The *Phleum* was generally very weak with ratings of 0 to 2 in most cases; however in Row 26 of Rep 1 it was very strong and received a 4 rating. Similarly the *Elymus* was strong (4 rating) on Rep 1 but had no germination on Rep 2.

The final evaluation of this site was done on October 4, 1975. Also at this time the adjacent forest area was shown to have around 75% ground cover consisting largely of *Hedysarum sp.*, *Arctostaphylos uva-ursi* and some *Elymus innovatus*.

At this time the rocky ground cover test site was also observed. Here the cover planted has come in very poorly with only around 15% success. The species present in significant quantities were *Phleum pratense* and *Festuca rubra* while lesser amounts of *Bromus inermis* and *Poa pratensis* were also observed.

The undisturbed area adjacent to this site has 99% ground cover. The two most dominant plants in this area were *Salix* spp. and *Cornus* spp. Native grasses present included *Calamagrostis canadensis*, *Poa palustris* and *Elymus innovatus*.

As a general observation the test row site will be very useful in future years while the ground cover site is in such a rocky area that not too much inprovement can be expected.

MOUNTAIN VIEW # 34

Location:

1.4 miles (2.2 km.) east on Highway 5 from Mountain View. Then 1 mile (1.6 km.) south

Longitude - 113° 40'

Latitude - 49° 5'

Legal - 14 - 2 - 28 - W4

Elevation - 1300 meters

Notes:

Ecological Zone - Mountain Area

Aspect - level

Soil Type - Dark grey wooded (nearly black) soil.

Moisture - fair

Disturbance of Soil - undisturbed (worked stubble)

Method / Date of Seeding:

cover crop - cyclone seeder; Oct. 24/74

test plants - hand planted; Oct. 24/74

Fertilizer - 100 lb./acre of 10-30-10 and
100 lb./acre of 21-0-0

Average frost-free period - 101 days;
May 30 - Sept. 9

Soil Properties:

Slightly acid soil adequately supplied with plant nutrients.

O B S E R V A T I O N S

This site was planted on October 24, 1974 on a farm belonging to Russ Walberger. At the time of planting two reps of eighteen ecotypes each were planted and a strip of *Festuca rubra* cv. Arcta Red was planted between the reps. This site was evaluated on June 19, 1975 and September 5, 1975.

The June 19 observation showed a major difficulty. This was the fact while it appeared that the test plants seemed to have survived they were completely engulfed by weeds, such as Canada thistle and stinkweed, which were over 24" high. Consequently arrangements were made with Russ Walberger to have everything cut down at the end of August.

This having been done the September evaluation proved much more useful. As all plants were now two inches high no height evaluation was made but each ecotype was evaluated for vigour. This examination disclosed a very successful test site. Eight of the ecotypes *(4 Agropyron spp., 2 Bromus spp., and 2 Festuca spp.)* were given vigour ratings of 5. In addition to this, three ecotypes received a 4 rating while four received a rating of 3. Thus only the two ecotypes of *Poa ampla* (323 & 85) received ratings of 1 while only *Poa pratensis 265* received a 2 rating.

As a general observation it can be stated that all ecotypes of *Agropyron, Bromus and Festuca* seem to have performed much better than the *Poa* ecotypes in competition with the weeds.

The Arctared fescue between the reps is doing well with about 75% ground cover after one year's growth. The presense of this fesuce and of the test rows could greatly reduce the amount of weed cover next year. The spring evaluation should prove informative regarding this.

BLUEBERRY MOUNTAIN #35

Location:

9.2 (5.7 miles) north on the Blueberry Mountain road from the junction with Highway 49 or 2.1 km. (1.3 miles) south of Blueberry Mountain on the farm of Hiram Esselink.

Longitude - 56° 15'

Latitude - 56° 15'

Legal = 3 - 80 - 8 - W6

Elevation - 660 meters

Notes

Ecological Zone - Aspen Parkland

Aspect - 35° north facing slope

Soil type - clay

Moisture - good

Disturbance of soil - none

Method / Date of seeding:

cover crop - not planted

test plants - hand planted; June 26.75

Fertilizer - none used

Average frost-free period - 113 days

May 19 - Sept. 10

Climate: Refer to #39 Grande Prairie

Soil Properties:

Neutral, heavy clay soil with a very low Phosphorus content.

BLUEBERRY MOUNTAIN #35

1 *Agropyron riparium* cv. Sodar

2 *Agropyron sp.*

3 *Agropyron trichophorum* cv. Greenleaf

4 *Agrostis gigantea*

5 *Alopecurus pratensis*

6 *Astragalus cicer*

7 *Bromus inermis*

8 *Elymus junceus* cv. Sawki

9 *Festuca rubra* cv. Reptans

10 *Medicago sp.* cv. Drylander

11 *Onobrychis sp.* cv. Melrose

12 *Poa ampla*

13 *Poa compressa*

14 *Poa glaucantha*

15 *Poa palustris*

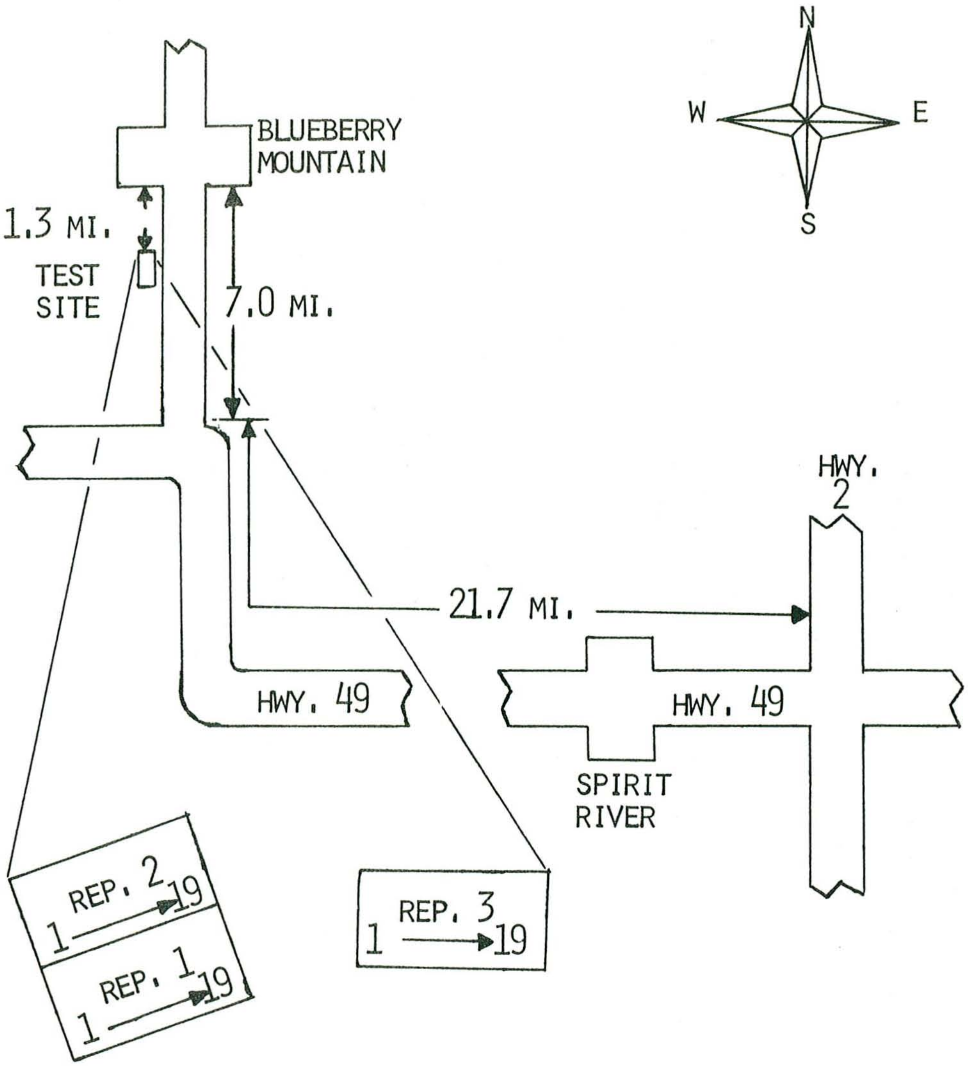
16 *Poa pratensis*

17 *Puccinellia sp.*

18 *Trifolium hybridum* cv. Aurora

19 *Trifolium pratense*

BLUEBERRY MOUNTAIN SITE #35



O B S E R V A T I O N S

This site was planted on June 26, 1975 with test plants being spaced 18" apart. The reason for this spacing, and not the usual 36" spread was a lack of land area which did not already have a ground cover of over 95%. The late planting resulted in little germination at the time of the evaluation done on August 31, 1975.

However despite the late planting it appeared that many plants were starting to come in quite well. At the time of evaluation the strongest ecotype was *Trifolium pratense* 122. Other ecotypes doing well were *Onobrychis sp.* 254 and *Festuca rubra* 24.

The site is on the outer edge of a private farm and has a native ground cover of around 40%. The major components of this cover are *Trifolium hybridum*, *Populus sp.*, *Epilobium sp.*, and *Rosa sp.* Ground cover adjacent to the site is similar with the addition of two major grasses, *Calamagrostis canadensis* and *Phleum pratense*.

COLD LAKE #36 ✓

Location:

1.25 miles (2.0 km.) W. of Grande Centre

Longitude - 110° 15'

Latitude - 54° 25'

Legal - SE 1/4 - 4 - 63 - 2 - W4

Elevation - 580 meters (1750 ft.)

Notes:

Ecological Zone - Central Parkland

Aspect - 2% N. facing slope

Soil type - clay

Moisture - good

Disturbance of soil - top soil removed

Method / Date of seeding - June 28/75

cover crop -

test plants -

Fertilizer - none

Average frost-free period - 80 days

June 6 - Sept. 2

Soil Properties:

Mildly alkaline soil with a very low Phosphorus content.

Table 1

CLIMATE: #36 COLD LAKE

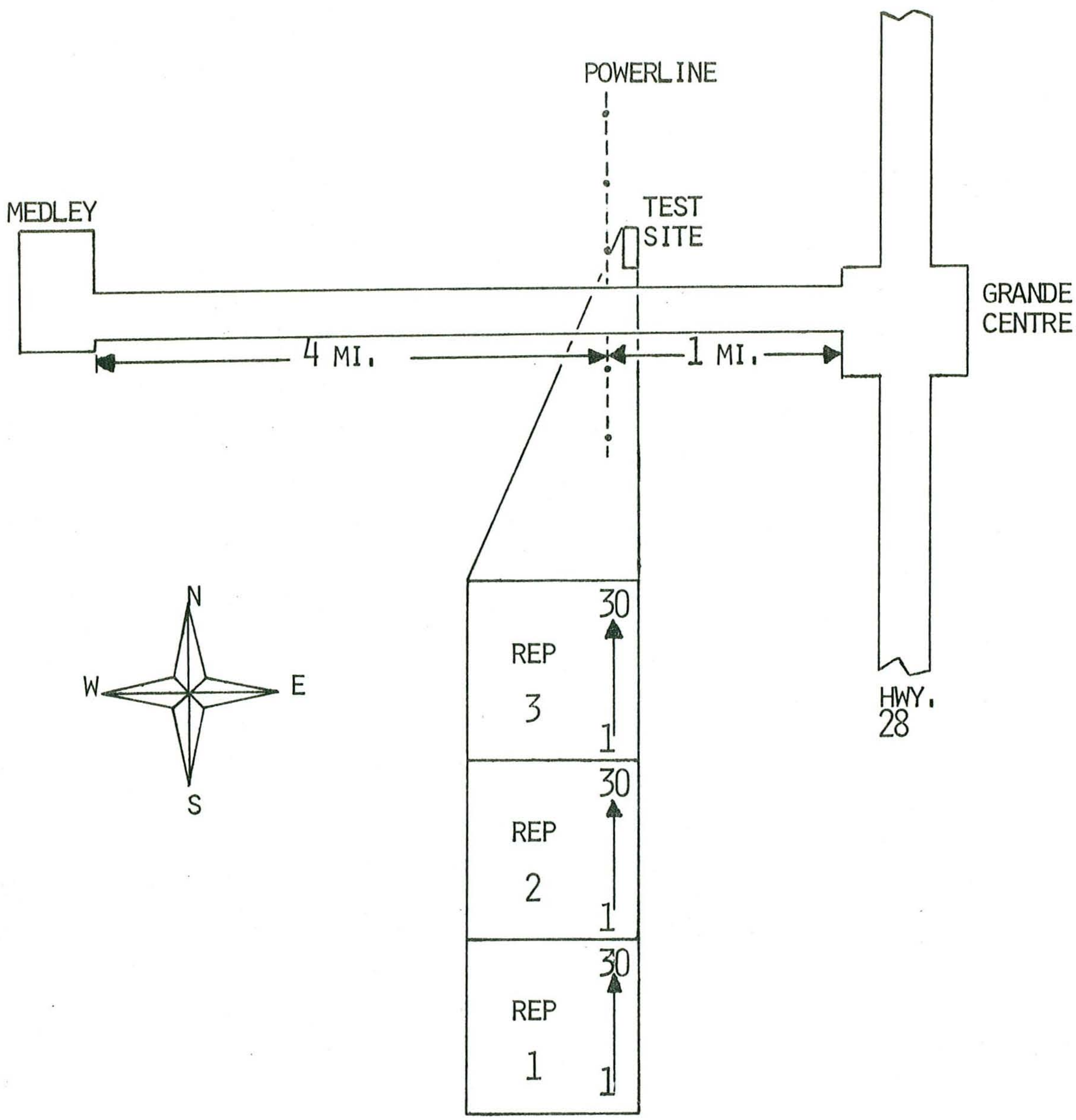
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-21.8	-14.2	-8.5	2.3	10.4	14.2	16.0	16.0	9.2	3.3	-6.7	-15.3	0.4
High (°C)	-16.3	-8.0	-2.7	8.2	17.8	20.8	22.5	23.2	15.8	9.4	-2.0	-10.3	6.5
Low (°C)	-27.4	-20.3	-14.3	-3.7	3.0	7.6	9.6	8.9	2.7	-1.2	12.8	-20.2	-5.7
Precip. (cm)	2.49	1.07	1.42	1.35	3.05	6.15	8.64	5.74	3.68	1.04	1.68	1.78	38.07
Wind *	26/5	24/4	25/6	19/11	19/12	21/9	26/5	25/6	22/8	21/10	26/4	28/3	284/81
Sunshine (# of hours)	96.4	115.9	165.7	231.5	302.6	277.4	310.5	302.1	172.3	159.9	87.8	80.9	2303.0

* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

COLD LAKE #36

1 *Agropyron riparium* cv. Sodar
2 *Agropyron smithii*
3 *Agropyron sp.*
4 *Agropyron trachycaulum*
5 *Agropyron trachycaulum* cv. Revenue
6 *Agropyron trichophorum* cv. Greenleaf
7 *Agrostis gigantea* 1
8 *Agrostis gigantea* 2
9 *Astragalus cicer*
10 *Bromus inermis*
11 *Bromus inermis* cv. Magna
12 *Bromus pumpellianus*
13 *Coronilla varia*
14 *Elymus innovatus*
15 *Elymus junceus* cv. Sawki
16 *Festuca elatior* cv. Tammisto
17 *Festuca ovina*
18 *Festuca rubra* cv. Boreal
19 *Lotus corniculatus* cv. Leo
20 *Medicago sativa* cv. Drylander
21 *Onobrychis sp.* cv. Melrose
22 *Phleum pratense* cv. Champ
23 *Poa ampla*
24 *Poa compressa*
25 *Poa pratensis*
26 *Poa pratensis* cv. Fylking
27 *Puccinellia sp.*
28 *Trifolium hybridum* cv. Aurora
29 *Trifolium pratense*
30 *Trifolium repens*

COLD LAKE SITE #36



O B S E R V A T I O N S

This site was planted on June 30, 1975 but showed surprisingly good growth in a very short period of time. This can be attributed to the fact that the site is in a moist area which also has good drainage. The plants were still short in height as 6 inches was the maximum, but from a vigour point of view nearly all of the rows were very healthy.

The evaluation of the site occurred on September 26, 1975 and at that time ten ecotypes received a vigour rating of 5 on at least one of the reps. These were the legumes *Trifolium pratense 260*, *Trifolium repens 256*, *Trifolium hybridum* cv. Aurora 115, *Onobrychis sp. 254* and *Medicago sativa* cv. Drylander 250. The grasses which received a 5 rating were *Agropyron trachycaulum* cv. Revenue; 246, *Agropyron smithii 261*, *Agropyron trichophorum* cv. Greenleaf 248, *Agropyron riparium* cv. Sodar 247 and *Festuca rubra* cv. Boreal 240.

Of the other ecotypes seven received a 4 rating, seven a 3 rating and two received a 2 rating. Only one legume, *Astragalus cicer 103*, and three grasses, *Bromus inermis* cv. Magna 242, *Elymus innovatus 294* and *Festuca elatior* cv. Tammisto 99 received a rating of 1.

The ground cover on Rep 1 is around 25% while reps 2 & 3 only have around 5%. This cover consists largely of *Melilotus spp.* and *Onobrychis sp.* Also weeds but few grasses are prominent. Adjacent ground cover is similar with the addition of *Trifolium hybridum* while an area across the highway which is not as well drained has large amounts of *Calamagrostis canadenis*, *Poa palustris* and *Beckmannia syzigachne*.

DEVON #37

Location:

3.0 miles (4.83 km.) north on Highway 60
from Devon at University of Alberta's Woodbend
Research Station
Longitude - 113° 50' W.
Latitude - 23° 25' N.
Legal - 15 - 51 - 26 - W5
Elevation - 710 meters

Notes:

Ecological Zone - Aspen Parkland
Aspect - 5° W. - facing slope
Soil Type - sand
Moisture - fair
Disturbance of Soil - brush cleared;
soil cultivated
Method / Date of seeding
cover crop - none
test plants - planted by hand; Aug. 12, 1975
Fertilizer - none
Average frost-free period 102 days
May 27 - Sept. 6

Soil Properties:

Sandy soil ranging from slightly acid to mildly alkaline in reaction. Potassium content is relatively low.

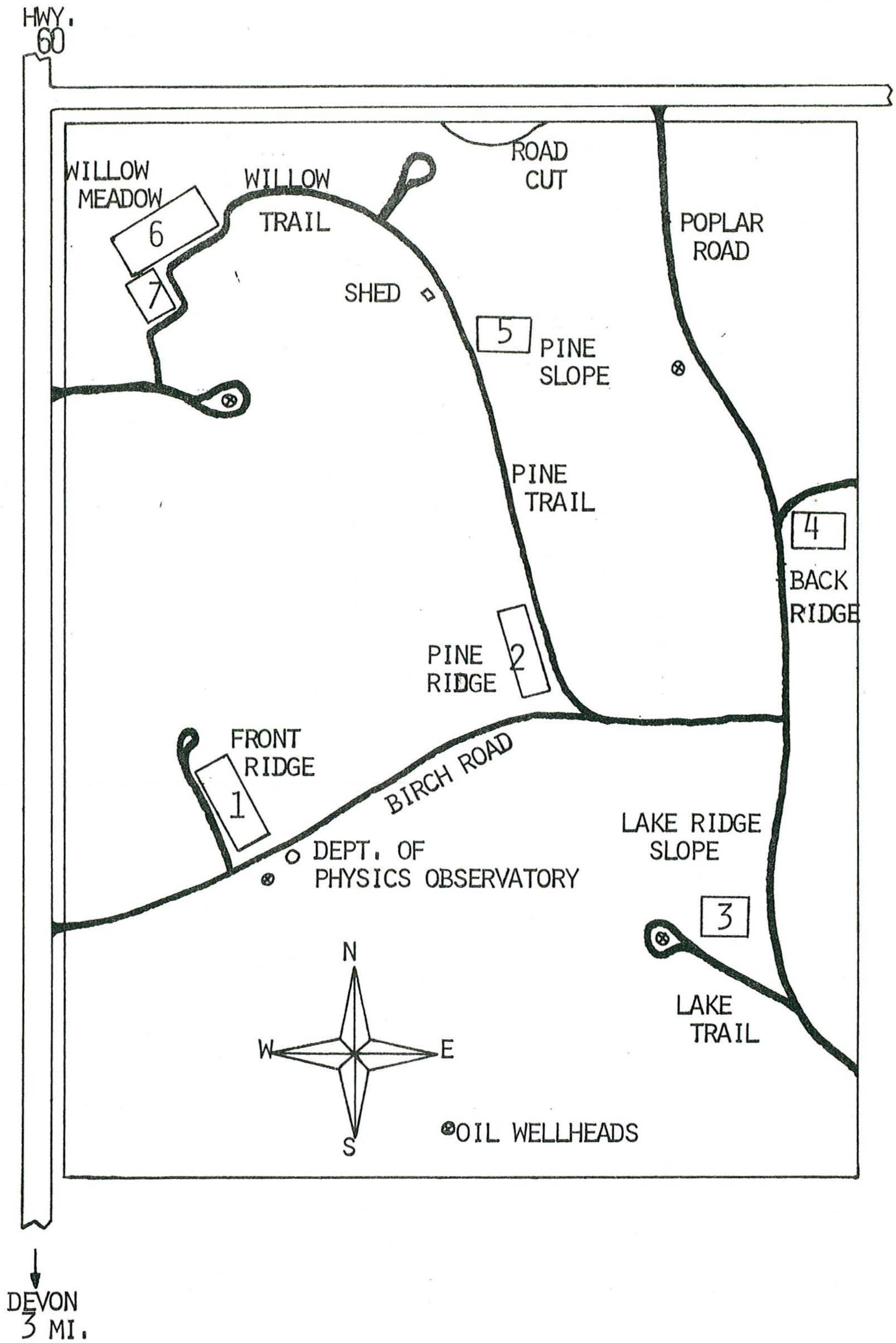
Table 2

CLIMATE: #37 DEVON

Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-20.1	-13.1	-7.7	2.3	9.8	13.5	15.3	15.4	9.5	3.5	-6.0	-14.4	0.6
High (°C)	-14.7	-5.7	-1.5	8.2	17.8	20.3	22.1	22.4	16.0	10.4	-0.9	-9.0	7.1
Low (°C)	-25.6	-20.4	-13.9	-3.7	1.8	6.8	8.4	8.4	3.5	-3.3	-11.2	-19.9	-5.8
Precip. (cm)	3.00	1.73	1.75	1.73	3.17	7.64	8.64	6.93	3.91	1.78	2.01	2.01	44.27
Wind *	22/9	21/7	23/8	16/14	17/14	20/10	22/9	23/8	19/11	20/11	22/8	23/8	248/117
Sunshine (# of hours)	96.4	115.9	165.7	231.5	302.6	277.4	310.5	302.1	172.3	159.9	87.8	80.9	2303.0

* Wind <u>up to 19.2 Km/hr.</u>
19.2 Km/hr. or over

DEVON SITE #37



O B S E R V A T I O N S

In 1975 approximately 7 acres of land were obtained for this research program at the University of Alberta's Woodbend Research Station at Devon. During 1975 this land was largely cleared and is now ready for planting in 1976.

At present there are 15 rows of legumes and shrubs planted there. These were put in on August 12, 1975 in 100 foot rows, with each row having 100 plants. This site is discussed in detail in section six of this report.

DIXONVILLE # 38

Location:

13.2 miles (21.1 km.) north on Highway 35 from the junction with Highway 2 or 9.4 miles (15.0 km.) south on highway 35 from the junction with Secondary Highway 689.

Longitude - 117° 36'

Latitude - 56° 25'

Legal - 32 - 85 - 23 - W5

Elevation - 660 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - 35° W. - facing slope

Soil Type - clay chips

Moisture - good 2 cm. down

Disturbance of soil - topsoil removed from roadside

Method / Date of planting:

cover crop - not planted

test plants - planted by hand; June 12/75

Fertilizer - none used

Average frost-free period - 91 days; June 6 - Sept. 6

Soil Properties:

Heavy clay soil with an extreme acid reaction. Inadequate supply of both Phosphorus and Nitrogen particularly under acid conditions.

Table 3

CLIMATE: #38 DIXONVILLE

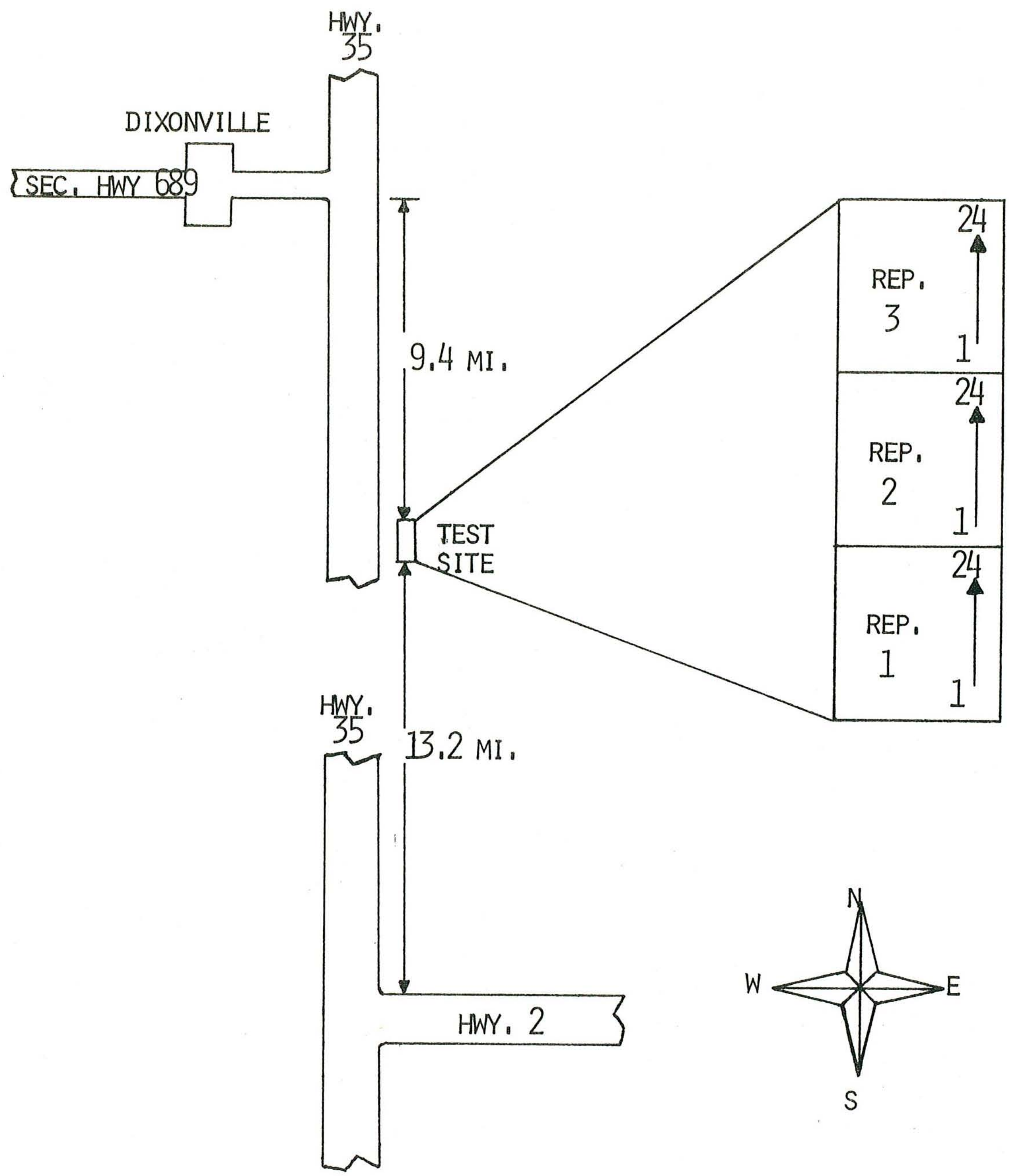
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-23.9	-15.7	- 8.4	1.5	10.3	14.2	16.1	15.7	8.5	3.4	-6.9	-15.5	-0.1
High (°C)	-18.9	-9.9	- 2.3	7.3	17.1	20.7	22.4	22.7	15.3	7.3	-2.2	-10.2	5.7
Low (°C)	-28.8	-22.1	-14.4	-4.2	3.6	7.7	9.7	8.8	1.9	-2.4	-11.6	-20.8	-6.5
Precip. (cm)	2.96	2.03	2.18	2.09	2.19	5.30	5.76	4.13	4.1	2.22	3.17	2.35	38.23
Wind *	27/4	25/3	26/5	23/7	19/12	22/8	25/6	25/6	23/7	23/8	25/5	27/4	290/75
Sunshine (# of hours)	81.4	111.5	171.3	216.6	285.5	270.0	279.3	262.7	157.1	132.2	75.4	62.3	2105.3

$$* \ \text{Wind} \ \frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$$

DIXONVILLE # 38

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Bromus inermis* cv. Magna
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca rubra* cv. Reptans
13 *Medicago sp.* cv. Drylander
14 *Onobrychis sp.* cv. Melrose
15 *Phleum pratense* cv. Climax
16 *Poa ampla*
17 *Poa compressa*
18 *Poa glaucantha*
19 *Poa palustris*
20 *Poa pratensis*
21 *Poa pratensis* cv. Fylking
22 *Puccinellia sp.*
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

DIXONVILLE SITE #38



O B S E R V A T I O N S

This site was hand planted with twenty-four different ecotypes in each of three reps. While planted at the same time as the other northern sites it is completely different because of the variance in soil conditions. The soil here is composed of clay, shale chips which do not appear to be conducive to the growth of anything. This statement is made because an area 50 yards to either side of our test site has a ground cover of 0%. In contrast the ground cover in all other areas around the test site is very similar to the Keg River site in that it is upwards of 80%.

Only two species have started to invade even a portion of the test site. These are *Prunus pennsylvanica* and *Rubus sp.* Otherwise the test site has no growth of any kind. This also applies to the test plants which were not in evidence at all at the time of the August 30th evaluation.

After these observations were made extensive soil samples were taken and these are being analyzed over the winter. Also this soil is being used for growth chamber and green house experiments in an effort to determine what the problem is. Assuming some tentative conclusions can be arrived at over the winter, additional planting will be done at this site in 1976.

GRANDE PRAIRIE #39

Location:

12.2 miles (19.5 km.) west on Highway 2
from the junction with Highway 40.
Longitude - 119° 07'
Latitude - 55° 10'
Legal - 26 - 71 - 8 - W6
Elevation - 760 meters

Notes:

Ecological Zone - Aspen Parkland
Aspect - 40° North facing slope
Soil type - clay - loam
Moisture - poor
Disturbance of soil - undisturbed; varying ground cover.
Method / Date of seeding:
cover crop: not planted
test plants: planted by hand; June 26/75
Fertilizer - none used
Average frost-free period - 113 days;
May 19 -- Sept. 10

Soil Properties:

Mildly alkaline, heavy clay soil with high levels of free carbonates. Phosphorus content is extremely low.

Table 4 CLIMATE: #39 GRANDE PRAIRIE

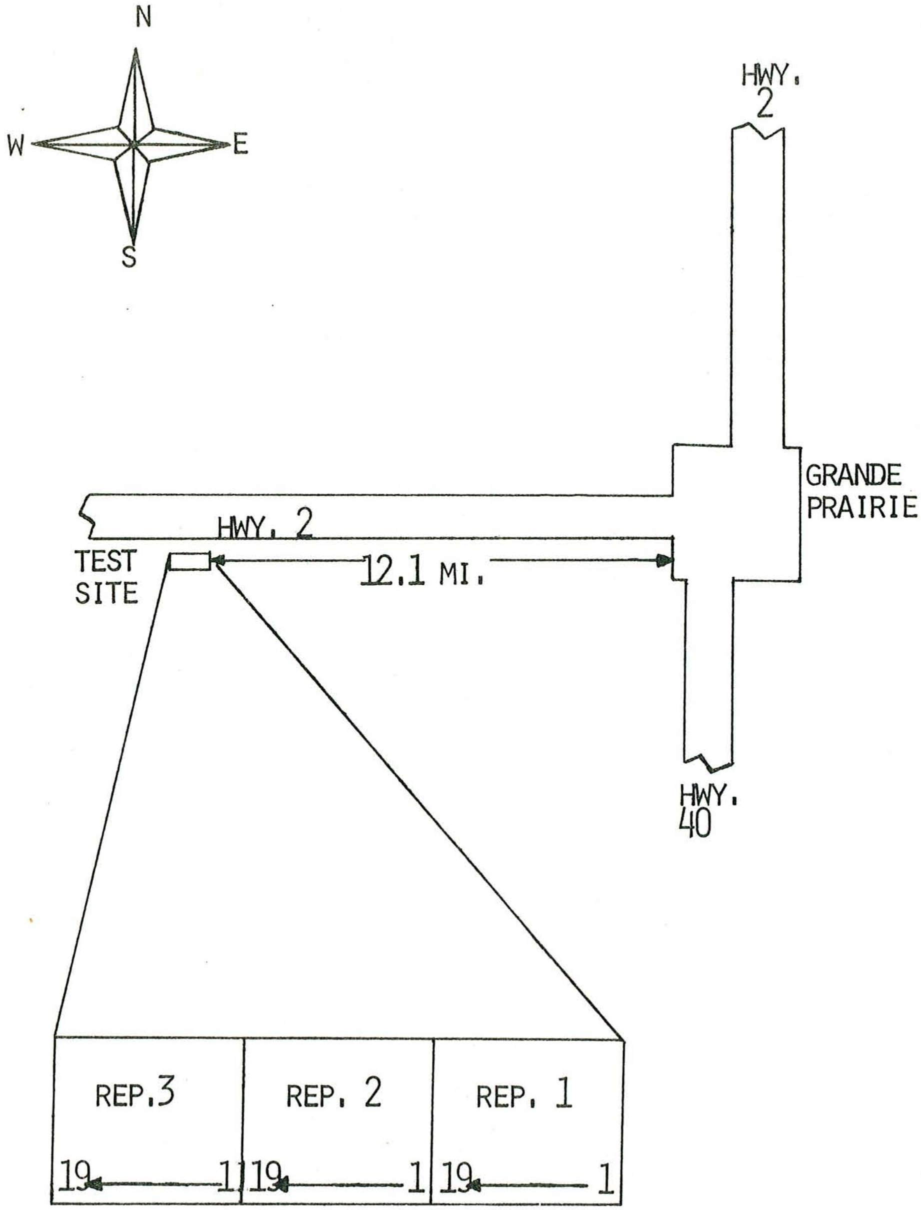
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-21.2	-12.8	-7.2	1.9	10.3	13.9	15.8	15.4	9.0	3.7	-7.3	-15.3	0.5
High (°C)	-16.0	-6.7	-1.4	7.7	17.0	20.0	22.0	22.0	14.8	9.4	-2.4	-10.1	6.3
Low (°C)	-26.4	-20.0	-12.9	-3.7	3.7	7.7	9.6	8.8	3.4	-2.0	-12.1	-20.5	-5.3
Precip. (cm)	3.66	2.38	2.18	2.41	2.41	7.49	5.61	5.38	4.62	1.80	3.63	2.59	44.19
Wind *	26/5	25/3	25/6	22/8	17/14	18/12	22/9	22/9	20/10	21/10	25/10	26/5	269/96
Sunshine (# of hours)	85.9	112.9	156.4	200.4	260.3	244.2	268.6	260.4	158.1	144.6	80.7	70.1	2042.6

* Wind up to 19.2 Km/hr.
19.2 Km/hr. or over

GRANDE PRAIRIE #39

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Elymus junceus* cv. Sawki
9 *Festuca rubra* cv. Reptans
10 *Medicago sp.* cv. Drylander
11 *Onobrychis sp.* cv. Melrose
12 *Poa ampla*
13 *Poa compressa*
14 *Poa glaucantha*
15 *Poa palustris*
16 *Poa pratensis*
17 *Puccinellia sp.*
18 *Trifolium hybridum* cv. Aurora
19 *Trifolium pratense*

GRANDE PRAIRIE SITE #39



OBSERVATIONS

This test site was hand planted on June 26, 1975 in the midst of an area which had previously received ground cover planting from the Department of Highways in some other year. When evaluation took place on August 31, 1975 there was very little growth noticeable in the test plants. This was not unexpected because of the late planting and also the presence of the already established cover crop.

At the time of the evaluation the most prominent of the test plants were *Trifolium pratense* 122, *Trifolium hybridum* cv. Aurora 115 and *Onobrychis* sp. 254. In later years this site may show better growth but it is also possible that our test plants will not survive because they are in a very weak bio-competitive position.

Present ground cover on the site is around 55% consisting of the Dept. of Highways mix. The most prominent species in this mix are *Medicago sp.*, *Trifolium sp.*, *Bromus inermis*, and *Festuca sp.*

OKOTOKS #40

Location:

1.3 miles (2.1 km.) south-east on Highway 2A
from the junction with Highway 7.
Longitude - 114° 10'
Latitude - 50° 43'
Legal - NE 21 - 20 - 29 - W4
Elevation - 1050 meters

Notes:

Ecological Zone - Aspen Parkland
Aspect - level
Soil type - rocky clay
Moisture - fair
Disturbance of soil - nil
Method / Date of seeding:
 cover crop - not planted
 test plants - hand planted; June 3/75
Fertilizer - none used
Average frost-free period - 120 days
 May 20 - Sept. 18

Table 5

CLIMATE: #40 OKOTOKS

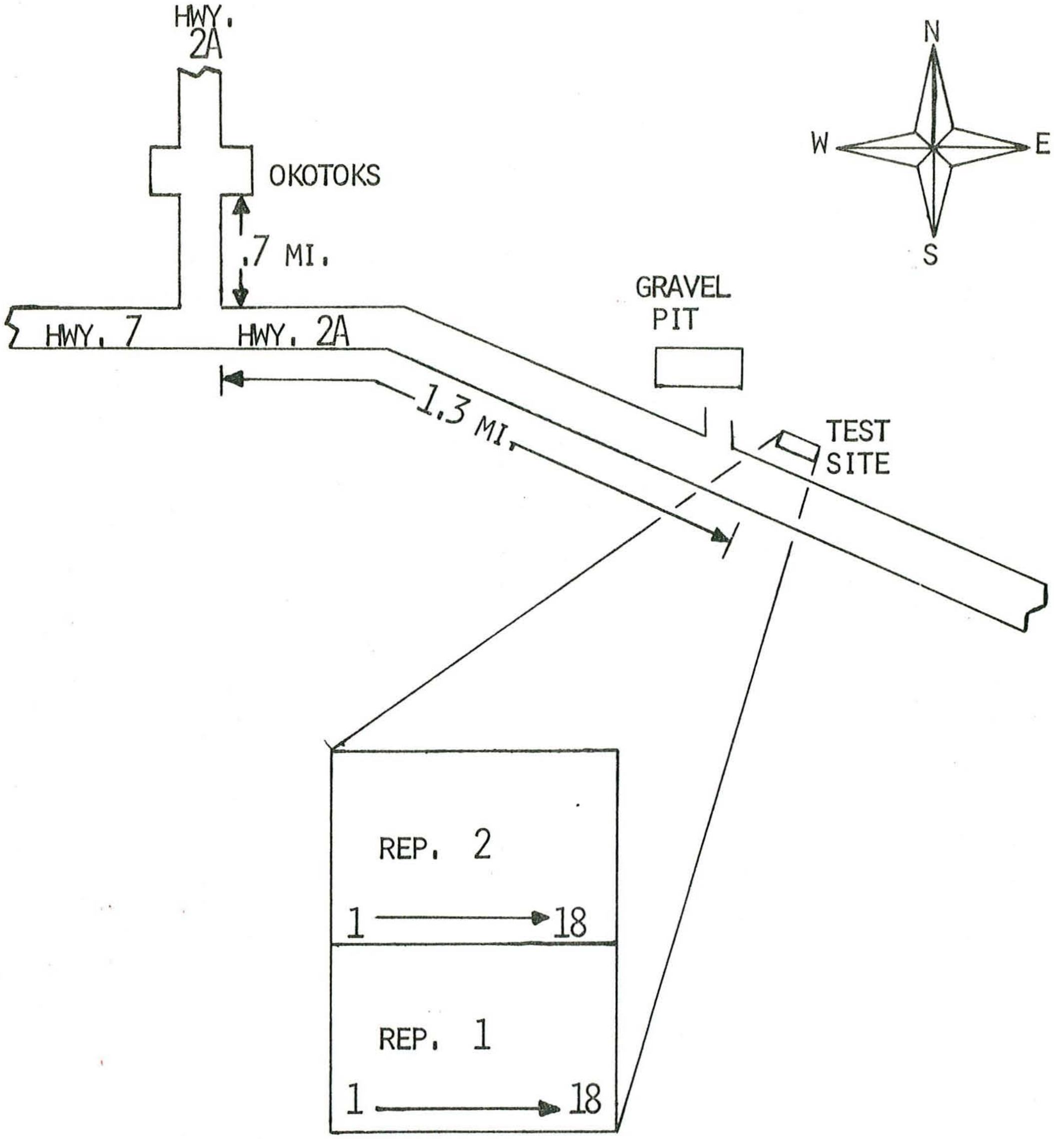
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-15.5	-7.5	-3.7	3.8	10.7	14.6	17.0	17.5	10.9	5.4	-2.8	-9.7	3.4
High (°C)	-10.2	6.7	2.4	10.0	17.7	21.0	24.2	25.2	17.8	12.2	2.4	-4.2	8.8
Low (°C)	-20.8	-13.7	-9.9	-2.2	3.7	8.2	9.9	9.9	4.2	-1.6	-8.0	-15.5	-3.6
Precip. (cm)	2.92	1.76	1.88	2.60	3.86	9.38	6.27	3.58	4.77	1.63	1.77	2.10	42.52
Wind *	21/10	20/8	20/11	15/15	16/15	18/12	21/10	21/10	19/11	16/15	21/9	21/10	229/146
Sunshine (# of hours)	94.0	132.1	170.1	184.3	262.1	240.3	329.6	316.5	193.6	166.7	111.2	91.8	2293.2

* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

OKOTOKS #40

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trachycaulum*
4 *Agropyron trichophorum* cv. Greenleaf
5 *Agrostis gigantea*
6 *Bromus inermis*
7 *Bromus inermis* cv. Magna
8 *Calamagrostis inexpansa*
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca scabrella*
13 *Hedysarum sp.*
14 *Onobrychis sp.* cv. Melrose
15 *Poa compressa*
16 *Trifolium hybridum* cv. Aurora
17 *Trifolium pratense*
18 *Trifolium repens*

OKOTOKS SITE #40



O B S E R V A T I O N S

This site was hand planted with test rows on June 3, 1975. No cover crop was planted as the site is in an area of native rangeland. The site was then twice evaluated during the summer; first on August 14, 1975 and again on October 5, 1975.

As expected the August evaluation showed no test plants above ground as yet. The October evaluation showed more promise as by this time some minute plants were beginning to emerge. However these were still less than 1/4" high so that no detailed evaluation could be done. This slow growth here, and at other rangeland sites, was expected to occur because of a combination of late planting, a dry summer, extensive native ground cover and no fertilization.

As mentioned, the native ground cover is extensive - being around 80%. The major components of this cover include *Agropyron smithii*, *Poa canbi*, *Poa pratensis*, *Festuca scabrella*, *Thermopsis rhombifolia* and some *Lupinus sp*. Ground cover adjacent to the site is similar with the addition of *Cirsium arvense* on the waste dump beside the site.

BOW CITY #41

Location:

1 mile (1.61 km.) west of Bow City

Longitude - 112° 16'

Latitude - 50° 27'

Legal - 17 - 17 - W4

Elevation - 770m

Notes:

Ecological zone - Shortgrass Prairie

Aspect - level

Soil Type - rocky clay

Moisture - good

Disturbance of Soil - recently leveled coal mine site

Method / Date of seeding:

cover crop - cyclone seeder; June 5/75

test plants - garden seeder; June 5/75

Fertilizer - 200 lbs./acre of 16 - 20 - 0 June 5, 1975.

Soil Properties:

Moderate to strongly alkaline soil with high levels of free carbonates. Phosphorus content is extremely low. High Sodium level also causes poor physical structure.

Table 6

CLIMATE: #41 BOW CITY

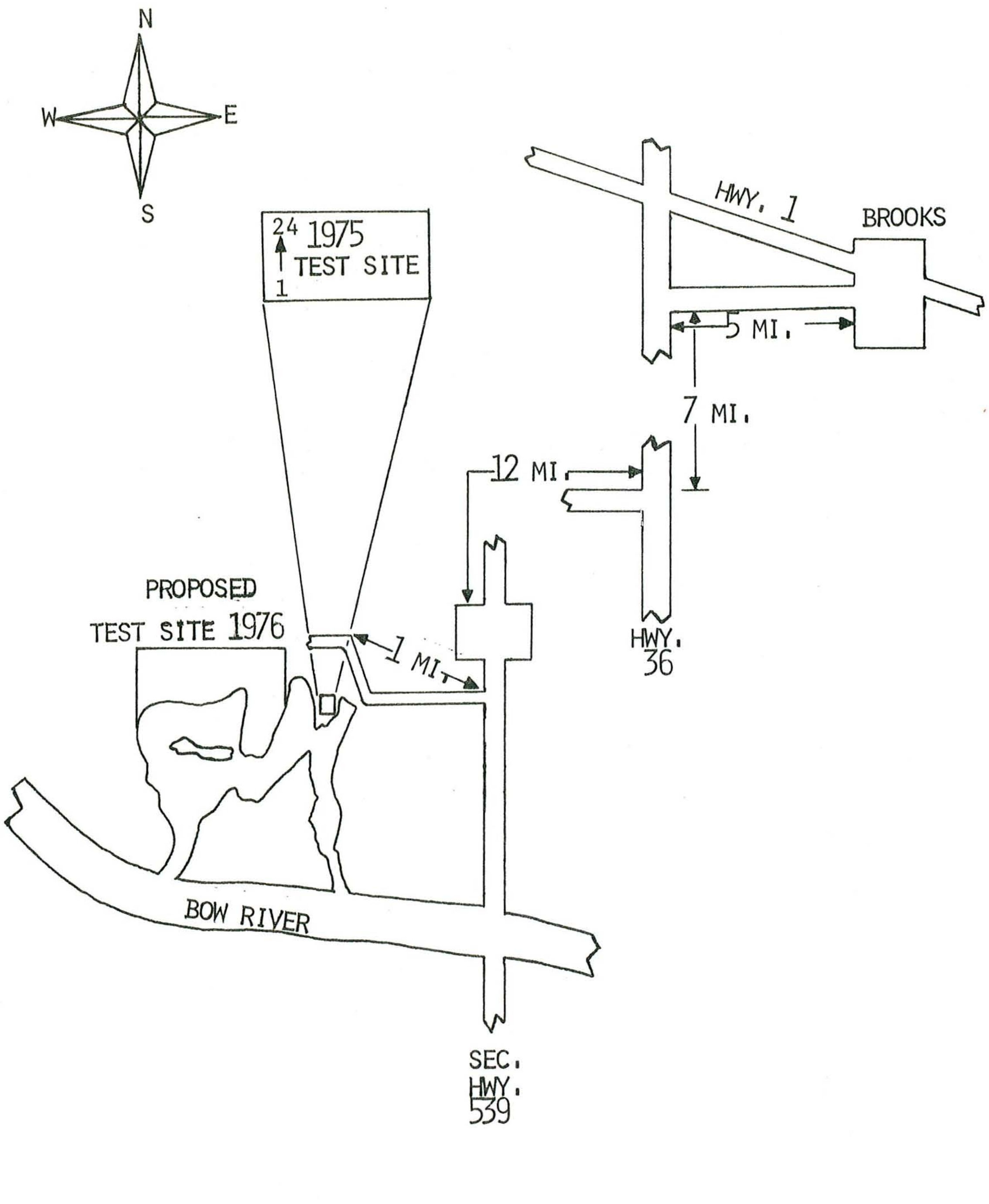
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-17.4	-9.7	-5.1	4.1	11.1	15.3	18.0	19.0	11.4	5.3	-3.6	-11.3	3.1
High (°C)	-4.7	-3.0	0.7	10.9	18.4	22.0	25.6	27.7	18.7	12.4	1.9	-5.7	9.8
Low (°C)	-22.9	-16.4	-10.9	-2.6	3.9	8.7	10.5	10.3	4.1	-1.9	-9.1	-17.0	-3.1
Precip. (cm)	3.05	1.29	1.27	2.06	3.07	8.28	3.37	2.77	3.98	2.06	1.62	1.98	34.82
Wind *	25/6	23/5	25/8	18/12	23/8	23/7	26/5	24/7	23/7	21/10	25/5	23/8	277/88
Sunshine (# of hours)	79.5	113.1	171.4	210.4	277.0	286.0	362.8	315.8	188.9	167.0	95.1	75.1	2342.1

* Wind up to 19.2 Km/hr.
19.2 Km/hr. or over

BOW CITY #41

1 *Agropyron cristatum* cv. Fairway
2 *Agropyron cristatum* cv. Summit
3 *Agropyron riparium* cv. Sodar
4 *Agropyron smithii*
5 *Agropyron trachycaulum*
6 *Agrostis gigantea*
7 *Bromus inermis*
8 *Bromus inermis* cv. Magna
9 *Elaeagnus commutata*
10 *Elymus canadensis*
11 *Elymus junceus* cv. Sawki
12 *Festuca ovina*
13 *Festuca rubra* cv. Boreal
14 *Medicago sp.*cv. Kane
15 *Medicago sp.* cv. Rambler
16 *Poa ampla*
17 *Poa compressa*
18 *Poa glaucantha 1*
19 *Poa glaucantha 2*
20 *Poa pratensis*
21 *Puccinellia nuttalliana*
22 *Trifolium hybridum* cv. Dawn
23 *Trifolium pratense*

BOW CITY SITE #41



O B S E R V A T I O N S

In 1975 a test site was obtained at the old abandoned coal mine at Bow City through the assistance of Alberta Environment. This whole area is currently being reclaimed by Environment, hopefully to be later used as a park. This site was planted on June 6, 1975 with both grasses and willow cuttings being put in.

Evaluation of this site took place both in August, 1975 and also on October 16, 1975. The early evaluation showed little growth in the grasses but some of the willows had already taken hold. The October evaluation showed many of the grasses to have germinated but as the height was still less than 1/2" no detailed evaluation could be done. At this time it was too late to get an accurate count of how many willows had taken root.

An additional site of approximately 6 acres has also been obtained from Environment for major revegetation research at Bow City. Starting in 1976 this site will become the focal point for revegetation work in southern Alberta. In 1975 a contractor was hired to grade this area and as this has now been adequately done extensive work will be undertaken on this area in 1976.

Native ground cover here is typical for the southern Alberta prairie region. The dominant grasses here are *Koeleria cristata, Stipa spp., Poa canbyi, Agropyron spp., Bouteloua gracilis, Sphenopholis sp., and Festuca sp.* The major legumes in this area are *Thermopsis rhombifolia* and *Astragalus sp.*

RAINBOW LAKE #42

Location: 87.2 miles (139.5 km.) west of Highway 35 on Highway 58 or 0.8 miles (1.3 km.) east of Rainbow Lake.

Longitude - 119° 25'

Latitude - 58° 10'

Legal - 109 - 9 - W6

Elevation

Notes:

Ecological Zone - Boreal Forest

Aspect - 5° N - facing slope

Soil - sandy clay

Moisture - poor

Disturbance of soil - topsoil removed from roadside

Method / Date of seeding:

cover crop - not planted

test plants - hand planted June 11/75

Fertilizer - none used

Average frost-free period - 91 days; June 6 - Sept. 6

Soil Properties:

Mildly alkaline soil deficient in both Phosphorus and Nitrogen.

Table 7

CLIMATE: #42 RAINBOW LAKE

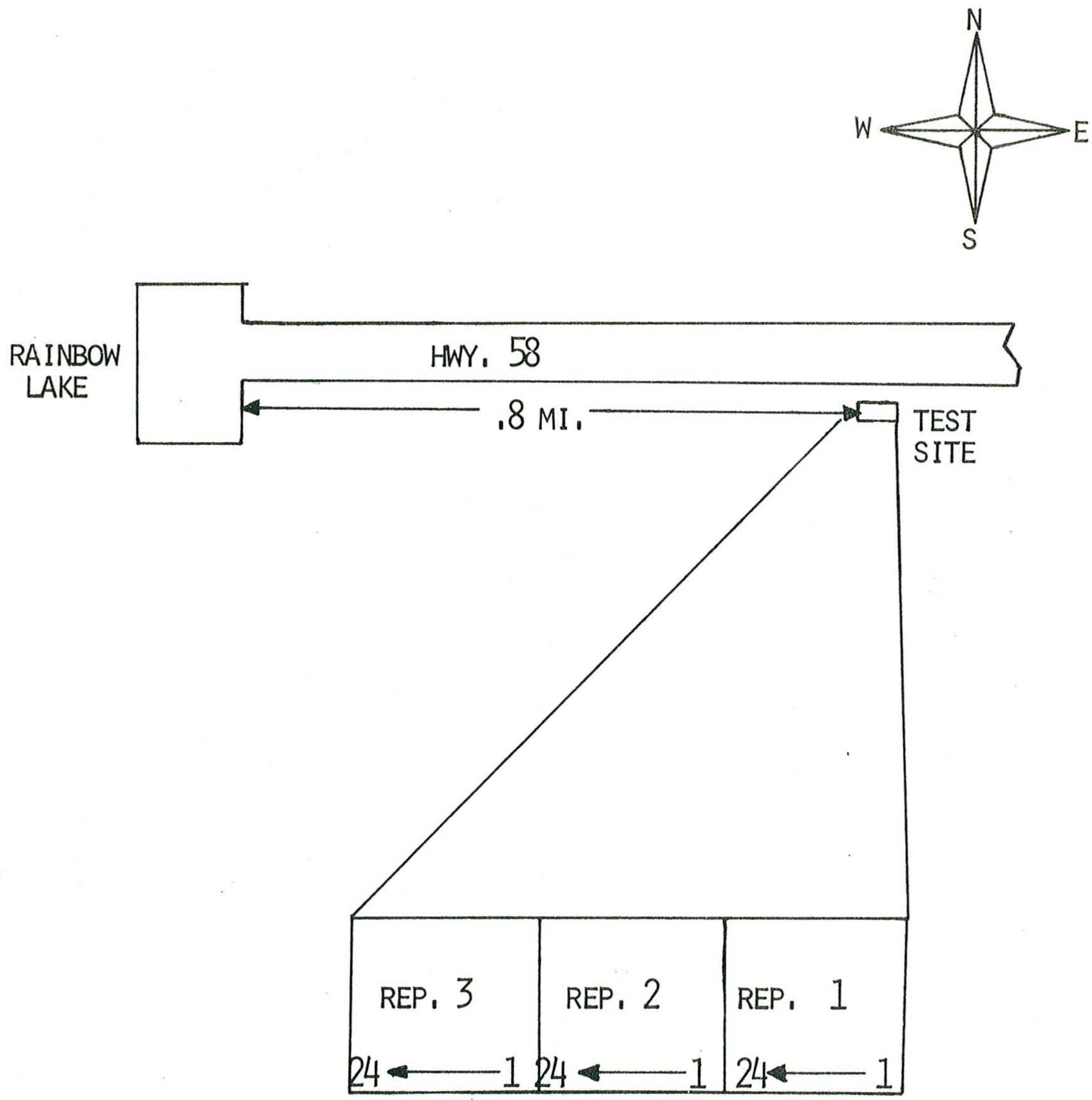
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-26.6	-18.7	-9.6	1.2	10.4	14.6	16.4	16.0	8.1	1.2	-6.6	-15.7	-0.7
High (°C)	-21.9	-13.2	-3.3	7.0	17.3	21.5	22.9	23.2	15.8	5.3	-2.0	-10.3	5.2
Low (°C)	-31.3	-24.2	-15.9	-4.7	3.5	7.7	9.8	8.9	0.4	-2.8	-11.2	-21.1	-7.7
Precip. (cm)	2.26	1.68	2.18	1.78	1.98	3.12	5.92	2.89	3.58	2.72	2.72	2.08	32.28
Wind *	28/3	26/2	27/4	24/6	22/9	25/5	28/3	28/3	27/3	26/5	26/4	29/2	316/49
Sunshine (# of hours)	76.9	110.2	186.2	232.9	310.8	295.9	311.5	269.7	154.3	119.8	59.5	36.9	2164.6

* Wind up to 19.2 Km/hr. / 19.2 Km/hr. or over

RAINBOW LAKE # 42

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Bromus inermis* cv. Magna
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca rubra* cv. Reptans
13 *Medicago sp.* cv. Drylander
14 *Onobrychis sp.* cv. Melrose
15 *Phleum pratense* cv. Climax
16 *Poa ampla*
17 *Poa compressa*
18 *Poa glaucantha*
19 *Poa palustris*
20 *Poa pratensis*
21 *Poa pratensis* cv. Fylking
22 *Puccinellia sp.*
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

RAINBOW LAKE SITE #42



O B S E R V A T I O N S

This site was planted on June 11, 1975 with three reps of test plants being put in but no cover crop.

Evaluation of this site took place on August 29, 1975 and as expected very few of the plants were substantially above ground. The late planting time and a shortage of moisture no doubt contributed to this lack of first year growth.

At the time of evaluation only two ecotypes, *Medicago sp.* cv. Drylander *250* and *Onobrychis sp. 254*, were taller than 1 inch. However the other legumes and many of the other grasses were definitely starting to come in. No detailed evaluation was done as all the others were still in the vicinity of 1/4" in height. Should these small plants overwinter successfully this site could give excellent results in future years.

The ground cover on and adjacent to the site is around 30%. The major species noticeable are *Melilotus spp.*, and *Epilobium sp.* Lesser amounts of *Hordeum sp.*, *Festuca sp.* and *Agropyron sp.* are also present.

INDIAN CABINS #45

Location:

17.5 miles (28.0 km.) north of north exit to Steen River service station or 0.7 miles (1.1 km.) south of north exit to Indian Cabins service station on Highway 35.

Longitude - 117° 05'

Latitude - 59° 50'

Legal - 125 - 18 - W5

Elevation

Notes:

Ecological Zone - Boreal Forest

Aspect - 0 - 20° E.-W. - facing slope

Soil - sand and gravel

Moisture - good 1 cm. down

Disturbance of soil - topsoil removed from roadside

Method / Date of seeding:

cover crop - not planted

test plants - hand planted; June 11/75

Fertilizer - none used

Average frost-free period - 91 days; June 6 - Sept. 6

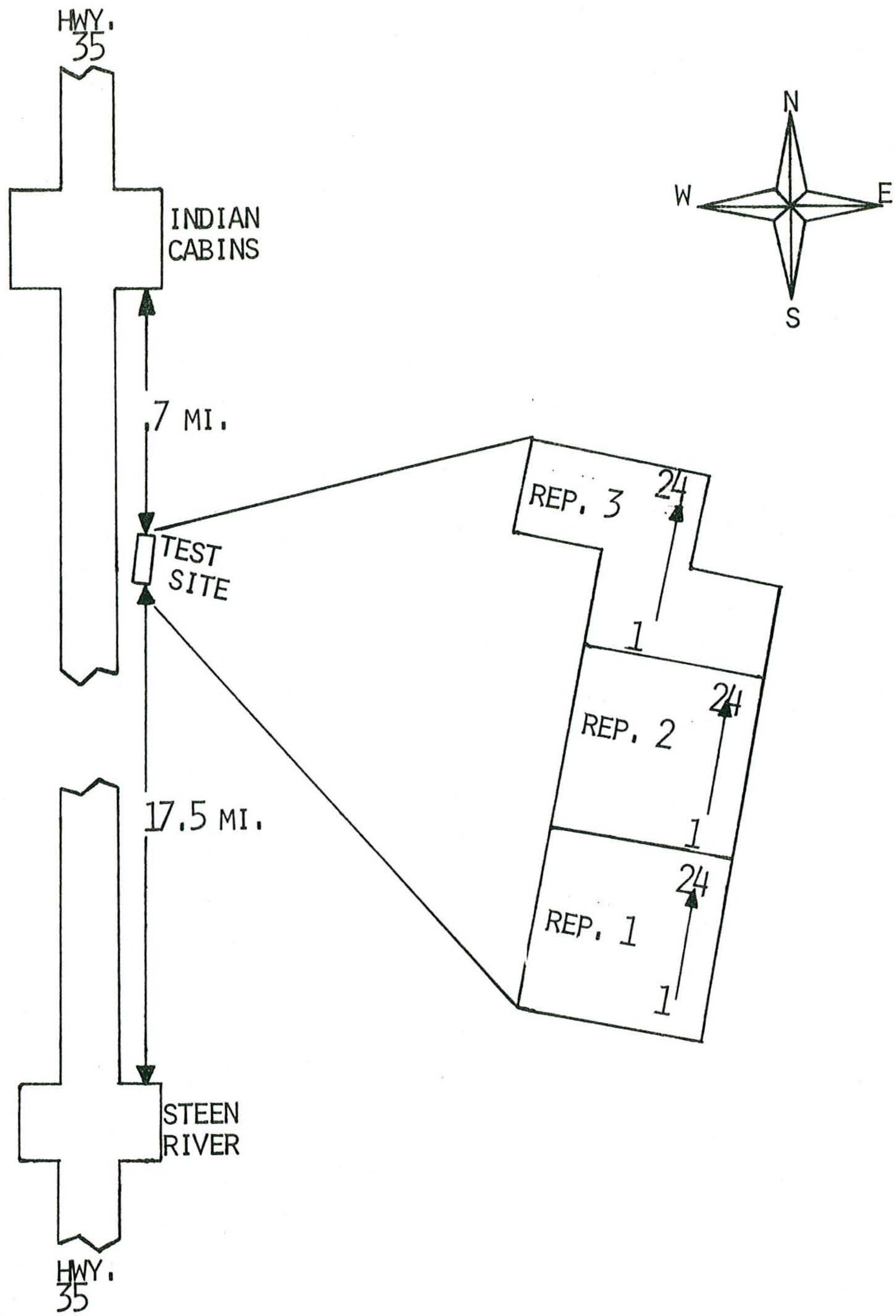
Soil Properties:

Strongly alkaline, coarse sandy soil with high levels of free carbonates. Deficient in all available plant nutrients.

INDIAN CABINS # 45

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Bromus inermis* cv. Magna
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca rubra* cv. Reptans
13 *Medicago sp.* cv. Drylander
14 *Onobrychis sp.* cv. Melrose
15 *Phleum pratense* cv. Climax
16 *Poa ampla*
17 *Poa compressa*
18 *Poa glaucantha*
19 *Poa palustris*
20 *Poa pratensis*
21 *Poa pratensis* cv. Fylking
22 *Puccinellia sp.*
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

INDIAN CABINS SITE #45



OBSERVATIONS

Three reps of test plants were put in at this test site on June 11, 1975. At the time of planting no ground cover crop was planted. This site is on generally poor soil as it is located in a mixture of sand and gravel. Consequently very little growth may be expected from these plants. In fact when the final evaluation took place on August 28, 1975 there was no evidence of any germination as yet. However it is possible that some of the test plants may well emerge in the spring of 1976.

At present native ground cover on the site is around 20% consisting almost exclusively of legumes and shrubs. The major species present include *Trifolium sp.*, *Medicago sp.*, *Melilotus sp.*, and *Rosa spp.* The growth of grasses on the site is very sporadic with only a little *Bromus sp.*, and *Festuca sp.* being evident.

FORT VERMILION #46 √

Location:

South off Highway 58A at the Canada Agriculture Experimental Farm sign for 0.5 miles (0.8 km.) then east 19.8 miles (31.3 km.)

Longitude - 115° 45'

Latitude - 58° 11'

Legal - 106 - 11 - W5

Elevation - 295 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - 0 - 40° E. - W. - facing slope

Soil - clay, some sand in Rep 3

Moisture - poor on slope; fair on level

Disturbance of soil - topsoil removed from roadside

Method / Date of seeding:

cover crop - not planted

test plants - hand planted; June 11/75

Fertilizer - none used

Average frost-free period - 91 days

June 6 - Sept. 6

Soil Properties:

Moderately alkaline, heavy clay soil with high levels of free lime. Extremely low in Phosphorus.

Table 8

CLIMATE: #46 FT. VERMILION

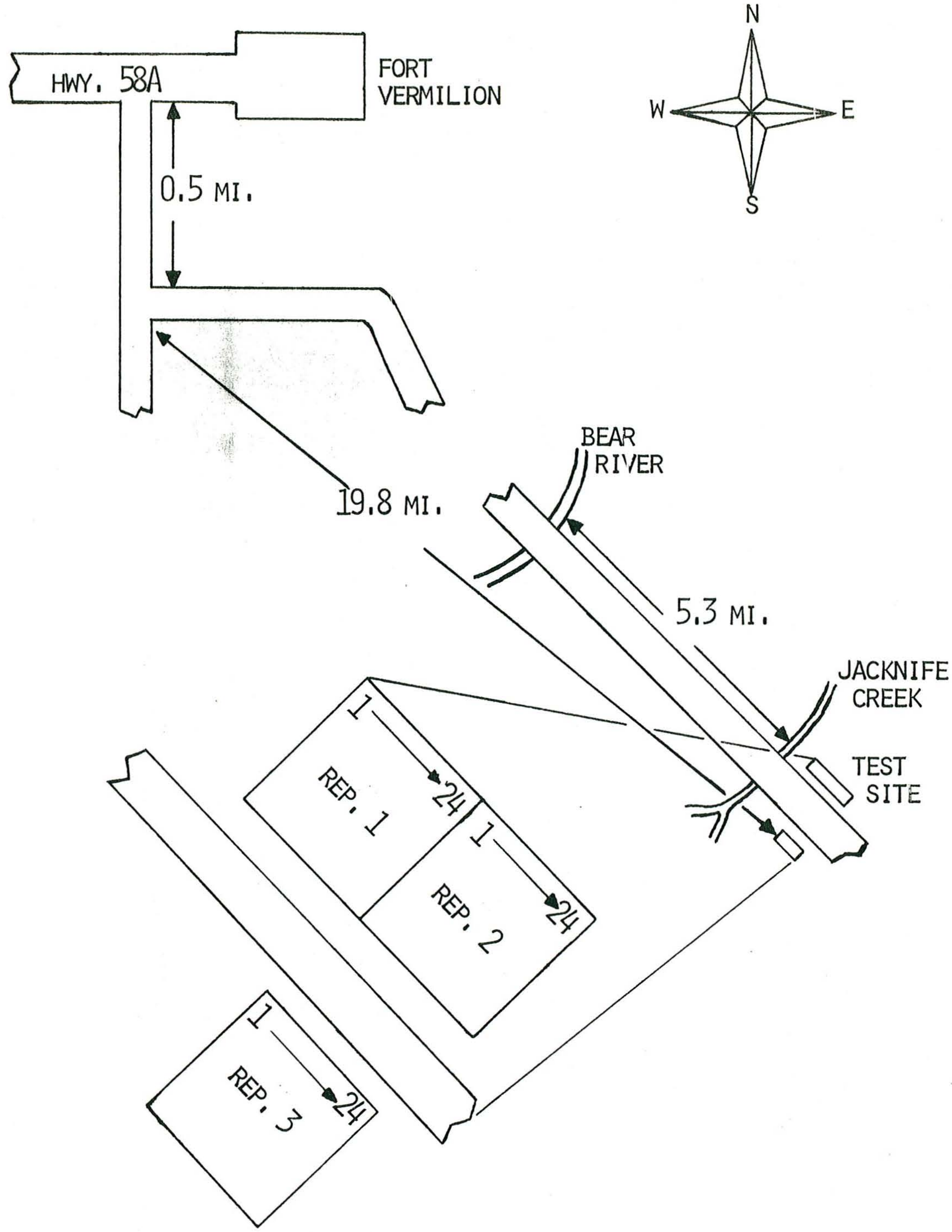
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-26.6	-18.7	-9.6	1.2	10.4	14.6	16.4	16.0	8.1	1.2	-6.6	-15.7	-0.7
High (°C)	-21.9	-13.2	-3.3	7.0	17.3	21.5	22.9	23.2	15.8	5.3	-2.0	-10.3	5.2
Low (°C)	-31.3	-24.2	-15.9	-4.7	3.5	7.7	9.8	8.9	0.4	-2.8	-11.2	-21.1	-7.7
Precip. (cm)	2.26	1.68	2.18	1.78	1.98	3.12	5.92	2.89	3.58	2.72	2.72	2.08	32.28
Wind *	$\frac{28}{3}$	$\frac{26}{2}$	$\frac{27}{4}$	$\frac{24}{6}$	$\frac{22}{9}$	$\frac{25}{5}$	$\frac{28}{3}$	$\frac{28}{3}$	$\frac{27}{3}$	$\frac{26}{5}$	$\frac{26}{4}$	$\frac{29}{2}$	$\frac{316}{49}$
Sunshine (# of hours)	76.9	110.2	186.2	232.9	310.8	295.9	311.5	269.7	154.3	119.8	59.5	36.9	2164.6

* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

FORT VERMILION # 46

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Bromus inermis* cv. Magna
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca rubra* cv. Reptans
13 *Medicago sp.* cv. Drylander
14 *Onobrychis sp.* cv. Melrose
15 *Phleum pratense* cv. Climax
16 *Poa ampla*
17 *Poa compressa*
18 *Poa glaucantha*
19 *Poa palustris*
20 *Poa pratensis*
21 *Poa pratensis* cv. Fylking
22 *Puccinellia sp.*
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

FORT VERMILION SITE #46



OBSERVATIONS

This site was planted on June 12, 1975. At the time, three reps, each having twenty-four rows of test plants, were put in but no ground cover seeding was done.

The site was evaluated on August 29, 1975. At this time very little growth was noticeable, a fact which can be directly attributed to the late planting time. The only plants which were visible at this time were some of the legumes. These included *Trifolium hybridum* cv. Aurora 115, *Trifolium pratense 122, Onobrychis* sp. 254 and *Medicago sp.* cv. Drylander 250. In all cases the maximum height was 1/4 inch so no detailed evaluation could be made.

The ground cover on the reps was less than 2% and consisted almost exclusively of *Hordeum* sp. It might be noted that even this ground cover looked extremely weak.

Ground cover in the vicinity of the site was not much stronger but also included *Vicia sp., Lathyrus sp.,* and *Calamagrostis canadensis.*

Next year's evaluations should prove informative in disclosing whether some of the seeds which did not germinate in 1975 will do so in 1976.

KEG RIVER #47

Location:

1 mile (1.6 km.) north of the Keg River townsite turnoff on Highway 35 or 13.0 (20.8 km.) south of Paddle Prairie.

Longitude - 117° 38'

Latitude - 58° 48'

Legal - 101 - (23 - 22) - W5

Elevation - 400 meters

Notes:

Ecological zone - Boreal Forest

Aspect - 0 - 30° E.W. - facing slope

Soil - silty clay

Moisture - dry on slopes, wet in ditches

Disturbance of soil - undisturbed recently; heavy ground cover

Method / Date of seeding:

cover crop - not planted

test plants - planted by hand; June 12,75

Fertilizer - none used

Average frost-free period - 91 days; June 6 - Sept. 6

Climate: Refer to #42 - Rainbow Lake

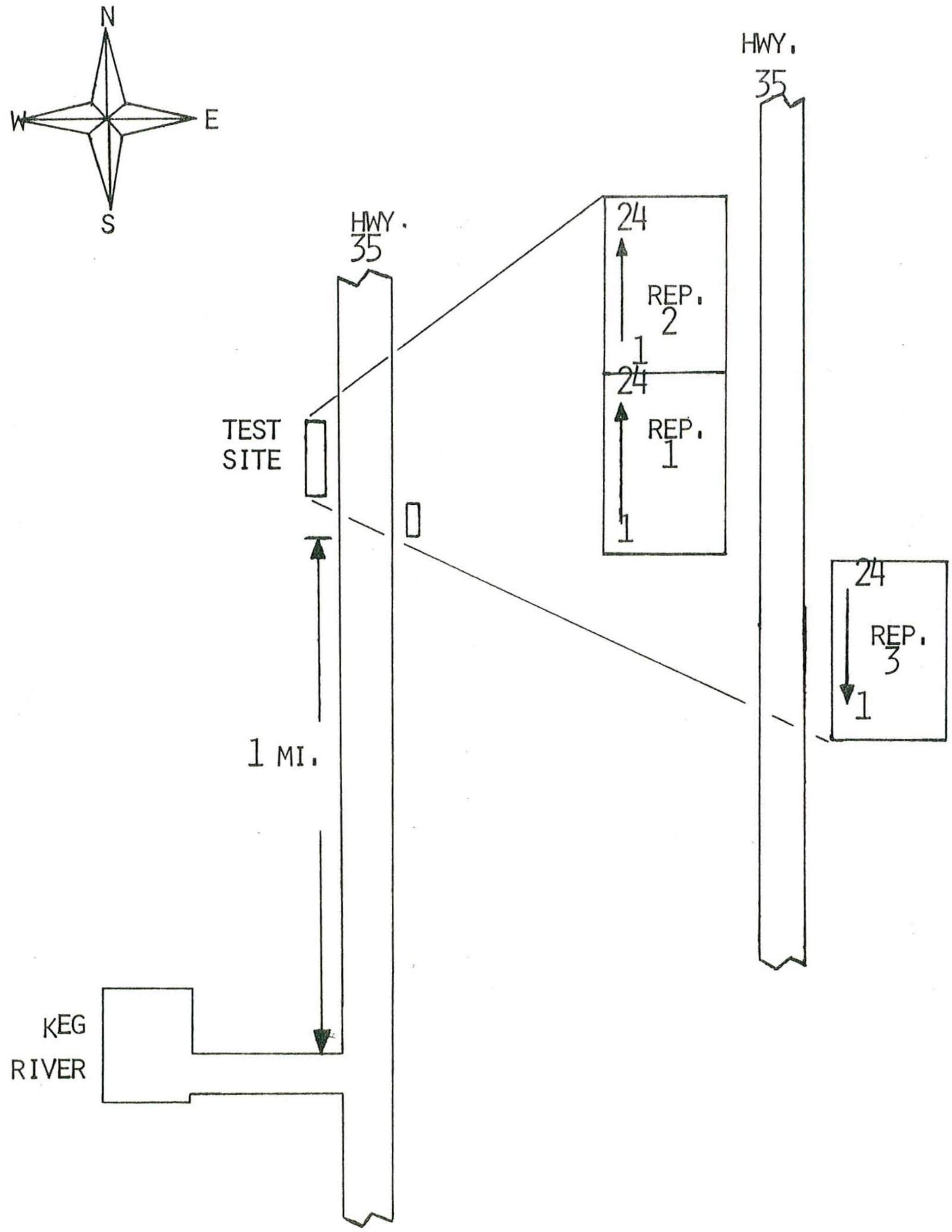
Soil Properties:

Moderately alkaline, heavy clay soil with high levels of free carbonates. Extremely low in Phosphorus.

KEG RIVER #47

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Bromus inermis* cv. Magna
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca rubra* cv. Reptans
13 *Medicago sp.* cv. Drylander
14 *Onobrychis sp.* cv. Melrose
15 *Phleum pratense* cv. Climax
16 *Poa ampla*
17 *Poa compressa*
18 *Poa glaucantha*
19 *Poa palustris*
20 *Poa pratensis*
21 *Poa pratensis* cv. Fylking
22 *Puccinellia sp.*
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

KEG RIVER SITE #47



O B S E R V A T I O N S

This site was planted on June 12, 1975. Here three reps containing twenty-four different ecotypes were hand planted. No ground cover crop was planted as there already is extensive ground cover on the site.

Little growth was expected in the first year because of the late planting, the dry soil conditions and the present ground cover. This proved to be the case when the site was evaluated on August 30, 1975. At this time most of the plants had not yet emerged above ground or were so small as to be unlocatable among the ground cover. The only ecotypes which were definitely identifiable at this time were *Medicago sp.* cv. Drylander 250 and *Trifolium pratense 122*. Even at that both of these ecotypes were less than 1/2 inch in height.

The ground cover on and adjacent to the site is very thick - being in the vicinity of 80%. This consists largely of shrubs and legumes with some grasses mixed in. The dominant shrubs are *Rosa acicularis, Shepherdia canadensis, Salix spp.* and dwarf *Populus sp.* The legumes which are on this site are more prevalent on Rep 3 than on Rep 1 or Rep 2. These include *Medicago sp., Melilotus spp., Trifolium sp.,* and *Astragalus sp.* As mentioned earlier there are few grasses on the site and of these the most noticeable is *Bromus inermis*.

This site could prove useful in the future if the seed planted in 1975 can germinate in the spring of 1976.

LOON LAKE #48

Location:

2.2 miles (3.5 km.) north of second Red Earth turnoff, or approximately 0.12 miles (0.2 km.) south of the Loon River Bridge.

Longitude - 115° 10'

Latitude - 56° 34'

Legal - 26 - 87 - 8 - W5

Elevation - 525 meters

Notes:

Ecological Zone - Boreal Forest

Aspect - level ground

Soil - silty loam

Moisture - extremely wet

Disturbance of soil - roadside, some erosion, topsoil removed

Method / Date of seeding:

cover crop - not planted

test plants - planted by hand; June 14/75

Fertilizer - none used

Average frost-free period - 67 days; June 18 - August 24

Soil Properties:

Heavy clay soil with a medium acid reaction. Deficient in Phosphorus.

Table 9

CLIMATE: #48 LOON LAKE

Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-21.3	-12.5	-6.7	2.0	9.3	13.3	15.3	15.0	8.3	2.8	-8.8	-15.7	-0.1
High (°C)	-15.5	-5.5	0.3	9.2	17.6	20.3	22.3	22.2	14.4	8.5	-3.7	-10.6	6.6
Low (°C)	-27.0	-19.7	-13.8	-4.7	2.0	6.2	8.2	7.8	2.2	-3.0	-12.8	-20.7	-6.8
Precip. (cm)	3.20	2.13	1.98	2.34	4.49	7.95	10.05	6.63	5.87	3.02	2.71	2.13	51.76
Wind *	$\frac{28}{3}$	$\frac{26}{2}$	$\frac{27}{4}$	$\frac{24}{6}$	$\frac{22}{9}$	$\frac{25}{5}$	$\frac{28}{3}$	$\frac{28}{3}$	$\frac{27}{3}$	$\frac{26}{5}$	$\frac{26}{4}$	$\frac{29}{2}$	$\frac{316}{49}$
Sunshine (# of hours)	81.4	111.5	171.3	216.6	285.5	270.1	290.0	265.0	156.2	132.2	70.1	54.5	2104.4

* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

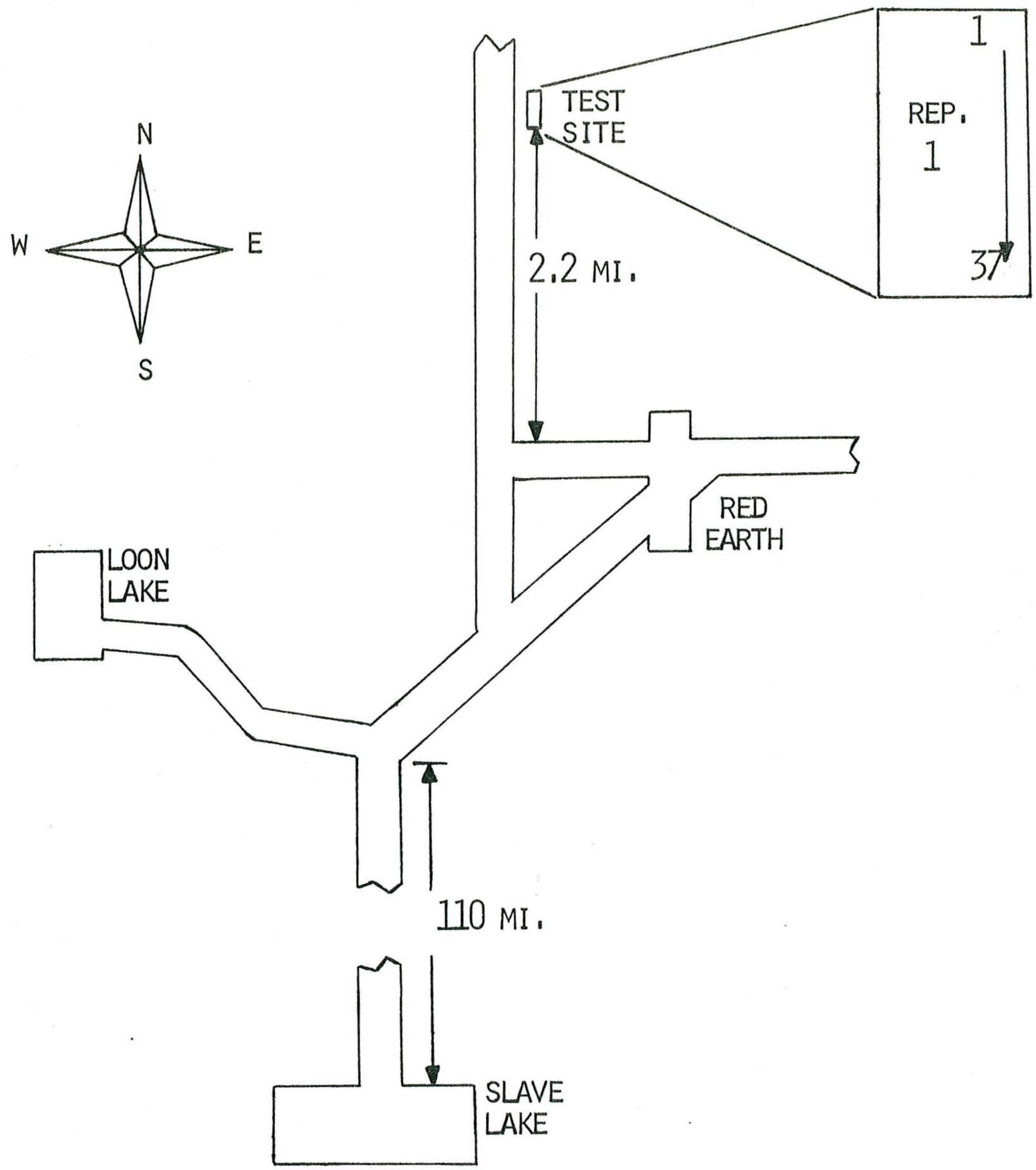
LOON LAKE #48

1 *Agropyron riparium* cv. Sodar
2 *Agropyron smithii*
3 *Agropyron sp.*
4 *Agropyron trachycaulum* 1
5 *Agropyron trachycaulum* 2
6 *Agropyron trachycaulum* cv. Revenue
7 *Agropyron trichophorum* cv. Greenleaf
8 *Agrostis gigantea* 1
9 *Agrostis gigantea* 2
10 *Agrostis sp.*
11 *Alopecurus pratensis*
12 *Astragalus cicer*
13 *Bromus inermis*
14 *Bromus inermis* cv. Magna
15 *Bromus pumpellianus*
16 *Coronilla varia*
17 *Elymus innovatus* 1
18 *Elymus innovatus* 2
19 *Elymus junceus* cv. Sawki
20 *Festuca rubra* cv. Arctared
21 *Festuca rubra* cv. Boreal
22 *Hedysarum sp.*
23 *Lotus corniculatus*
24 *Medicago sp.* cv. Drylander
25 *Medicago sp.* cv. Kane
26 *Onobrychis sp.* cv. Melrose
27 *Phleum pratense* cv. Astra
28 *Poa ampla*
29 *Poa compressa* 1

LOON LAKE # 48 CONT'D

30 *Poa compressa* 2
31 *Poa pratensis*
32 *Poa pratensis* cv. Nugget
33 *Puccinellia sp.*
34 *Trifolium hybridum* cv. Aurora
35 *Trifolium hybridum* cv. Dawn
36 *Trifolium pratense*
37 *Trifolium repens*

LOON LAKE SITE #48



O B S E R V A T I O N S

Test plants were put in by hand at this site on June 14, 1975. No evaluation was done in 1975 because of the need to rent a four-wheel drive truck to gain access to the site. It was felt that this was economically unfeasible for a first year evaluation of just one test site.

Consequently all commentary regarding this site will have to wait until subsequent years.

WHITECOURT # 49

Location:

16.1 miles (25.7 km.) west on highway 43 from the Texaco station in Whitecourt.

Longitude - 116° 01'

Latitude - 54° 13'

Legal - 60 - 14 - W5

Elevation - 780 meters

Notes:

Ecological zone - Boreal Forest

Aspect - 45° E. - W. - facing slope

Soil type - sand

Moisture - good

Disturbance of soil - roadside

Method / Date of seeding -

cover crop - not planted

test plants - planted by hand; June 26,75

Fertilizer - none used

Average frost-free period - 67 days;

June 18 - Aug. 25

Soil Properties:

Strongly alkaline, sandy soil with high levels of free carbonates. Extremely low in Phosphorus and Potassium.

Table 10

CLIMATE: # 49 WHITECOURT

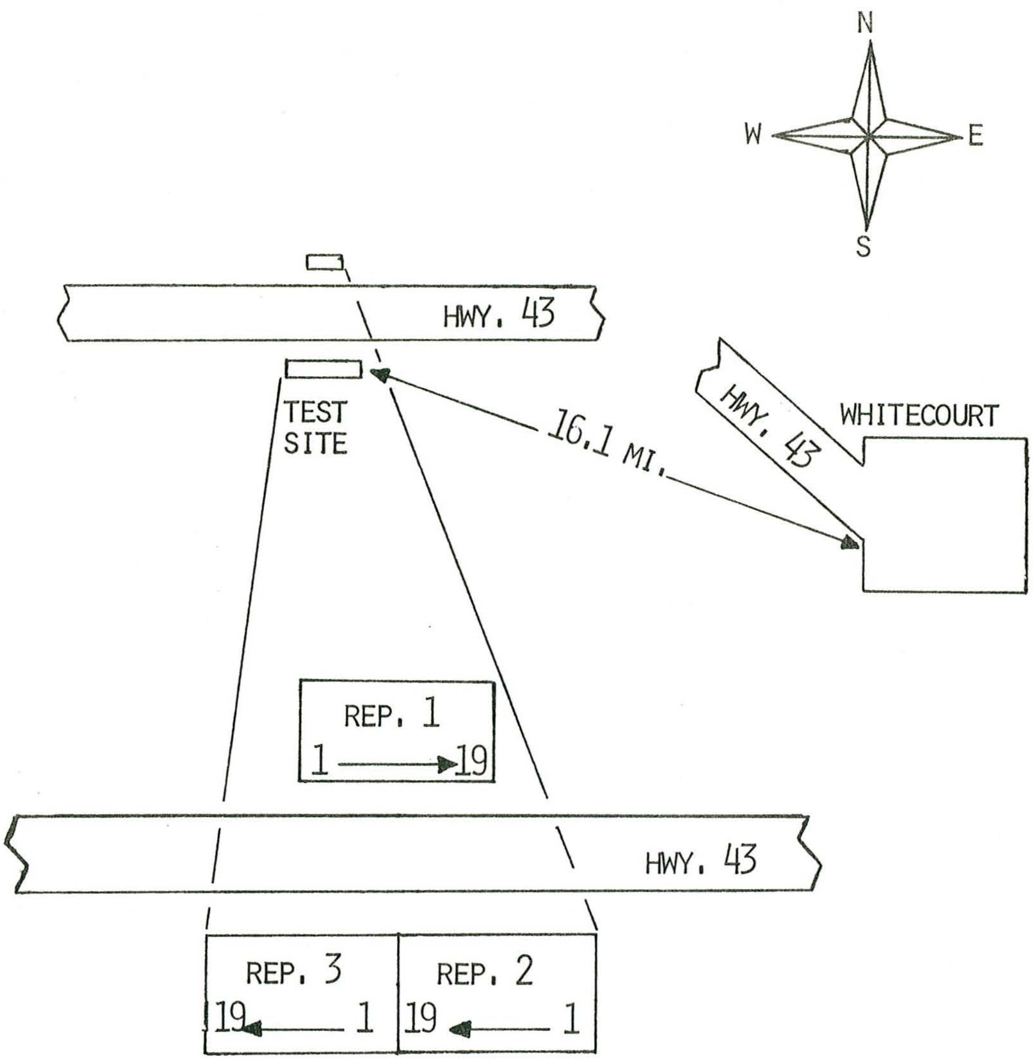
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-17.7	-8.5	-4.6	2.3	8.9	12.4	14.7	14.5	8.4	3.1	-6.7	-13.4	1.1
High (°C)	-11.6	-1.2	2.4	9.2	17.8	19.5	21.8	21.9	15.3	10.0	-2.3	-7.4	7.9
Low (°C)	-23.9	-15.8	-11.6	-4.6	1.8	5.3	7.7	7.2	1.6	-3.8	-11.3	-18.9	-5.6
Precip. (cm)	3.53	2.26	2.23	2.13	5.05	9.96	12.65	7.24	4.57	2.39	2.36	1.73	55.78
Wind *	29/2	26/2	26/5	23/7	26/5	25/5	27/4	28/3	26/4	27/4	26/4	29/2	318/47
Sunshine (# of hours)	85.9	112.9	156.4	200.4	260.3	244.2	268.6	260.4	158.1	144.6	80.7	70.1	2042.6

* Wind up to 19.2 Km/hr. / 19.2 Km/hr. or over

WHITECOURT #49

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trichophorum* cv. Greenleaf
4 *Agrostis gigantea*
5 *Alopecurus pratensis*
6 *Astragalus cicer*
7 *Bromus inermis*
8 *Elymus junceus* cv. Sawki
9 *Festuca rubra* cv. Reptans
10 *Medicago sp.* cv. Drylander
11 *Onobrychis sp.*
12 *Poa ampla*
13 *Poa compressa*
14 *Poa glaucantha*
15 *Poa palustris*
16 *Poa pratensis*
17 *Puccinellia sp.*
18 *Trifolium hybridum* cv. Aurora
19 *Trifolium pratense*

WHITECOURT SITE #49



O B S E R V A T I O N S

This site was hand planted on June 26, 1975 in very sandy soil. Evaluation of this site took place on October 20, 1975 and showed a site where the growth was minimal but many plants appeared to be just emerging. The only ecotype which had over 50% of the test plants above ground was *Onobrychis sp. 254*. Plants of this ecotype had reached a height of 3" on all three reps. Other ecotypes with some emergence on at least one of the reps included *Trifolium hybridum* cv. Aurora 115, *Trifolium pratense 122*, *Medicago sp.* cv. Drylander 250, *Astragalus cicer 103*, *Agropyron trichophorum* cv. Green leaf 248, *Agropyron riparium* cv. Sodar 247, *Festuca rubra* cv. Reptans 24, and *Bromus inermis* 366. While these other ecotypes had emerged they were still at a height of less than 1/2". If these ecotypes can overwinter successfully they may well show what can be done with sandy slopes.

At present native ground cover on these reps is minimal with Reps 2 & 3 having around 5%. This cover consists of *Rosa acicularis*, *Festuca rubra*, and *Poa sp*. Ground cover adjacent to these reps is similar but also includes *Prunus pennsylvanica*. On and adjacent to Rep #1 there is no ground cover at all.

SMITH # 50

Location:

East roadside at the junction of highways 2 and 44

Longitude - 114° 04' W

Latitude - 55° 04' N

Legal - 15 - 70 - 1 - W5

Elevation - 620 meters

Notes:

Ecological zone - Boreal Forest

Aspect - 10 - 20° S.- W. - facing slope

Soil type - sand

Moisture - moist upper 10cm, dry below

Disturbance of soil - topsoil removed

Method / Date of seeding:

test plants - hand planted; June 3/75

Fertilizer - none used

Average frost-free period - 67 days;

June 18 - Aug. 24

Climate:

Refer to #48, Loon Lake

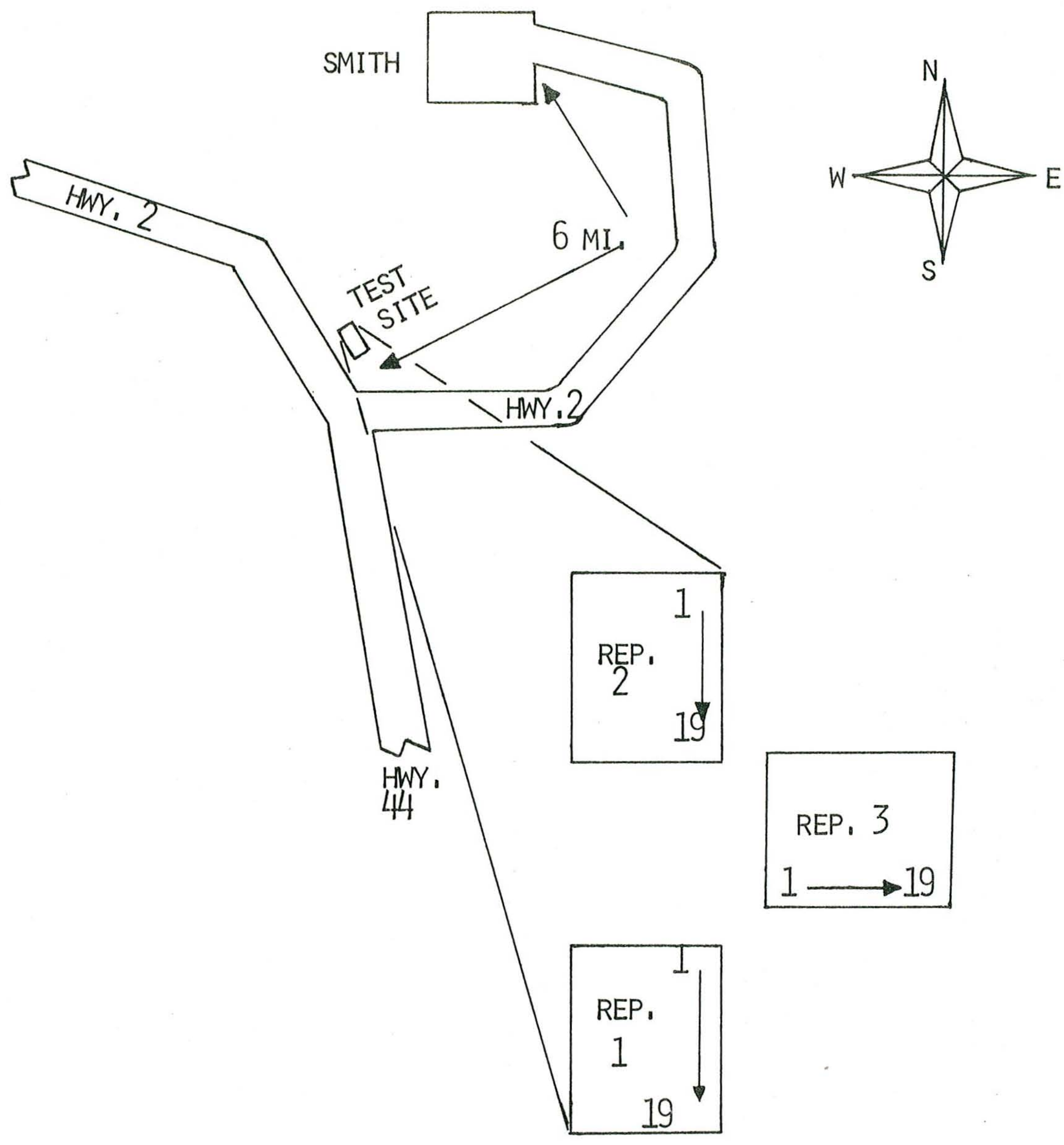
Soil Properties:

Strongly alkaline, sandy soil with high levels of free carbonates. Extremely low in Phosphorus and Potassium.

SMITH #50

1	*Agropyron cristatum* cv. Summit
2	*Agropyron riparium* cv. Sodar
3	*Agropyron sp.*
4	*Agrostis gigantea*
5	*Astragalus cicer*
6	*Bromus inermis*
7	*Elymus innovatus*
8	*Festuca ovina*
9	*Festuca rubra* cv. Boreal
10	*Hierochloe odorata 1*
11	*Hierochloe odorata 2*
12	*Medicago sp.* cv. Drylander
13	*Medicago sp.* cv. Kane
14	*Onobrychis sp.* cv. Melrose
15	*Poa ampla*
16	*Poa compressa*
17	*Poa pratensis*
18	*Trifolium hybridum* cv. Dawn
19	*Trifolium pratense*

SMITH PLOT SITE #50



O B S E R V A T I O N S

This test site was planted on June 3, 1975. The first evaluation was planned to take place on July 29, 1975. However upon arriving at the site it was immediately noticeable that the Department of Highways had regraded and oiled the land area upon which the site is located. Consequently there was no plant growth anywhere as the ground cover on both the test site area and on the adjacent land was zero.

The site was also glanced at on September 29, 1975 while en route to the Slave Lake test site. Once again there was absolutely no growth of any kind.

Thus if this site is to be useful, and it would be as it consists of sandy slopes, it will have to be replanted in the spring of 1976.

COCHRANE SOD #51

Location:

9.5 miles (15.2 km.) north of Cochrane on Highway 22,
1.0 mile (1.6 km.) West - .35 miles (.55 km.) South.
Longitude - 114° 31'
Latitude - 51° 19'
Legal - NE 21 - 27 - 4 - W5
Elevation - 1250 meters

Notes:

Ecological Zone - Mountain Area
Aspect - level
Soil type - clay - loam
Moisture - poor
Disturbance of soil - native sod
Method / Date of seeding:
cover crop - nil
test plants - by hand; June 12/75
Fertilizer - nil
Average frost-free period - 101 days,
May 30 - Sept. 9

Climate:

Refer to #40, Okotoks

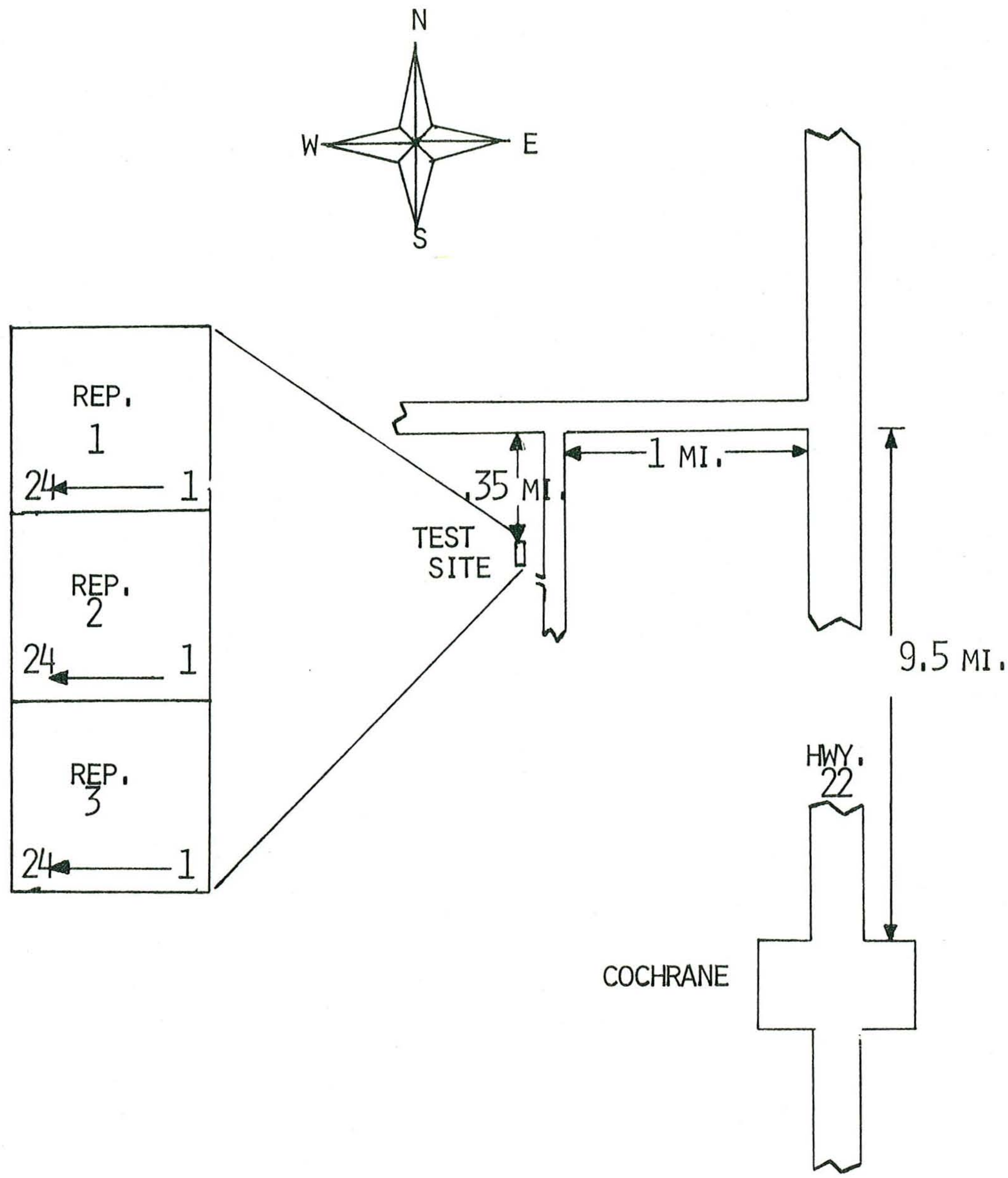
Soil Properties:

Medium acid soil with a low Phosphorus content.

COCHRANE SOD # 51

1 *Agropyron cristatum* cv. Fairway
2 *Agropyron cristatum* cv. Summit
3 *Agropyron riparium* cv. Sodar
4 *Agropyron smithii*
5 *Agropyron sp.*
6 *Agrostis gigantea*
7 *Astragalus cicer*
8 *Bromus inermis*
9 *Coronilla varia*
10 *Elymus innovatus*
11 *Elymus junceus* cv. Sawki
12 *Festuca elatior* cv. Tammisto
13 *Festuca ovina*
14 *Festuca rubra* cv. Boreal
15 *Festuca rubra* cv. Reptans
16 *Festuca scabrella*
17 *Lotus corniculatus* cv. Leo
18 *Phleum pratense* cv. Champ
19 *Poa ampla*
20 *Poa compressa*
21 *Poa pratensis*
22 *Poa pratensis* cv. Fylking
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

COCHRANE SOD SITE #51



OBSERVATIONS

Test plants were hand planted on this site on June 12, 1975 and evaluation took place on October 10, 1975. This site is in an area of range land which has thick native ground cover. At the time of evaluation our plants were extremely small. In general the legumes were stronger as most of them were above ground. Specifically *Trifolium pratense* 122, *Trifolium hybridum* cv. *Aurora 255*, *Astragalus cicer* 103, *Coronilla varia* 253, and *Lotus corniculatus* cv. Leo had all emerged to a height of 1/4". Of the grasses the most successful were *Agropyron cristatum* cv. Summit 244 and *Agropyron riparium* cv. Sodar 247 which had both grown to a height of 1/2"

Native ground cover here is about 95% and includes the following grasses; *Poa spp.*, *Festuca sp.*, *Phleum pratense*, *Agropyron subsecundum*, and *Koeleria cristata*. There is also extensive coverage by native legumes, of which the most prominent are *Oxytropis splendens*, *Oxytropis campestris*, and *Astragalus spp.*

Adjacent to our site is a wetter area which has ground cover including *Salix spp.*, *Agrostis scabra* and *Poa palustris*.

COCHRANE WASTE GROUND #52

Location:

9.5 miles (15.2 km.) north of Cochrane on Highway 22,
3.9 miles (6.25 km.) west
Longitude - 114° 32'
Latitude - 51° 19'
Legal - SW29 - 27 - 4 - W5
Elevation - 4100' (1250 meters)

Notes:

Ecological Zone - Mountain Area
Aspect - Rep I - 20° N. facing
Rep II - 20° S. facing
Soil type - heavy clay - loam
Moisture - poor
Disturbance of soil - spoil pile
Method / Date of seeding:
cover crop - nil
test plants - by hand; June 12,75
Fertilizer - nil
Average frost-free period - 101 days
May 30 - Sept. 9

Climate:

Refer to #40, Okotoks

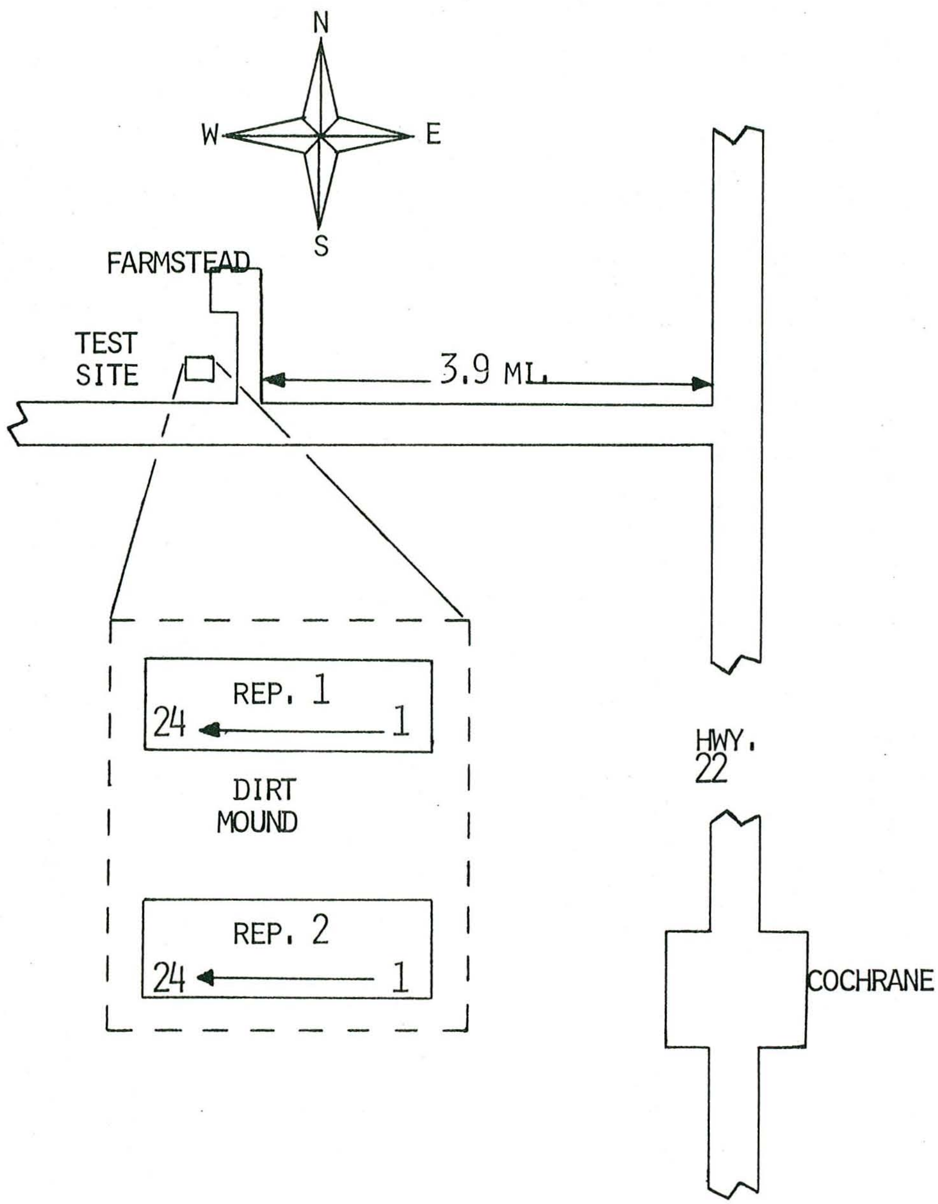
Soil Properties:

Mildly alkaline soil with high levels of free carbonates. Extremely low Phosphorus content.

COCHRANE WASTE GROUND #52

1 *Agropyron cristatum* cv. Fairway
2 *Agropyron cristatum* cv. Summit
3 *Agropyron riparium* cv. Sodar
4 *Agropyron smithii*
5 *Agropyron sp.*
6 *Agrostis gigantea*
7 *Astragalus cicer*
8 *Bromus inermis*
9 *Coronilla varia*
10 *Elymus innovatus*
11 *Elymus junceus* cv. Sawki
12 *Festuca elatior* cv. Tammisto
13 *Festuca ovina*
14 *Festuca rubra* cv. Boreal
15 *Festuca rubra* cv. Reptans
16 *Festuca scabrella*
17 *Lotus corniculatus* cv. Leo
18 *Phleum pratense* cv. Champ
19 *Poa ampla*
20 *Poa compressa*
21 *Poa pratensis*
22 *Poa pratensis* cv. Fylking
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

COCHRANE WASTE-GROUND SITE #52



O B S E R V A T I O N S

This site was hand planted on June 12, 1975. Evaluation took place on October 10, 1975 but unfortunately no plants were there to evaluate. Despite this lack of germination the ecotypes planted may well grow here. The problem with this site is that both reps which were planted have had extensive disturbance since the time of planting. If no growth is observable at the time of the 1976 spring evaluation then this site will have to be replanted.

Ground cover on Rep #1 is around 20% consisting of weeds while Rep #2 has a ground cover of less than 5% consisting again of weeds. Ground cover on the adjacent rangeland, which has been extensively grazed, is over 90%, consisting mainly of *Poa sp.*, *Festuca sp.*, and *Agropyron sp.*

COLEMAN # 53

Location:

4.8 miles (7.7 km.) west on Highway 3 of the Driftwood Confectionery in Coleman.

Longitude - 49° 38'

Latitude - 114° 35'

Legal - 10 - 8 - 5 - W5

Elevation - 1400 meters

Notes:

Ecological Zone - Mountain Area

Aspect - 60° S.-facing slope

Soil - clay chips

Moisture - fair

Disturbance of soil - roadside

Method / Date of seeding:

cover crop - not planted

test plants - hand planted June 23/75

Fertilizer - none used

Average frost-free period - 101 days;

May 30 - Sept. 9

Soil Properties:

Moderately alkaline soil low in both Phosphorus and Potassium.

Table 11

CLIMATE: #53 COLEMAN

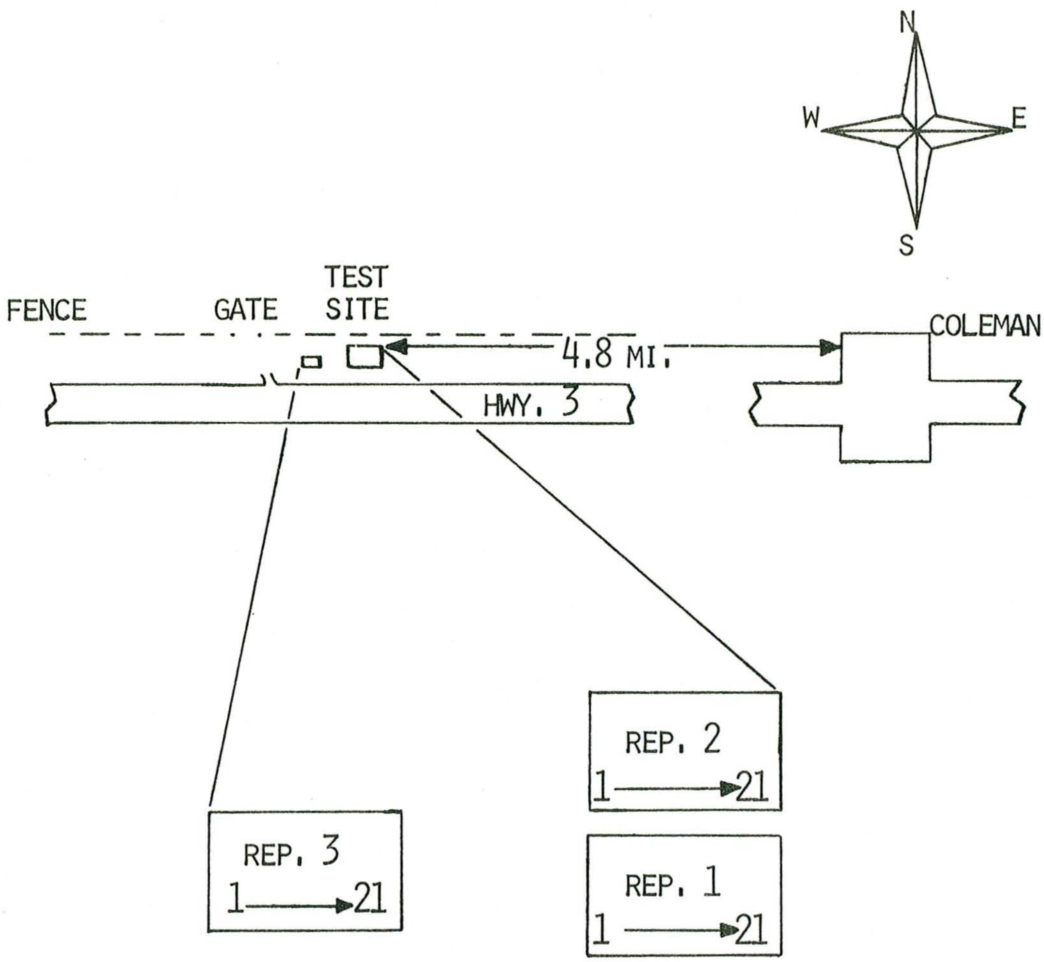
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (^{o}C)	-12.7	-5.4	-3.9	1.2	7.1	10.8	13.5	14.0	8.6	4.3	-2.2	-8.8	2.2
High (^{o}C)	-6.5	1.0	2.5	7.2	14.4	18.3	22.3	23.2	15.7	10.4	3.1	-3.5	9.0
Low (^{o}C)	-19.0	-11.9	-10.4	-4.9	-0.2	3.3	4.8	5.0	1.5	-1.7	-7.5	-14.0	-4.6
Precip. (cm)	4.44	3.15	4.72	7.06	7.95	11.96	5.31	4.83	8.05	4.52	3.45	4.83	70.28
Wind *	$\frac{25}{6}$	$\frac{27}{1}$	$\frac{28}{3}$	$\frac{25}{5}$	$\frac{26}{5}$	$\frac{28}{2}$	$\frac{30}{1}$	$\frac{29}{2}$	$\frac{27}{3}$	$\frac{28}{3}$	$\frac{28}{2}$	$\frac{29}{2}$	$\frac{330}{35}$
Sunshine (# of hours)	85.9	112.9	156.4	200.4	260.3	244.2	268.6	260.4	158.1	144.6	80.7	70.1	2042.6

* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

COLEMAN #53

1 *Agropyron cristatum* cv. Summit
2 *Agropyron riparium* cv. Sodar
3 *Agropyron smithii*
4 *Agropyron sp.*
5 *Agropyron trachycaulum* cv. Revenue
6 *Agrostis gigantea*
7 *Astragalus cicer*
8 *Bromus inermis* cv. Magna
9 *Coronilla varia*
10 *Elymus canadensis*
11 *Elymus innovatus*
12 *Elymus junceus* cv. Sawki
13 *Festuca ovina*
14 *Festuca rubra* cv. Boreal
15 *Medicago sp.* cv. Kane
16 *Onobrychis sp.* cv. Melrose
17 *Phleum pratense* cv. Climax
18 *Poa ampla*
19 *Poa pratensis*
20 *Puccinellia nuttalliana*
21 *Trifolium hybridum* cv. Dawn

COLEMAN SITE #53



OBSERVATIONS

Test plants were hand planted on this site on June 23, 1975. Evaluation of this site took place on September 7, 1975 and at that time there was no visible germination. A contributing factor here was the late planting time but it is possible that very few of the ecotypes will ever emerge as this site is on poor soil.

The growth possibilities here are indicated by the present ground cover which is around 10%. This contrasts with ground cover of areas in the vicinity which is extensive. The ground cover which is on the site consists largely of *Agropyron cristatum* and *Bromus inermis* on the lower half of the site. The upper half of the site is nearly bare, just having occasional *Melilotus alba* and *Melilotus officinalis* plants along with one fairly large *Astragalus sp.*

If no growth is evident next year then different methods will have to be used for future coal area test sites.

GRANDE CACHE #54

Location:

4.5 miles (7.2 km.) east of Grande Cache townsite or 2.1 miles (3.4 km.) east of the Grande Cache town limits sign.

Longitude - 119° 02'

Latitude - 53° 55'

Legal - 7 - 57 - 7 - W6

Elevation - 1170 meters

Notes:

Ecological Zone - Mountain Areas

Aspect - 25° S. - facing slope

Soil - coal - west end top of the slope
sand - east end top of the slope
rocky-clay - bottom of the slope

Moisture - dry forest 5 cm., good below

Disturbance of soil - roadside, topsoil removed, preparation nil.

Method / Date of seeding:

cover crop - not planted; appears to have been seeded, with a sparce growth of *Festuca rubra, Bromus inermis* and *Phleum pratense*.

test plants - planted by hand; June 12/75

Fertilizer - none used

Average frost-free period - 80 days; June 9 - Aug. 29

Soil Properties:

Mildly alkaline soil with a high percentage of coal. Extremely low in both Phosphorus and Potassium.

Table 12

CLIMATE: #54 GRANDE CACHE

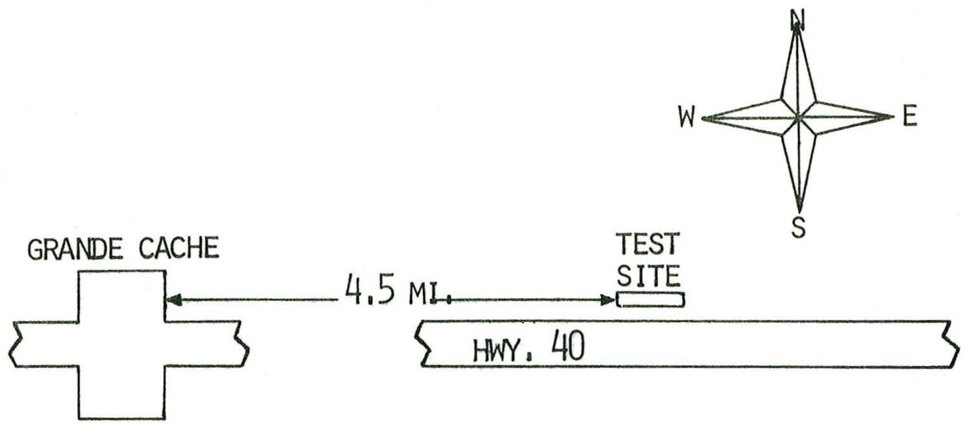
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-14.8	-6.1	-2.3	4.2	8.8	12.8	14.9	15.3	9.2	4.2	-3.3	-11.0	2.7
High (°C)	-9.9	0.1	3.7	11.5	15.8	19.6	22.2	22.9	15.2	9.7	1.3	-6.7	8.8
Low (°C)	-19.2	-12.3	-8.4	-3.1	1.9	6.1	7.7	7.6	3.2	-1.4	-7.6	-15.2	-3.4
Precip. (cm)	3.94	2.49	1.73	2.41	2.97	5.59	5.51	4.93	3.53	2.72	2.36	2.74	40.92
Wind *	28/3	27/1	29/2	28/2	29/2	28/2	31/0	31/0	29/1	29/2	29/1	29/2	347/18
Sunshine (# of hours)	85.9	112.9	156.4	200.4	260.3	244.2	268.6	260.4	158.1	144.6	80.7	70.1	2042.6

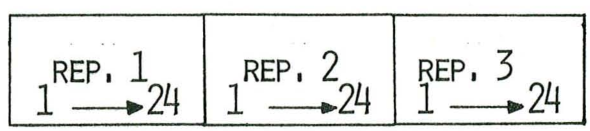
* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

GRANDE CACHE #54

1 *Agropyron smithii*
2 *Agropyron sp.*
3 *Agropyron trachycaulum* 1
4 *Agropyron trachycaulum* 2
5 *Agropyron trichophorum* cv. Greenleaf
6 *Agrostis gigantea*
7 *Alopecurus pratensis*
8 *Bromus inermis*
9 *Coronilla varia*
10 *Elymus innovatus* 1
11 *Elymus innovatus* 2
12 *Festuca rubra* cv. Arctared
13 *Festuca rubra* cv. Boreal
14 *Hedysarum sp.*
15 *Medicago sp.* cv. Kane
16 *Onobrychis sp.* cv. Melrose
17 *Phleum pratense* cv. Astra
18 *Poa ampla*
19 *Poa compressa*
20 *Poa pratensis*
21 *Poa pratensis* cv. Park
22 *Trifolium hybridum* cv. Dawn
23 *Trifolium pratense*
24 *Trifolium repens*

GRANDE CACHE SITE #54





O B S E R V A T I O N S

The Grand Cache site was planted on June 12, 1975. At this site no cover crop was put in either by the Department of Highways or by this research program. The site is largely bare with ground cover consisting of less than 5%. This is not necessarily indicative of poor growing conditions as the area has been recently disturbed by highway maintenance. The ground cover which is present consists largely of *Bromus inermis*, *Agropyron cristatum*, *Phleum pratense* and *Festuca sp.* Also adjacent to the site is some *Trifolium hybridum*.

The site was evaluated on September 1, 1975. Due to the late planting time little growth was expected and this proved to be the case. The grasses planted were all very small but germination was apparent in many. The legumes were more advanced with the best two ecotypes being *Medicago sativa* 251 and *Onobrychis* sp. 254. Both of these had reached a height of 4". Others showing definite promise were *Trifolium pratense* 260 and *Trifolium hybridum* 161.

More significant evaluation of this site will have to take place in subsequent years.

LONGVIEW # 55

Location:

7.5 miles (12.0 km.) south of Black Diamond on Highway 7 or 1.4 (2.3 km.) south of Secondary Highway 543 junction with Highway 7 then east on loose surface road to buildings.

Longitude - 114° 13'

Latitude - 50° 35'

Legal - 4 - 19 - 2 -- W5

Elevation - 1250 meters

Notes:

Ecological Zone - Aspen Parkland

Aspect - level

Soil - rocky soil

Moisture - poor

Disturbance of soil - compacted

Method / Date of seeding:

cover crop - not planted

test plants - hand planted; June 3/75

Fertilizer - none used

Average frost-free period - 120 days,
May 20 - Sept. 18

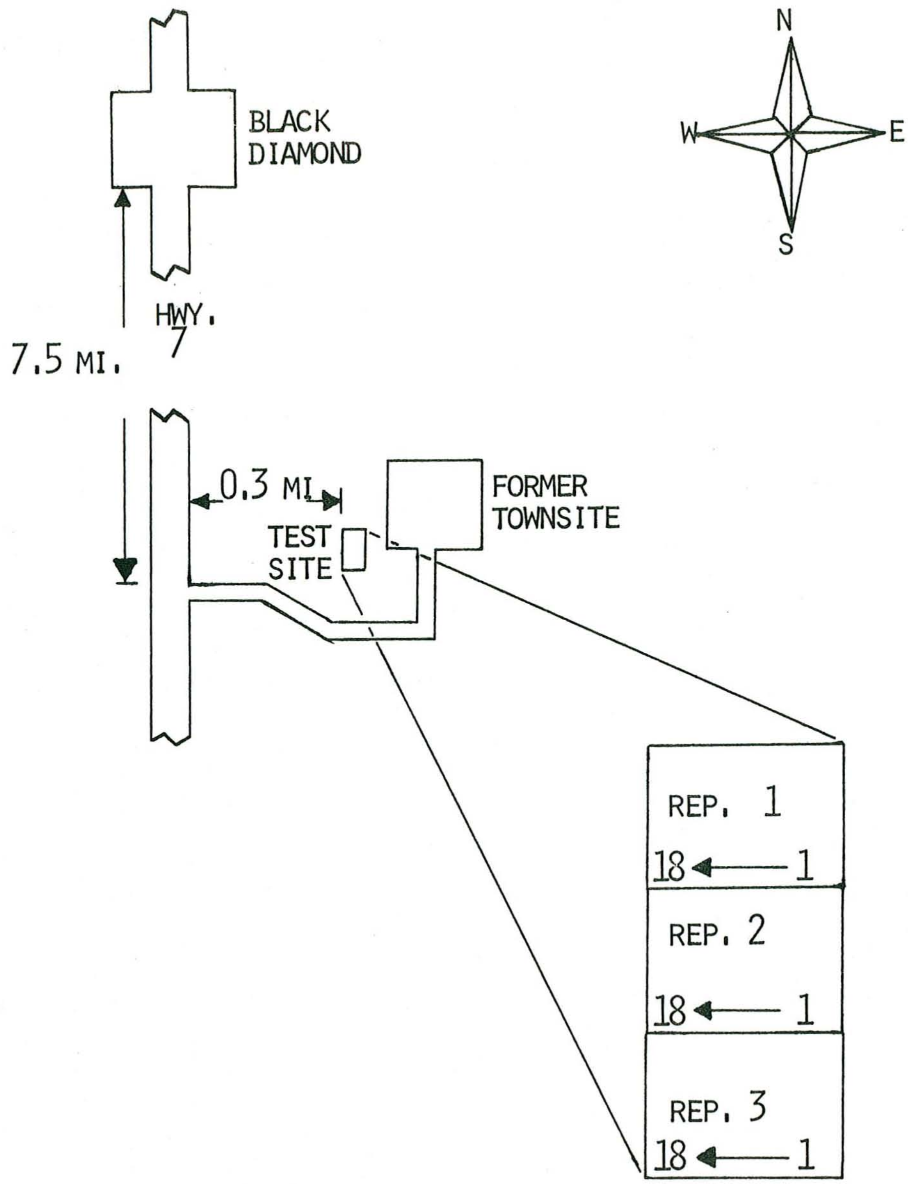
Climate:

Refer to #40, Okotoks

L O N G V I E W # 5 5

1 *Agropyron riparium* cv. Sodar
2 *Agropyron sp.*
3 *Agropyron trachycaulum*
4 *Agropyron trichophorum* cv. Greenleaf
5 *Agrostis gigantea*
6 *Bromus inermis* cv. Magna
7 *Calamagrostis inexpansa*
8 *Coronilla varia*
9 *Elymus innovatus*
10 *Elymus junceus* cv. Sawki
11 *Festuca rubra* cv. Boreal
12 *Festuca scabrella*
13 *Hedysarum sp.*
14 *Onobrychis sp.* cv. Melrose
15 *Poa compressa*
16 *Trifolium hybridum* cv. Aurora
17 *Trifolium pratense*
18 *Trifolium repens*

LONGVIEW SITE#55



O B S E R V A T I O N S

Three reps of test plants were planted at this site on June 3, 1975. At the time of planting no ground cover crop was put in. This site was then evaluated on August 14, 1975 and October 25, 1975.

At the time of planting there was very little moisture at the site and also it is on very rocky soil. Thus very little growth was expected and this proved to be the case as no plants were visible at either evaluation time.

Native ground cover on the site fluctuates from a high of 85% on Rep #1 down to 50% on Rep #3. The major species occurring throughout the site are *Bromus inermis*, *Phleum pratense*, *Poa canbyi*, *Poa pratensis*, *Agropyron smithii*, *Hordeum sp.*, and *Cirsium arvense*.

Minor species in the area include *Agropyron subsecundum*, *Agropyron trachycaulum*, *Calamagrostis sp.*, *Melilotus spp.*, *Festuca sp.*, and *Artemesia spp.*

If, at the time of the spring 1976 evaluation, there is still no growth evident this site may be replanted as it appears that fertilization may be necessary to induce growth on this soil.

ROCKY MOUNTAIN HOUSE #56

Location:

27.0 miles (43.5 km.) southwest of Rocky Mountain House on Secondary Highway #752.

Longitude: 115° 20'

Latitude: 52° 12'

Legal: 37 - 10 - W5

Elevation: 1370 m

Notes:

Ecological Zone - Mountain Areas

Aspect - level

Soil type - clay, loam

Moisture - good

Disturbance of Soil - topsoil removed

Method / Date of seeding:

cover crop - nil

test plants - hand planted 10/6/75

Fertilizer - nil

Average frost-free period - 84 days

June 7 - Aug. 31

Soil Properties:

Neutral to mildly alkaline soil with a low content of both Phosphorus and Potassium.

Table 13 CLIMATE: #56 ROCKY MOUNTAIN HOUSE

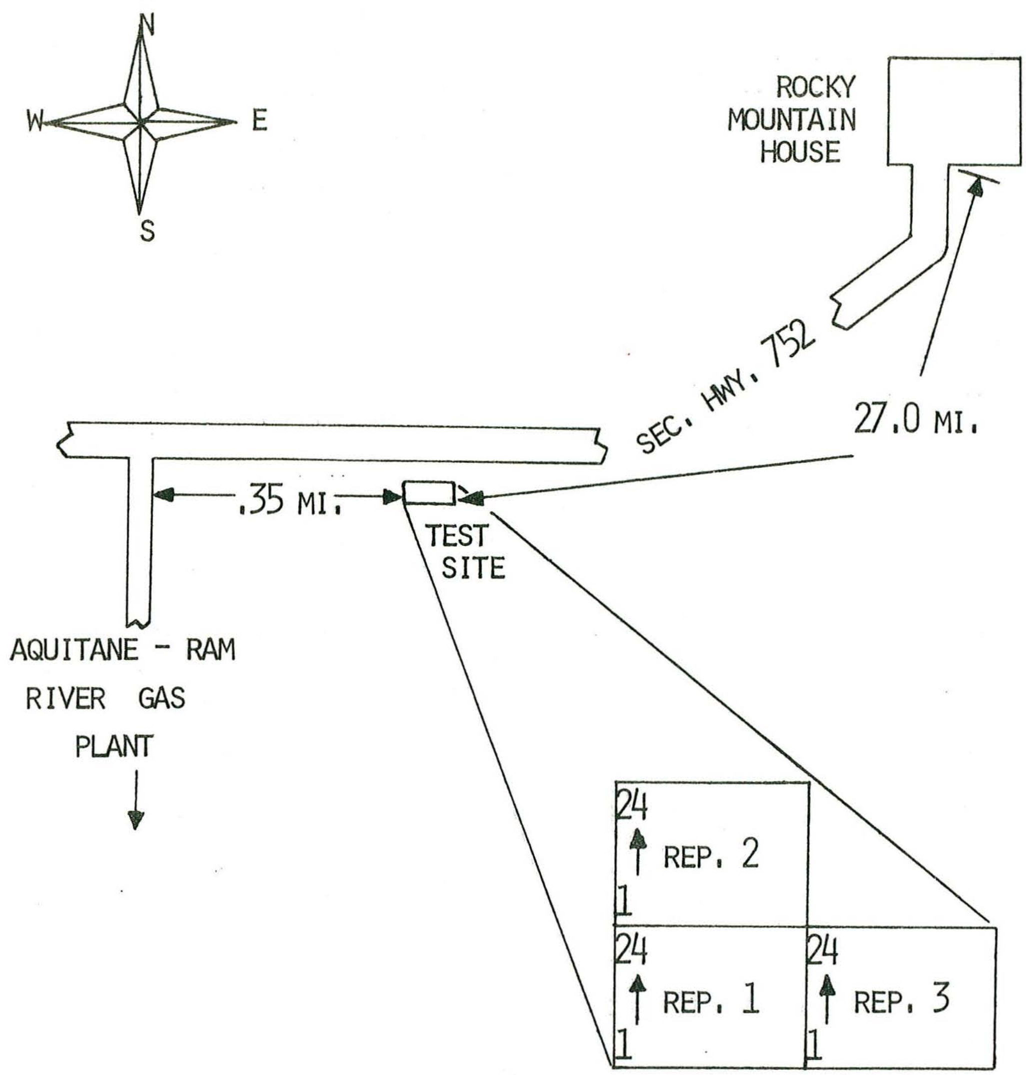
Average	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Temp. (°C)	-16.4	-8.2	-3.9	2.7	9.4	12.8	15.1	15.2	9.4	4.5	-4.1	-11.3	2.1
High (°C)	-10.9	-1.1	2.6	8.8	16.3	19.3	21.7	22.4	16.3	11.2	1.3	-5.6	8.5
Low (°C)	-21.8	-15.3	-10.5	-3.4	2.5	6.3	8.5	8.0	2.6	-2.2	-9.5	-17.0	-4.3
Precip. (cm)	3.15	2.06	2.13	2.49	4.14	13.8	11.7	5.66	5.46	2.95	2.21	2.31	58.17
Wind *	$\frac{25}{6}$	$\frac{27}{1}$	$\frac{28}{3}$	$\frac{25}{5}$	$\frac{26}{5}$	$\frac{28}{2}$	$\frac{30}{1}$	$\frac{29}{2}$	$\frac{27}{3}$	$\frac{28}{3}$	$\frac{28}{2}$	$\frac{29}{2}$	$\frac{330}{35}$
Sunshine (# of hours)	85.9	112.9	156.4	200.4	260.3	244.2	268.6	260.4	158.1	144.6	80.7	70.1	2042.6

* Wind $\frac{\text{up to 19.2 Km/hr.}}{\text{19.2 Km/hr. or over}}$

ROCKY MOUNTAIN HOUSE # 56

1 *Agropyron cristatum* cv. Fairway
2 *Agropyron cristatum* cv. Summit
3 *Agropyron riparium* cv. Sodar
4 *Agropyron smithii*
5 *Agropyron sp.*
6 *Agrostis gigantea*
7 *Astragalus cicer*
8 *Bromus inermis*
9 *Coronilla varia*
10 *Elymus innovatus*
11 *Elymus junceus* cv. Sawki
12 *Festuca elatior* cv. Tammisto
13 *Festuca ovina*
14 *Festuca rubra* cv. Boreal
15 *Festuca rubra* cv. Reptans
16 *Festuca scabrella*
17 *Lotus corniculatus* cv. Leo
18 *Phleum pratense* cv. Champ
19 *Poa ampla*
20 *Poa compressa*
21 *Poa pratensis*
22 *Poa pratensis* cv. Fylking
23 *Trifolium hybridum* cv. Aurora
24 *Trifolium pratense*

ROCKY MOUNTAIN HOUSE SITE #56



O B S E R V A T I O N S

This site was hand planted on June 10, 1975 but the present location has already been abandoned as a feasible site. The reason for this is that the October 12, 1975 evaluation showed it to be in an area which is a biocompetitive impossibility for our plants.

This site was located in a ditch which had a ground cover of over 95% on reps 1 & 3. This cover consisted of typical wet area species such as *Salix spp.*, *Carex spp.*, *Calamagrostis canadensis* and *Poa palustris*. Rep #2 also had extensive ground cover of over 75%. This, however, consisted of the Department of Highways mix in which the prominent species were *Festuca rubra*, *Agropyron cristatum*, and *Trifolium hybridum*. Considering the intensity of this established ground cover our ecotypes would have virtually no chance of succeeding and so this site will be replanted in 1976. (At the time of evaluation none of the test plants were visible and even if any had germinated the locating of these minute plants was impossible due to the ground cover.) Adjacent to the site the most prominent species were *Vicia americana* and *Deschampsia sp.*

6 Miles from our site is an area recently disturbed by fire. In this area the first species to recolonize were the following: *Agrostis scabra*, *Calamagrostis canadensis*, *Phleum pratense* and *Elymus innovatus*. Also in evidence were lesser amounts of *Deschampsia sp.*, and *Poa pratensis*.

SOIL ANALYSIS

HAROLD FEDDEMA

ALBERTA AGRICULTURE

INTRODUCTION

In cooperation with the Alberta Soil and Feed Testing Laboratory, soil samples from each of the new revegetation sites and also from previously established sites displaying growth problems were analyzed. The results for each site were tabulated and a short resume of the soil properties which may effect plant growth is included with the site description and evaluation.

It must be remembered that these tests are designed for agricultural soils and agricultural field crops. Most native species are not as specific in their nutrient and soil property requirements. The following is a discussion of the analyses to aid in the understanding of the data presented.

METHODS AND INTERPRETATION OF SOIL TEST RESULTS

AVAILABLE PLANT NUTRIENTS

Methods

Nitrogen (N) and Phosphorus (P)

Determined colorimetrically in .03 N NH_4 ± .03N H_2SO_4 extracts of soil using a 1:5 soil: solution ratio.

Potassium (K)

Determined flamephotometrically neutral normal NH_4OAc extracts of soil using a 1:5 soil: solution ratio.

Interpretation

Amounts expressed in Kg/ha. A general rating for the relative availability of these three major plant nutrients is shown in the following table:

RATING	NITROGEN	PHOSPHORUS	POTASSIUM
low	0-22.4 Kg/ha	0-33.6 Kg/ha	0-168 Kg/ha
medium	23.5-56 Kg/ha	34.7-78.4 Kg/ha	168-336 Kg/ha
high	57.1 Kg/ha or more	79.5 Kg/ha or more	337.1 Kg/ha or more

SOIL REACTION (pH)

Method

Determined in 1:2 soil: water suspensions and were read on pH meter following 30 minutes of shaking.

Interpretation

This is a measure of soil acidity or alkalinity. The plant species contained in a community are determined as much by soil pH as by any other single soil property. Tolerance to acidity or alkalinity varies greatly among plant species. The following table will illustrate optimum pH levels.

pH Values

5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5

very strongly acid	strongly acid	medium acid	slightly acid	neutral	neutral	mildly alkaline	moderately alkaline	strongly alkaline

Range for optimum plant growth of most species

SOIL SALINITY

Methods

Soluble Sulfate (SO_4)

Semi-quantitative reaction with BaCl using 1:2 water extract.

Sodium (Na)

Determined simultaneously in extracts prepared for Potassium determination.

Conductivity

Determined simultaneously in suspension prepared for soil reaction determination using a conductivity meter.

Interpretation

Conductivity is a measure of the total salt concentration in a soil. When the concentration of salts is high, plant growth is reduced, and the soil is considered saline. Sulfates and Sodium are determined to identify specific salts commonly causing salinity. The Sulfate and Sodium tests are rated in four categories: high (H), medium (M), low (L) and none (nil). The degree within each category is indicated by a + or - sign. A high sodium test may indicate a solonetzic soil with a potential for poor physical structure, restricted rooting, drainage and aeration.

CONDUCTIVITY TEST

0-2	negligible salt effects
2-4	very sensitive crops effected
5-10	most plants effected
11-16	only tolerant plants survive
16+	very high

ORGANIC MATTER

Method

Vixual inspection and comparison with known standards.

Interpretation

Soil organic matter tests give an estimate of the humus content of the soil. Therefore non-decayed organic matter is not included. Organic matter is very important as it has a tremendous impact upon the chemical, physical and biological properties of soil. Results are rated into four categories as with the sulfate test.

FREE LIME ($CaCO_3$)

Method

Degree of reaction with dilute Hydrochloric acid (HCI)

Interpretation

Free lime in a soil is related to the soil's pH, that is, soil high in free lime will tend to be alkaline in reaction. If present in the soil, free lime may reduce the nutrient availability. Increasing soil organic matter content will help to remedy this situation. Results from the free lime test are again rated into four categories as mentioned with the sulfate test.

TEXTURE

Method

Hand texture by feel of water saturated soils.

Interpretation

Texture indicates the amount of sand, silt and clay in a soil. The results are shown as six ratings:

1. very course - sands, loamy sands
2. course - sandy loam, fine sandy loam
3. medium - loam, sandy clay loam, sandy clay, clay loam.
4. fine - silt loam, silty clay loam, silt
5. very fine - clay, silty clay, heavy clay
6. organic - peat

Table 14

SOIL ANALYSIS - 1975 Samples

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha)			SOIL REACTION	SOIL SALINITY			ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K	(pH)	SOLUBLE SULFATE (SO_4)	CONDUCTIVITY (mmhos)	SODIUM (kg/ha)			
Site 3 - Camrose:										
Top of Rep.I	17	73	522	7.4	M^-	2.3	1096	L^+	L	3
Bottom of Rep.I	11	8	389	7.8	M	4.7	1443	L	L^+	4
Top of Rep II	26	31	445	7.3	L	1.3	342	L^+	M	3
Slope of Rep II	11	6	300	8.1	L^-	1.2	547	L	H^-	4
Slope of South ½	49	1	491	8.4	M^+	9.1	1033	L	M^-	4
Slope of North ½	21	15	640	8.3	M	9.1	1929	L	L	4
Site 4 - Champion:										
East ½	18	49	764	8.0	M^+	5.4	1621	M^-	nil	3
West ½	10	28	852	7.9	M	2.3	102	M^-	nil	3
Site 9 -Bow Island:										
East ½	13	3	427	8.1	M^-	2.9	304	L	H^-	3
West ½	15	1	32	8.0	M^-	3.1	32	L	H	3
Site 11 - Elkwater										
South ½	61	50	1193	8.0	H^-	7.8	1943	L	L	5

Table 14 - continued

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha)			SOIL REACTION (pH)	SOIL SALINITY			ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K		SOLUBLE SULFATE (SO_4)	CONDUCT-IVITY (mmhos)	SODIUM (kg/ha)			
North ½	26	22	1123	8.0	M	8.0	1937	L	L^-	5
Site 12- Enchant										
South ½	74	56	1090	6.2	-	.4	166	L^+	nil	3
North ½	18	25	653	8.8	L^-	1.5	1911	L^+	L^-	3
Site 13 - Onefour										
East ½	41	10	675	7.8	-	.3	92	L	nil	2
West ½	31	28	599	7.1	-	.2	152	L	nil	2
Site 14 -Sounding Crk										
1974 Planting	10	28	951	6.1	-	.1	140	M^-	L^-	3
1975 Planting	11	18	722	6.5	-	.2	754	L^+	nil	3
Site 25 - Slave Lake										
East-facing slope	10	65	31	5.8	-	.1	63	L^-	L^-	1
West-facing slope	8	61	28	5.6	-	.1	54	L^-	nil	1
Site 28 - Big Horn										
East ½	17	0	103	8.7	-	.2	147	L	H^+	3

Table 14 - continued

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha) N	P	K	SOIL REACTION (pH)	SOIL SALINITY SOLUBLE SULFATE (SO_4)	CONDUCTIVITY (mmhos)	SODIUM (kg/ha)	ORGANIC MATTER	FREE LIME	TEXTURE
West ½	17	0	90	8.8	-	.2	141	L	H+	3
Site 29 -Big Horn:										
East ½	40	0	174	8.3	-	.8	83	L+	H+	2
West ½	18	0	133	8.4	-	.6	118	L+	H+	2
Site 30 - Big Horn										
South ½	22	2	425	8.2	-	.4	118	L+	H+	3
North ½	21	1	285	8.2	-	.5	101	L+	H+	3
Site 31 - Chain Lakes										
South ½ of Top	18	1	539	8.3	-	.5	198	L	H-	5
North ½ of Top	15	1	337	8.2	-	.4	106	L	H	5
South ½ of Bottom	12	1	387	8.4	-	.2	113	L	M+	4
North ½ of Bottom	15	2	512	8.4	-	.2	176	L	M+	4
Site 33 - Kananaskis:										
South ½	11	0	215	8.2	-	.2	76	L	H+	2
North ½	11	0	125	8.4	-	.2	82	L	H+	2

Table 14 - continued

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha)			SOIL REACTION	SOIL SALINITY			ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K	(pH)	SOLUBLE SULFATE (SO_4)	CONDUCTIVITY (mmhos)	SODIUM (kg/ha)			
Site 34- Mountain - View										
South ½	24	89	478	6.4	-	.2	98	M	nil	3
North ½	26	31	361	6.1	-	.2	82	M	nil	3
Site 35 - Blueberry Mountain										
East ½	12	4	365	6.0	-	.2	137	L	nil	5
West ½	17	0	388	8.2	-	.4	141	L	L^+	5
Site 36- Cold Lake										
South ½	15	38	360	7.7	-	.3	74	L^+	L^-	3
North ½	12	8	318	7.1	-	.2	98	L	L^-	4
Site 38- Dixonville										
Top	11	7	304	3.7	-	.1	103	L	nil	5
Center	9	15	272	3.6	-	.2	206	L	L^-	5
Bottom	10	47	348	3.5	-	.1	97	L	L^-	5

Table 14 - continued

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha)			SOIL REACTION	SOIL SALINITY			ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K	(pH)	SOLUBLE SULFATE (SO_4)	CONDUCT-IVITY (mmhos)	SODIUM (kg/ha)			
Site 39- Grande Prairie										
East ½	11	0	411	8.1	-	.4	137	L	M+	5
West ½	12	1	398	7.8	M	2.5	103	L	M	5
Site 41 - Bow City										
Plot 1- South ½	28	6	617	7.9	nil	4.5	1934	L+	L	3
Plot 1- North ½	21	4	645	8.3	nil	3.3	1930	L+	L	3
Plot 2- South ½	26	7	326	8.4	M	5.0	1950	L	H-	4
Plot 2- North ½	6	4	390	8.3	L+	3.3	1952	L	H-	3
Plot 3- East ½	27	0	373	9.2	L-	3.1	1945	L+	H	3
Plot 3- West ½	21	0	531	8.5	-	.8	828	L+	H	3
Site 42-Rainbow Lake										
East ½	8	1	237	7.7	-	.5	146	L	L	4
West ½	8	0	188	8.0	-	.3	88	L	M	4
Site 45- Indian Cabins										
South ½	10	8	173	8.4	-	.2	149	L-	H-	1

Table 14 - continued

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha)			SOIL REACTION (pH)	SOIL SALINITY			ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K		SOLUBLE SULFATE (SO_4)	CONDUCT-IVITY (mmhos)	SODIUM (kg/ha)			
North ½	9	6	157	8.6	-	.2	82	L^-	H^-	1
Site 46 -Ft. Vermilion										
East ½	12	0	433	7.9	M	3.7	268	L	H^-	5
West ½	15	1	783	8.3	L^-	1.0	533	L	H	5
Site 47- Keg River										
East ½	9	0	334	8.1	L^+	2.3	95	L^+	H^-	5
West ½	8	0	347	8.1	-	.3	94	L	H^-	5
Site 48-Loon Lake										
South ½	25	134	410	5.1	-	.1	129	L	L^-	5
North ½	10	16	345	6.0	-	.2	119	L	L^-	5
Site 49- Whitecourt										
South ½	10	0	54	8.9	-	.1	101	L^-	H^-	1
North ½	10	0	56	8.7	-	.1	65	L^-	H^-	1
Site 50 - Smith	9	3	75	8.2	-	.2	65	L^+	H	1

Table 14 - continued

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS (kg/ha)			SOIL REACTION (pH)	SOIL SALINITY			ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K		SOLUBLE SULFATE (SO_4)	CONDUCTIVITY (mmhos)	SODIUM (kg/ha)			
Site 51- Cochrane										
South ½	10	17	822	5.9	-	.1	64	M	nil	3
North ½	18	13	672	6.0	-	.1	74	M	nil	3
Site 52- Cochrane										
South ½	66	8	712	7.8	-	.7	231	M^-	H	3
North ½	58	3	687	7.9	-	.4	181	M^-	H	3
Site 53 - Coleman										
East ½	16	6	206	8.1	M^-	2.7	78	L^+	L	2
West ½	11	7	199	8.4	-	.2	83	L^+	M^-	2
Site 54 - Grande Cache										
East ½	16	3	1	8.3	-	.2	86	L	M	2
West ½	9	4	12	7.2	-	.4	118	M^-	L^+	3
Site 56 - Rocky Mtn. House										
South 3/5	10	3	224	7.2	-	.3	67	L	L	3
North 2/5	11	11	179	7.8	-	.4	71	L	M^+	3

SEED TECHNOLOGY STUDY

GAYLE SIMONSON

ALBERTA ENVIRONMENT

INTRODUCTION

Because most shrub seeds exhibit some type of dormancy which prevents immediate germination, the use of shrub seeds in revegetation programs can only be considered after some knowledge of these dormancies is available. The situation is complex because the conditions required to break a dormancy vary widely, not only between species, but sometimes between ecotypes of the same species.

Failure to germinate may result from a restrictive seed coat, a true embryo dormancy, or a combination of the two. With some species, scarification may be sufficient to break down a hard seed coat. With other species, the time of seeding may be chosen to compensate for dormancy mechanisms. For instance, if a cold treatment is required, then fall seeding might be a practical solution. Laboratory trials have therefore been set up to learn something of the conditions required for germination of a variety of shrub species.

In addition to these shrub dormancy studies, chromosome counts have been made on some species of grasses.

SHRUB DORMANCY STUDIES

Stratification and germination trials were set up, using 4 replicates of 25 seeds each, unless otherwise specified. In all trials, the incubator was set to a cycle of 16 hours light at 20°C, and 8 hours dark at 10°C.

1) Spring stratifications

Over the spring and summer, some of the seed stored from previous years was tested for germination response.

Prunus virginiana (Chokecherry) - seed collected in Edmonton in the fall of 1974 was given a four-month cold stratification. Of 50 dried berries treated in moist peat at 4°C, 14 germinated after removal to the greenhouse. Of 50 cleaned seeds placed in petri dishes on moist filter paper and kept at 4° for four months, 13 germinated after transfer to the incubator. Therefore, there was no apparent difference in germination rate between cleaned and uncleaned seed and the overall rate was 27%.

Arctostaphylos uva-ursi (Common bearberry) - seeds were stratified on moist filter papers in petri dishes at 4°C for four months. After stratification, the dishes were transferred to the incubator. Of 50 seeds from Waterton, 5 germinated. However, seed from Enterprise showed no germination.

Symphoricarpos occidentalis (Buckbrush) - seed from Fort McMurray was treated for one hour in 70% H_2SO_4, then rinsed thoroughly.

After a four-month cold treatment in a petri dish, the dish was transferred to the incubator and 6 of 50 seeds germinated. Of 50 berries, similarly acid-treated and stratified in moist peat, none germinated in the greenhouse.

Cornus stolonifera (Red-osier dogwood) - 50 berries were placed in moist peat at 4°C for three months. After removal to the greenhouse, 4 seedlings emerged over a period of two months.

Juniperus horizontalis (Creeping juniper) - 50 berries were placed in moist peat at 4°C for four months. They were then transferred to the greenhouse, but none germinated.

2) Fall stratifications

Over the summer, many fresh samples of shrub seeds were brought into the lab. Some of the seed was cleaned from the fruit, and the rest was dried before storage.

Stratification and germination trials for all these samples were set up in October. Most of these studies are complete, but some are still underway. Results of completed tests are reported on the following pages.

Acer negundo (Manitoba maple)

The literature indicated that 12 weeks at 4°C might be required by this species for stratification. The treatment proved effective, though germination took several weeks after the material was transferred to the incubator.

Total Time (Weeks)	% Germination B556
12	0%
13	9%
14	32%
15	43%

In petri dishes, the outer covering of the seeds tended to mould and required cleaning several times. However, this would not be a problem if fall seeding could be used for this species.

Alnus species (Alder)

Alder cones were collected near Fort McKay in August. Both brown cones from the previous year and fresh green cones were brought into the lab. The older cones had very little seed in them but there was a good supply of seed in the green cones. (B557).

Germination tests were set up in petri dishes on moist filter paper. A literature review indicated a two-month cold treatment might be required for germination.

Time in Incubator (Days)	% Germination	
	No cold Treatment	2 mths. pretreatment at 4°C
5	8%	63%
10	22%	79%
15	51%	81%

No further germination occurred in either seed lot. Thus, it seems that some, but not all seed, has a dormancy which can be broken by a cold treatment.

Amelanchier alnifolia (Saskatoon-berry)

Seeds of this species require a prolonged cold spell for germination. Cleaned seeds were placed on moist filter paper at 4°C. Many seeds germinated under these conditions. After 16 weeks they were transferred to the incubator.

Total time (Weeks)	% Germination			
	B559	B560	B561	B562
8	20	3	26	0
10	24	13	34	0
12	31	19	40	2
14	38	33	55	8
15	50	41	70	15
16	76	49	81	19
17	82	61	86	31

Differences between these samples are manifested, not only in the germination rates, but also in the time for initiation of germination.

Because this species germinates slowly under stratification conditions, it will not be feasible to sow stratified seed. Fall planting may therefore be necessary if large-scale seeding programs are to be undertaken.

Cornus stolonifera (Red-osier dogwood)

Although information received from the tree nursery at Oliver indicates that a three-month stratification is sufficient for germination of this species, results here have not been encouraging. Last year, after 3 months at 4°C, 7 of 100 seeds germinated. After 7 months at 4°, only 15 of 200 seeds germinated. Thus, the extended period of stratification did not improve germination.

The 3-month stratification was tested again this year with fresh seed. However, 4 weeks after transfer to the greenhouse, B569 showed no germination, and B571 reached only 2%.

In future trials, a combination of acid treatment and cold stratification may be required.

Dryas drummondii (Yellow Dryad)

Three samples of this species were brought into the lab. Two of the samples were collected on the same date at the same location (Barrier Dam) but in one, the heads were still closed (574), while in the other, the heads were open (575). The third sample had been collected at the Ice Caves (580).

These seeds germinated in the incubator with no pretreatment.

Botany Number	Time (days)	% Germinated
574	7	72%
	16	91%
575	7	20%
	16	64%
580	7	22%
	16	28%

Many of the seedlings developed a root rot while in the petri dishes, so were submitted for pathological testing.

Elaeagnus commutata (Silverberry)

This species has no stratification requirements, but germinates slowly under greenhouse conditions. For testing, seeds were planted in flats of soil and left in the greenhouse. Seed from two locations was used. In an initial test, both lots reached 38% germination in 5 weeks. However, seedlings were severely damaged by fungus gnat larvae, and accurate counts could not be obtained. Therefore, a second trial was set up.

Total time (weeks)	% Germination	
	B581	B582
4	29%	26%
5	55%	41%
6	56%	41%
7	57%	42%

Control of the fungus gnats was not complete, so these figures may be slightly below the true germination rate.

Fraxinus sp. (Ash)

These seeds require a cold stratification for germination. Seeds were cleaned and placed on moist filter papers in petri dishes for 12 weeks. They were then transferred to the incubator.

Total time (weeks)	% Germination B584
12	0%
13	64%
14	80%

Thus, the published stratification procedure is suitable for seed collected locally.

Lonicera tatarica (Tartarian honeysuckle)

This species had no apparent dormancy, but germination depended on the conditions under which the trials were carried out. The only seed available was collected in 1974.

Last year, a short after-ripening period was required, but after this, germination reached 92% in 7 weeks at room temperature.

The same batch of seed was tested this year to determine if storage had affected seed viability. Two dishes, each containing 25 seeds on moist filter paper, were prepared. One was placed in the incubator (16 hour photoperiod, 20° - 10° diurnal temperature variation) and the other was left in a dark drawer at room temperature (21°C). After 7 weeks, only 2 seeds in the incubator had germinated, while 18 in the drawer had. This test was repeated, and two more treatments were added.

Time (Weeks)	Germination/25 seeds			
	Room Temperature		Incubator	
	Light	Dark	Light	Dark
1	0	2	0	0
2	9	15	0	11
3	11	19	0	15
4	12	21	2	18
5	12	21	2	18

Thus, light appears to inhibit germination of these seeds. The seeds from the incubator which had been in the light were transferred to a drawer at the end of the 5 weeks. However, no germination occurred after this. Therefore, it seems probable that light may cause a chemical reaction, producing an inhibitor which is fairly stable.

The intermediate amount of germination of the seeds in the light at room temperature may be affected by two factors:

1) light quantity - the light in the room is of a much lower intensity than the light in the incubator, so may not be bright enough to have a great effect, or -
2) light quality - the inhibition reaction may require light of a particular wavelength (this occurs in some lettuce seeds). Since the two types of light are not characterized, we don't know if there are differences in this aspect.

Present studies cannot distinguish between these two explanations.

Present results indicate that, if this seed were used in revegetation work, depth of seeding could be an important factor in germination. More seed should be collected next summer so that more exhaustive testing of this species may be undertaken.

Pinus sylvestris (Scots pine)

Pine cones were collected in Edmonton and the seeds were extracted. Seeds with whitish colouration were hollow, so were discarded. Only hard black seeds were tested.

Germination tests were set up in petri dishes. A literature review indicated that a cold treatment was probably necessary, but this was not the case. Four dishes, with 25 seeds per dish were used. Germination occurred in the incubator.

Days in Incubator	% Germination	
	No cold treatment	3 weeks pretreatment at 4°C
7	56%	98%
16	95%	- - -

Therefore, this sample of pine seed had no dormancy and the over-all germination rate was 96.5%.

About half the seedlings developed with white roots, while half showed a strong red colouration. However, there was no evidence of disease and the two lots showed comparable seedling development.

Prunus padus (var. commutata) (May Day tree)

May Day tree is not native to Alberta, but is related to the chokecherry and pincherry, which are common throughout the province. It has been used quite extensively as an ornamental, and is hardy in this area. Therefore, seed was collected for germination testing.

Two trials were set up with B586. One lot of berries was treated with 70% H_2SO_4 for 15 minutes. Then both lots were stratified in moist peat at 4°C for twelve weeks before being placed in the greenhouse.

Total time (Weeks)	% Germination	
	no acid	acid treatment
12	0%	6%
13	11%	40%
14	17%	43%
15	24%	51%

These results indicate that an acid treatment prior to stratification hastens the germination of *P. padus* seeds. The trials are being continued to determine the final difference in germination between the two treatments.

Prunus virginiana (Chokecherry)

Eight collections of chokecherry were made in 1975. These varied in their response to stratification.

Last year's seed, B144, germinated 27% after a 3 month stratification. Therefore, this method was used on 1975 seed, with treatment in moist peat at 4°C. Samples from all eight seed sources were given this standard stratification. In addition, samples of four of these (B593, 595, 599, 600) were treated for 15 minutes in 70% H_2SO_4, before being subjected to stratification. After 12 weeks, all were transferred to the greenhouse.

After 3 weeks in the greenhouse, no germination was evident in the following samples:

1) B593 (acid treated and non-acid treated)
2) B597 (" " " " " ")
3) B595 (non-acid treated)
4) B594

Results for the others are in the following table:

Total time (Weeks)	% Germination					
	600 (acid)	600 (non-acid)	595 (acid)	597	598	592
12	0	0	0	0	0	0
13	16	4	2	11	15	3
14	39	20	9	14	44	4
15	46	28	11	18	45	6

The tests will be continued until all germination is complete. At present, it appears that, in 600 and 595, acid treatment prior to stratification improves germination.

Although differences in germination rate have sometimes been attributed to environmental differences, or differences in collection date, other factors must also be involved. Both 597 and 598 were collected on the same date. Although they were collected from different shrubs, the shrubs were very close together, Thus, some inherent characteristics of the parent, not strictly related to ecotype, must be involved in variations in germination response.

Rosa sp. (Rose)

Last year, germination of seed from Taber was better than 80%. The treatment used to achieve this was 1 hour in 70% H_2SO_4, followed by 1 month at 20°, then 2 months at 4°. The material was transferred back to 20° for germination.

Seed was available from 4 sources in 1975. The temperature regime used on Taber seed was tested on all 4 seed lots, on both acid-treated and untreated seed. The only germination occurred in B604, where the non-acid treated seed germinated 5%.

Extensive testing of rose seed will therefore be required to determine if each seed lot has specific dormancy requirements or if a common procedure can be established.

Shepherdia argentea (Thorny buffaloberry)

Two seed collections were made, B655 and B647. Tests last year showed that seeds of this species required 12 weeks under moist conditions at 4°C before they would germinate. After this pretreatment, the germination rate of last year's seed was high.

To determine if the same treatment was effective on the new collections, cleaned seeds were placed in petri dishes on moist filter paper. The dishes were left at 4° for twelve weeks, then transferred to the incubator.

Total time	% Germination	
(Weeks)	B644	B647
12	25%	0%
13	96%	45%
14	97%	80%

Since these samples appear to have a consistent pretreatment requirement and germination presents no problem, this species may prove useful in revegetation work.

Shepherdia canadensis (Canadian buffaloberry)

Five samples of *Shepherdia canadensis* berries were available from the 1975 seed collection. These seeds require a fairly long treatment at 4°C before they will germinate. Cleaned seeds were placed in petri dishes on moist filter paper.

One sample (B608) proved to be an exceptionally fast germinating type, so seeds were transferred from 4°C to the incubator after 8 weeks. Results for this seed are summarized in the following table.

Total time (Weeks)	% Germination	
	8 wks. at 4° 9 th wk. in incubator	9 wks. in incubator no cold treatment
6	31%	4%
8	44%	4%
9	88%	4%

The other four seed lots were left at 4° for 12 weeks then tranferred to the incubator.

Total time (Weeks)	% Germination			
	B607	B609	B610	B611
12	4%	48%	2%	8%
13	18%	45%	11%	44%
14	19%	52%	11%	49%
15	19%	52%	11%	49%

This species shows that ecotypes differ, not only in their rates of germination, but also in their requirements to overcome dormancy.

Vaccinium vitis-idaea (Bog cranberry)

This species requires a cold treatment to break its dormancy. Three samples of seed have been tested in petri dishes.

Weeks in Incubator		% Germination	
		No cold treatment	30 days pretreatment at 4°C
Thickwood hills seed			
B617	3	-	3
	4	-	42
	5	-	76
	12	0	-
Yellowknife seed			
B619	3	-	22
	4	-	50
	5	-	78
	12	4	-

Therefore, with pretreatment, the germination rate of Thickwood Hills seed is 76%. That of Yellowknife seed is 78%. Results are not complete with B616.

Unsuccessful trials:

1) 3 months in moist peat at 4°C

Corylus cornuta (Beaked hazelnut) - 2 locations

Juniperus communis (Ground juniper) - 1 location

J. horizontalis (Creeping juniper) - 1 location

Prunus pensylvanica (Pincherry) - 3 locations

Sorbus sp. (Mountain ash) - 1 location

2) 4 months in moist peat at 4°C

Arctostaphylos rubra (Alpine bearberry) - 1 location

Arctostaphylos uva-ursi (Common bearberry) - 2 locations

Viburnum edule (Low-bush cranberry) - 1 location

Viburnum trilobum (High-bush cranberry) - 3 locations

3) 1 hour 70% H_2SO_4, 4 months in moist peat at 4°C

Symphoricarpos albus (Snowberry) - 1 location

Symphoricarpos occidentalis (Buckbrush) - 1 location

Incomplete trials

1) 4 months on moist filter paper at 4°C

Ribes americanum (Wild black currant) - 1 location

Ribes triste (Wild red currant) - 1 location

2) 2 months on moist filter paper at 4°C

Vaccinium myrtilloides (Blueberry) - 1 location

CHROMOSOME STUDIES

Chromosome studies on grasses were initiated in April. These studies are useful in two ways:

1) Many grass species are difficult to distinguish morphologically from other closely related species. Where differences in chromosome number exist between such species, they can be used as an additional criterion for identification.
2) Some seed populations show variation in chromosome numbers within the population. Therefore, great variability should exist. Evaluation of such lines on a plot basis would be of little value, but such variability offers great potential for selection, if such selections are made on a single-plant basis.

Methods:

Seeds were germinated in petri dishes on moist blotting paper. When roots were approximately one half inch long, they were removed and placed in vials of ice water for 24 hours. They were then transferred to fixative (95% ethanol: glacial acetic acid, 3:1) and left at room temperature for at least three days.

For slide preparation, root tips were blotted dry, then placed in IN HCl at 60°. The time for this hydrolysis was genus dependent. Root tips were again blotted dry, and transferred to vials of Feulgen[1] for staining. Squash preparations of stained portions were made with aceto-carmine[2], and the slides were examined under a light microscope at 128X or 320X.

Times of hydrolysis

Genus	Time (minutes)
Agropyron	12
Agrostis	6
Alopecurus	9
Beckmannia	12
Bromus	7
Deschampsia	6
Elymus	8
Festuca	5
Glyceria	5
Hierochloe	5

1. R. D. Lillie, Stain Technology 26:123,163. 1951.

2. Edward Gurr. The Rational Use of Dyes in Biology. Leonard Hill: London. 1965. 422 pp.

Results of Chromosome Studies

Botany Number 1974 Seed	Species Name		Chromosome Number
244	*Agropyron*	*cristatum*	28[1]
245	*A.*	*cristatum*	14
1	*A.*	*repens*	42
247	*A.*	*riparium*	28
357	*A.*	*riparium*	28
261	*A.*	*smithii*	28
361	*A.*	*smithii*	28
48	*A.*	*smithii*	28
50	*A.*	*smithii*	28
46	*A.*	*smithii*	28
301	*A.*	*sp.*	28
325	*A.*	*sp.*	28
54	*A.*	*sp.*	28
56	*A.*	*sp.*	28
5	*A.*	*sp.*	28
326	*A.*	*sp.*	28
309	*A.*	*sp.*	42
4	*A.*	*subsecundum*	4
246	*A.*	*trachycaulum*	28
285	*A.*	*trachycaulum*	42[2]
299	*A.*	*trachycaulum*	28
8	*A.*	*trachycaulum*	28
286	*A.*	*trachycaulum*	28
248	*A.*	*trichophorum*	42
310	*A.*	*tsukusiense*	42
311	*A.*	*tsukusiense*	42
365	*Agrostis*	*gigantea*	42
269	*A.*	*gigantea*	42
162	*A.*	*gigantea*	42

Botany Number 1974 Seed	Species Name	Chromosome Number
13	*A. sp.*	28
14	*A. sp.*	28
15	*A. sp.*	28
16	*A. sp.*	28
329	*A. tenuis*	28
280	*Alopecurus pratensis*	28
17	*Alopecurus sp.*	28
97	*Alopecurus ventricosus*	28
267	*Beckmannia syzigachne*	14
263	*Bromus inermis*	56
366	*B. inermis*	56
243	*B. inermis*	56
242	*B. inermis*	56
63	*B. inermis*	56
62	*B. inermis*	56
61	*B. inermis*	56
346	*B. pumpellianus*	56
268	*B. pumpellianus*	56
65	*B. sp.*	56
20	*Elymus canadensis*	28
274	*Elymus cinereus*	56
298	*Elymus innovatus*	28-35[3]
300	*Elymus innovatus*	28
294	*Elymus innovatus*	28
364	*Elymus innovatus*	28
70	*Elymus innovatus*	28
249	*Elymus junceus*	14
73	*Elymus sp.*	28
74	*Elymus sp.*	28
283	*Festuca arundinacea*	42
21	*F. ovina*	14
100	*F. ovina*	42

Botany Number 1974 Seed	Species Name	Chromosome Number
22	*F. rubra*	56
76	*F. rubra*	56
154	*F. rubra*	42
240	*F. rubra*	42
24	*F. rubra*	56
26	*F. scabrella*	56
77	*F. sp.*	14,28[4]
30	*Glyceria sp.*	20

1975 Seed		
464	*Agropyron cristatum*	14
465	*A. elongatum*	42
333	*A. smithii*	28
48	*A. smithii*	28
470	*A. smithii*	28
477	*A. sp.*	14
47	*A. sp.*	28
485	*A. sp.*	28
4	*A. subsecundum*	28
487	*A. subsecundum*	28
489	*A. trachycaulum*	42[2]
491	*A. yukonense*	28
327	*Agrostis gigantea*	42
280	*Alopecurus pratensis*	28,42[4]
	Bromus inermis	56
68	*Deschampsia sp.*	26
294	*Elymus innovatus*	28
22	*Festuca rubra*	56
527	*F. saximontana*	42

1. Commercial crested wheat grass, cv. Summit, is not really *Agropyron cristatum*, but *A. desertorum*.
2. Since literature values for *A. trachycaulum* show only 28, these are possibly wrongly identified.
3. This mixed line should show great variation.
4. These lines are mixed but vary only in ploidy level. Thus, each is probably composed of two populations which are relatively stable genetically.

TESTING OF GRASSES ON VARIOUS SOIL TYPES

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ALBERTA ENVIRONMENT
AOSERP

INTRODUCTION

Previous work in the field of revegetation has concentrated upon the use of agricultural varieties for the restoration of disturbed areas. This has been done on the assumption that natural revegetation would follow this artificial revegetation.

However native grasses potentially useful for revegetation or reclamation are largely noncultivated and relatively unknown. Information on complex plant-environment interactions is required if these species are to be used in revegetation. This study was basically initiated to fill this gap. The aim was to accumulate basic information about both native and naturalized grass species which could be used in revegetation programs.

The purposes of this study may be summarized as follows: to accumulate basic information about various species and ecotypes which have been collected largely from Northwest America; and to provide reliable and standardized data about these species and ecotypes for further studies. The above purposes may be broken down into several objectives. These are to study: plant response to fertilizer application; plant growth patterns in various soil types; and top/root ratios.

MATERIALS AND METHOD

Plant growth in various soil types was tested with and without fertilizer in either growth chambers or a greenhouse. Seed of native and naturalized grass species was collected, primarily from Alberta, for this purpose. The soils also were collected mainly from Alberta in the fall of 1975. The experiment covered a period of approximately three months, with slight variations depending upon the maturities of the species studied.

Plant Selection

Twelve grass species (Table 15) were selected from over 300 species or ecotypes in the seed stock of the Botany Section and planted in 6 inch (approx. 15 cm.) diameter pots containing different soil types. The selection criteria were based on our previous experience, with the specific concerns being: 1) aggressiveness with extensive root systems; 2) adaptability to some special edaphic factors; and 3) rapid growth with excellent natural reproduction, either vegetatively or sexually.

Each species was quite heavily seeded on the soils of pots which were carefully prepared and watered one week before seeding. The pots were then watered daily with such amounts as to give the plants best growth. The plants were thinned out to five per pot a few weeks after seeding.

TABLE 15

PLANT SPECIES USED IN THIS STUDY

AND THEIR COMMON NAMES

B. No.*	Plant Species	Common Name
8	*Agropyron trachycaulum*	Slender wheat grass
333	*Agropyron smithii*	Western wheat grass
327	*Agrostis gigantea*	Red top
280	*Alopecurus pratensis*	Meadow foxtail
263	*Bromus inermis*	Smooth brome
68	*Deschampsia sp.*	Hair grass
294	*Elymus innovatus*	Hairy wild rye
22	*Festuca rubra*	Red fescue
527	*Festuca saximontana*	Native fescue
89	*Poa palustris*	Fowl bluegrass
264	*Poa pratensis*	Kentucky bluegrass
43	*Puccinellia sp.*	Alkali grass

* Botany Collection Number

Soil

Eight representative soils (Table 16), which are likely to need revegetation, were collected from Alberta and the Northwest Territories in the fall of 1975. In addition to the eight soils, steam-sterilized greenhouse soil was made by mixing black loam, peat, and sand in a ratio of 3:2:1 respectively.

The soils were analyzed for both physical and chemical properties by the Alberta Soil and Feed Testing Laboratory using their standard soil analyses. The soil samples were air dried, ground, and analyzed for electrical conductivity, pH., Sodium, nitrogen, potassium, phosphorus, sulphates, organic matter, free lime, and texture. The levels chosen are related to those recommended for field crops because they were the only standards readily available.

Layout of the Experiment

There were two sets of soil and plant combinations, one with ten species and five soils, the other with six species and five soils. The ten species were seeded on October 23, 1975 and uprooted on January 17, 1976 for a total experiment duration of 86 days. Three growth chambers, each containing 100 pots were allocated for this test for a total of 300 pots. In the second test three species; *Agropyron trachycaulum, Festuca saximontana,* and *Poa pratensis* were tested from November 19, 1975 to February 5, 1976, for a total of 77 days in a growth chamber, while the other three species: *Agropyron smithii, Elymus innovatus* and *Festuca rubra* were tested from November 21, 1975 to February 6, 1976, a total of 76 days in a greenhouse.

TABLE 16

SOIL TYPES AND THEIR SOURCES

Soil Type	Source
Sand	Devon
Tar sand tailing	Fort McMurray
Peat	Peers
Clay	Ellerslie
Tailing sand	Yellowknife
Tar sand	Fort McMurray
Coal	Round Hill
Clay	Dixonville
Greenhouse soil	Edmonton

Growth Chambers and Greenhouse

Four growth chambers and one bench of a greenhouse were allocated for this experiment. Each growth chamber was capable of containing 100 six inch pots. The details of growth chamber and the greenhouse environments are shown in Table 17.

TABLE 17 Environments of Growth Chambers and the Greenhouse

	Growth chambers	Greenhouse
Day length	15 hours	16 hours
Light intensity	2000 foot-candles	2500 foot-candles
Temperature, day	20° C.	21° C.
Temperature, night	12° C.	15° C.
Relative humidity	65%	60%

Miscellaneous

Fertilizer. A 14-14-14 slow release fertilizer (commercial name OSMOCOAT) was applied once to one half of the 480 pots at the time of planting. The quantity of fertilizer was 1.2 grams per pot, equivalent to 800 Kg. per hectar.

Plant height. The plant heights in all pots were measured weekly at the early stage of growth and then biweekly until the plants were uprooted. Three measurements per pot were taken at each time.

Top/root ratio. The top and root dry weights of all 480 pots were measured at the end of the experiment. The aerial parts of the plants were cut at soil level. The roots were washed thoroughly in water and then the aerial parts and roots were oven-dried to constant weight at 100°C.

OBSERVATIONS AND RESULTS

Soil Properties

The nine soils used in this study were analysed for both physical and chemical properties (Table 18). The majority of the soils were low in nitrogen, phosphorus, and organic matter. The pH values varied from 3.7 to 8.7. Electrical conductivity was generally low except in tailing sand from Yellowknife. Each soil type is briefly delineated according to the results of soil analyses and observations.

Sand

The course sand from Devon which was fairly well vegetated showed high pH, 8.1, with very low organic matter content. This sand had the highest nitrogen level per acre among the nine soils. The phosphorus level was also high at 24 lbs/A.

Tar sand tailing

This tailing sand had the highest pH, 8.7, with the least potassium 18 lbs/A., of the nine soils. The nitrogen content was extremely low as was organic matter.

Peat

The peat from Peers had low pH, 5.4, as well as low nitrogen content, 1 lb/A. It was very light when dried and tended to dry easily during the experiment.

TABLE 18

Physical and Chemical Properties of Nine Soils used for Testing

SOIL TYPES	lbs/Acre N	P	K	Na	pH	mmhos	SO_4	Org. Matter	Free Lime $CaCO_3$	Texture
Sand	13	24	154	L-	8.1	0.3		L-	M+	1
Tailing sand, Ft. McMurray	1	4	18	L	8.7	0.2		L-		1
Peat	1	18	79	L	5.4	0.2		H-		peat
Clay, Ellerslie	12	1	459	H-	8.3	0.6		L+	M+	5
Tailing sand, Yellowknife	3	1	250	H	8.4	5.2	H	L	H+	2
Tar sand	1	4	22	L-	7.5	0.2		M		1
Coal	1	1	129	H+	6.1	2.3	M+	coal		coal
Clay, Dixonville	2	24	310	L	3.7	0.4		L+		5
Greenhouse soil	100+	38	245	L-	5.8	0.6		M-		10

Clay, Ellerslie

This clay had the largest potassium content, 459 lbs/A., but the phosphorus level was only 1 lb/A. The pH value was high at 8.3. It was later found that the Department of Highways had sprayed a herbicide on this soil.

Tailing sand, Yellowknife

This tailing sand had very high electrical conductivity, 5.2 mmhos/cm. The amount of phosphorus was very low, 1 lb/A. It was much finer than the sand from Devon.

Tar Sand

The tar sand had low nitrogen and phosphorus levels, 1 and 4 lbs/A. respectively with a pH value of 7.5. This tar sand did not hold water at all except when some clay coexisted with it. The tar sand became very hard when it was dried.

Coal

This coal was fairly coarse, but contained fine particles. The nitrogen and phosphorus levels were very low, each equalling 1 lb/A. The pH was 6.1 and conductivity was 2.3 mmhos.

Clay, Dixonville

This grey-coloured clay was very low in pH at 3.7. The nitrogen and organic matter contents were low, but the amount of potassium was the second highest of the nine at 310 lbs/A.

Greenhouse soil

This greenhouse soil, a mixture of loam, sand, and peat had large amounts of nitrogen, phosphorus and potassium, 100, 38, and 245 lbs/A respectively. The pH was 5.8. The electrical conductivity was 0.6 mmhos/cm.

PLANT GROWTH IN SAND, TAILING SAND (FORT McMURRAY), PEAT and CLAY

In general most plants did not grow well in the unfertilized soils of this group. However, when these same soils were fertilized the plants grew quite well and developed normal underground parts, i.e. roots and rhizomes (Figure 1 and 2). Four of the ten species tested on the fertilized soils produced inflorescence within 70 days of being seeded. These four were *Agropyron trachycaulum, Agrostis gigantea, Poa palustris,* and *Puccinellia* sp.

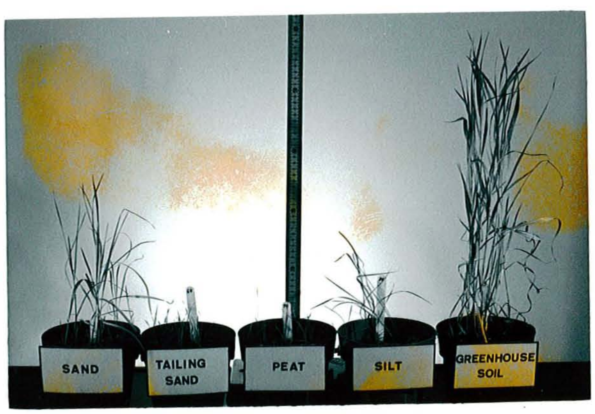
Most plants in the unfertilized soils managed to survive but stopped growing one to two weeks after germination, apparently suffering from nutrient deficiency and some other factors (Table 20). Many young plants turned a light purple colour while very few looked normal judging from their size and colour.

Sand (Devon)

The ten species in fertilized sand grew normally with three species, *Agropyron trachycaulum, Poa palustris,* and *Puccinellia* sp. producing inflorescence during the 86 days of the growth chamber experiment. The dry weights of the biomass* ranged from 11.0g *(Alopecurus pratensis* and *Bromus inermis)* to 3.5g *(Festuca saximontana).* These dry weights were much less than those of plants growing in greenhouse soil which ranged from 32.8g *(Poa palustris)* to 3.8g *(Festuca saximontana).* The highest T/R ratio was 2.78 for *Puccinellia* sp. and the lowest was 0.69 for *Poa pratensis.*

* Biomass is the combined dry weight of the tops and the roots of the plants in each pot, weighed at the end of the experiment.

A



B

Figure 1 Photographs of *Bromus inermis* in five fertilized and unfertilized soils. (December 30, 1975).

A. Fertilized soils. B. Unfertilized soils.

Silt...Wrong sign. It should be Clay.

A

B

Figure 2 Photographs showing the roots of *Poa pratensis* and *Alopecurus pratensis* in five fertilized soils. (January 17, 1976).

A. *Poa pratensis* B. *Alopecurus pratensis*

TABLE 19

Combined Biomass in grams and Top/Root Ratios

in Five Soils

Fertilized	Top(g)	Root(g)	Biomass(g)	T/R
Sand (Devon)	43.1	41.1	84.2	1.05
Tailing sand (Ft. McMurray)	40.7	46.0	86.7	0.88
Peat (Peers)	38.8	22.0	60.8	1.76
Clay (Ellerslie)	60.8	42.4	103.2	1.43
Greenhouse soil	74.2	73.7	147.9	1.00
Unfertilized				
Sand (Devon	8.4	16.8	25.2	0.50
Tailing sand (Ft. McMurray)	0.22	0.21	0.43	1.05
Peat (Peers)	0.36	0.18	0.54	2.00
Clay (Ellerslie)	2.10	1.24	3.34	1.69
Greenhouse soil	45.0	56.0	101.0	0.80

The biomass of the ten species were combined to calculate the average top/root ratio in each soil type.

TABLE 20

Plant Height in cm. of Ten Species in Five Soil Types as Measured 14, 35 and 69 Days After Seeding.

	Days After Seeding (Seeded on October 23, 1975)		
Combination	14	35	69
Fertilized Sand			
Agropyron trachycaulum	6.1	15.1	34.1
Agrostis gigantea	2.4	12.7	23.8
Alopecurus pratensis	4.3	15.3	28.6
Bromus inermis	5.5	14.9	36.2
Deschampsia sp.	3.6	9.3	15.1
Elymus innovatus	6.0	11.9	24.7
Festuca saximontana	2.1	4.8	10.2
Poa palustris	0.9	11.8	35.7
Poa pratensis	1.7	10.3	16.9
Puccinellia sp.	1.4	7.9	27.4
Fertilized Tar Sand tailing			
Agropyron trachycaulum	10.8	20.4	41.4
Agrostis gigantea	2.6	12.1	25.8
Alopecurus pratensis	6.3	20.6	29.9
Bromus inermis	5.9	17.6	37.9
Deschampsia sp.	3.1	20.5	18.2
Elymus innovatus	5.1	16.8	24.1
Festuca saximontana	2.0	4.9	10.2
Poa palustris	1.6	14.9	41.2
Poa pratensis	2.8	10.5	25.0
Puccinellia sp.	1.2	9.1	27.1

Table 20 - continued

Combination	Days After Seeding (Seeded on October 23, 1975) 14	35	69
Fertilized Peat			
Agropyron trachycaulum	9.2	16.4	32.3
Agrostis gigantea	3.6	13.0	22.6
Alopecurus pratensis	7.2	19.6	22.4
Bromus inermis	6.4	17.3	33.2
Deschampsia sp.	4.0	9.3	16.3
Elymus innovatus	7.6	15.8	26.9
Festuca saximontana	2.9	5.5	10.3
Poa palustris	2.9	14.0	41.9
Poa pratensis	4.4	10.3	18.7
Puccinellia sp.	1.6	9.0	24.9
Fertilized Clay (Ellerslie)			
Agropyron trachycaulum	8.3	17.8	39.4
Agrostis gigantea	4.4	10.9	29.5
Alopecurus pratensis	5.7	14.3	40.8
Bromus inermis	6.3	17.7	33.9
Deschampsia sp.	3.2	7.1	16.1
Elymus innovatus	6.7	9.8	25.5
Festuca saximontana	3.1	4.9	10.0
Poa palustris	2.4	15.3	46.7
Poa pratensis	2.8	9.5	21.7
Puccinellia sp.	1.7	7.3	31.4

Table 20 - continued

Combination	Days After Seeding (Seeded on October 23, 1975) 14	35	69
Fertilized Greenhouse Soil			
Agropyron trachycaulum	9.8	20.8	51.7
Agrostis gigantea	4.3	14.2	22.1
Alopecurus pratensis	6.7	21.0	36.9
Bromus inermis	7.3	22.5	45.0
Deschampsia sp.	3.8	1.2	20.0
Elymus innovatus	7.8	17.2	30.8
Festuca saximontana	3.3	6.1	12.6
Poa palustris	2.3	16.7	43.8
Poa pratensis	3.9	11.1	23.4
Puccinellia sp.	1.8	10.1	26.8
Unfertilized Sand			
Agropyron trachycaulum	7.0	15.7	17.4
Agrostis gigantea	1.5	8.9	19.2
Alopecurus pratensis	4.4	15.8	15.7
Bromus inermis	8.5	16.1	18.5
Deschampsia sp.	3.1	8.1	11.1
Elymus innovatus	5.3	12.5	35.2
Festuca saximontana	2.8	4.8	8.1
Poa palustris	1.1	11.4	29.8
Poa pratensis	2.7	9.8	13.2
Puccinellia sp.	1.5	18.0	19.8

Table 20 - continued

Combination	Days After Seeding (Seeded on October 23, 1975) 14	35	69
Unfertilized Tar Sand Tailing			
Agropyron trachycaulum	5.2	10.1	5.6
Agrostis gigantea	1.6	2.2	2.3
Alopecurus pratensis	3.8	4.9	3.1
Bromus inermis	6.6	10.2	7.4
Deschampsia sp.	2.9	3.5	2.7
Elymus innovatus	5.3	6.8	4.0
Festuca saximontana	2.0	2.8	1.5
Poa palustris	1.2	1.2	0.6
Poa pratensis	2.0	2.5	1.5
Puccinellia sp.	0.8	1.4	0.8
Unfertilized Peat			
Agropyron trachycaulum	7.6	10.1	8.9
Agrostis gigantea	2.6	4.7	6.3
Alopecurus pratensis	5.5	6.4	7.2
Bromus inermis	6.1	8.4	8.6
Deschampsia sp.	3.6	5.4	4.2
Elymus innovatus	6.9	8.4	5.3
Festuca saximontana	7.6	3.8	3.6
Poa palustris	1.4	1.8	3.5
Poa pratensis	2.9	3.6	4.4
Puccinellia sp.	1.4	2.0	2.0

Table 20 - continued

	Days After Seeding (Seeded on October 23, 1975)		
Combination	14	35	69
Unfertilized Clay (Ellerslie)			
Agropyron trachycaulum	7.9	11.6	7.2
Agrostis gigantea	2.7	5.1	9.2
Alopecurus pratensis	5.4	9.0	13.4
Bromus inermis	5.4	8.8	10.2
Deschampsia sp.	2.4	3.0	5.4
Elymus innovatus	5.7	4.8	6.6
Festuca saximontana	2.4	2.6	10.6
Poa palustris	1.6	1.8	6.4
Poa pratensis	2.2	2.7	4.3
Puccinellia sp.	1.3	3.8	9.3
Unfertilized Greenhouse Soil			
Agropyron trachycaulum	9.8	21.6	36.8
Agrostis gigantea	3.2	13.8	29.7
Alopecurus pratensis	6.4	21.6	33.9
Bromus inermis	7.1	19.5	44.6
Deschampsia sp.	3.8	10.2	17.3
Elymus innovatus	7.8	16.0	30.5
Festuca saximontana	3.4	5.8	12.1
Poa palustris	2.4	21.5	47.7
Poa pratensis	3.0	10.0	20.4
Puccinellia sp.	1.7	11.1	27.4

The numbers are the averages of nine measurements in centimeters.

TABLE 21

Top/Root Ratio and Biomass in g. of Ten Species in Five Soil Types as Measured 86 Days After Seeding

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Fertilized Sand				
Agropyron trachycaulum	4.3	4.8	9.1	0.90
Agrostis gigantea	5.3	4.7	10.0	1.13
Alopecurus pratensi	4.7	6.3	11.0	0.75
Bromus inermis	5.0	6.0	11.0	0.83
Deschampsia sp.	3.9	4.4	8.3	0.89
Elymus innovatus	4.8	3.3	8.1	1.45
Festuca saximontana	2.3	1.2	3.5	1.92
Poa palustris	5.8	4.5	10.3	1.29
Poa pratensis	3.1	4.5	7.6	0.69
Puccinellia sp.	3.9	1.4	5.3	2.78
Fertilized Tar Sand Tailing				
Agropyron trachycaulum	4.3	4.7	9.0	0.91
Agrostis gigantea	5.3	4.8	10.1	1.10
Alopecurus pratensis	4.7	8.8	13.5	0.53
Bromus inermis	4.5	5.2	9.7	0.87
Deschampsia sp.	4.3	5.1	9.4	0.84
Elymus innovatus	3.9	3.0	6.9	1.30
Festuca saximontana	1.5	1.2	2.7	1.25
Poa palustris	6.1	7.2	13.3	0.85
Poa pratensis	2.6	5.1	7.7	0.51
Puccinellia sp.	3.5	0.9	4.4	3.89

Table 21 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Fertilized Peat				
Agropyron trachycaulum	4.3	2.5	6.8	1.72
Agrostis gigantea	5.1	1.7	6.8	3.00
Alopecurus pratensis	3.6	2.5	5.1	1.44
Bromus inermis	3.9	2.6	6.5	1.50
Deschampsia sp.	4.2	2.1	6.3	2.00
Elymus innovatus	4.3	1.4	5.7	3.07
Festuca saximontana	1.9	0.8	2.7	2.38
Poa palustris	5.3	4.8	10.1	1.10
Poa pratensis	3.0	2.9	5.9	1.03
Puccinellia sp.	3.2	0.7	3.9	4.57
Fertilized Clay (Ellerslie)				
Agropyron trachycaulum	6.9	4.7	11.6	1.47
Agrostis gigantea	8.9	6.0	14.9	1.48
Alopecurus pratensis	6.0	6.0	12.0	1.00
Bromus inermis	8.4	7.5	15.9	1.12
Deschampsia sp.	6.0	3.6	9.6	1.67
Elymus innovatus	5.0	2.3	7.3	2.17
Festuca saximontana	2.2	1.0	3.2	2.20
Poa palustris	8.7	3.7	12.4	2.35
Poa pratensis	4.4	6.4	10.8	0.69
Puccinellia sp.	4.3	1.2	5.5	3.58

Table 21 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Fertilized Greenhouse Soil				
Agropyron trachycaulum	9.3	4.4	13.7	2.11
Agrostis gigantea	9.2	7.8	17.0	1.18
Alopecurus pratensis	8.0	12.4	20.4	0.65
Bromus inermis	9.0	6.3	15.3	1.43
Deschampsia sp.	7.2	5.0	12.2	1.44
Elymus innovatus	5.8	1.3	7.1	4.46
Festuca saximontana	2.5	1.3	3.8	1.92
Poa palustris	11.5	21.3	32.8	0.54
Poa pratensis	6.4	12.6	19.0	0.51
Puccinellia sp.	5.3	1.3	6.6	4.08
Unfertilized Sand				
Agropyron trachycaulum	0.7	1.4	2.1	0.50
Agrostis gigantea	1.3	2.0	3.3	0.65
Alopecurus pratensis	0.6	2.0	2.6	0.3
Bromus inermis	0.7	1.9	2.6	0.37
Deschampsia sp.	1.1	1.9	3.0	0.58
Elymus innovatus	0.7	1.0	1.7	0.70
Festuca Saximontana	0.8	1.4	2.2	0.57
Poa palustris	0.9	2.6	3.5	0.35
Poa pratensis	0.5	1.6	2.1	0.31
Puccinellia sp.	1.1	1.0	2.1	1.1

Table 21 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Unfertilized Tar Sand Tailing				
Agropyron trachycaulum	0.04	0.04	0.08	1.00
Agrostis gigantea	0.01	0.01	0.02	1.00
Alopecurus pratensis	0.02	0.03	0.05	0.67
Bromus inermis	0.07	0.05	0.12	1.40
Deschampsia sp.	0.02	0.01	0.03	2.00
Elymus innovatus	0.03	0.02	0.05	1.50
Festuca saximontana	0.007	0.01	0.017	0.70
Poa palustris	0.005	0.01	0.015	0.50
Poa pratensis	0.007	0.01	0.017	0.70
Puccinellia sp.	0.007	0.02	0.027	0.35
Unfertilized Peat				
Agropyron trachycaulum	0.04	0.03	0.07	1.33
Agrostis gigantea	0.04	0.01	0.05	4.00
Alopecurus pratensis	0.05	0.03	0.08	1.67
Bromus inermis	0.07	0.03	0.10	2.33
Deschampsia sp.	0.03	0.01	0.04	3.00
Elymus innovatus	0.05	0.03	0.08	1.67
Festuca saximontana	0.03	0.01	0.04	3.00
Poa palustris	0.03	0.02	0.05	1.50
Poa pratensis	0.01	0.01	0.02	1.00
Puccinellia sp.	0.01	0.004	0.014	2.5

Table 21 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Unfertilized Clay (Ellerslie)				
Agropyron trachycaulum	0.3	0.2	0.5	1.50
Agrostis gigantea	0.3	0.1	0.4	3.00
Alopecurus pratensis	0.2	0.3	0.5	0.67
Bromus inermis	0.3	0.2	0.5	1.50
Deschampsia sp.	0.1	0.05	0.15	2.00
Elymus innovatus	0.2	0.1	0.3	2.00
Festuca saximontana	0.2	0.1	0.3	2.00
Poa palustris	0.13	0.006	0.19	2.17
Poa pratensis	0.07	0.03	0.10	2.33
Puccinellia sp.	0.3	0.1	0.4	3.00
Unfertilized Greenhouse Soil				
Agropyron trachycaulum	4.1	2.1	6.2	1.95
Agrostis gigantea	6.5	6.1	12.6	1.07
Alopecurus pratensis	4.3	12.2	16.5	0.35
Bromus inermis	4.3	5.6	9.9	0.77
Deschampsia sp.	4.7	5.4	10.1	0.87
Elymus innovatus	3.6	0.9	4.5	4.00
Festuca saximontana	2.3	0.8	3.1	2.88
Poa palustris	7.0	13.8	20.8	0.51
Poa pratensis	4.2	7.3	11.5	0.58
Puccinellia sp.	4.0	1.8	5.8	2.22

The plants were seeded on October 23, 1975 and uprooted on January 17, 1976 (86 days). The numbers are averages of three replications.

All ten species grew substantially less in unfertilized than in fertilized sand, but growth in unfertilized sand was the best among the four unfertilized soils. *Poa palustris* and *Puccinellia* sp. developed inflorescence in the unfertilized sand. The differences in biomass among the ten species were not great; the highest was the 3.5 g. of *Poa palustris* and the lowest was the 1.7 g. of *Elymus innovatus*. The T/R ratios ranged from a high of 1.1 to a low of 0.3.

Tailing sand (Fort McMurray)

The ten species grew as well in fertilized tailing sand as in the fertilized sand from Devon. For example *Alopecurus pratensis* and *Poa palustris* produced more biomass in the tailing sand than they did in the sand. The biomass ranged from 13.5 g. of *Alopecurus pratensis* to the 2.7 g. of *Festuca saximontana.* The dry weights of roots produced by the ten species varied widely, from the 8.8 g. of *Alopecurus pratensis* to the 0.9 g. of *Puccinellia* sp. As a result the T/R ratios showed wide differences between species, i.e. a low of 0.51 for *Poa pratensis* and a high of 3.89 for *Puccinellia* sp. (Table 21). Four of ten species, as compared to three in the sand, developed inflorescence. These were *Agropyron trachycaulum, Agrostis gigantea, Poa palustris,* and *Puccinellia* sp. No appreciable abnormalities except some slight chlorosis symptoms (Figure 3) were observed during the experiment.

All ten species in unfertilized tailing sand germinated well but became stunted at the three to four leaf stage (Figure 4). The ten species all had biomass less than 0.12 g. The T/R ratios

A

B

Figure 3 Photographs of ten species in fertilized tailing sand from Fort McMurray. (December 30, 1975).

A. *Agropyron trachycaulum, Agrostis gigantea, Alopecurus pratensis Bromus inermis* and *Deschampsia sp.*, left to right.

B. *Elymus innovatus, Festuca saximontana, Poa palustris, Poa pratensis,* and *Puccinellia sp.*, left to right.

A

B

Figure 4. Photographs of five species in fertilized and unfertilized tailing sand from Fort McMurray (January 17, 1976).

A. Fertilized B. Unfertilized

Elymus innovatus, *Festuca saximontana*, *Poa palustris*, *Poa pratensis* and *Puccinellia sp.*, left to right.

ranged from 2.00 for *Deschampsia* sp. to 0.35 for *Puccinellia* sp. The majority of the ten species had pink or purple coloured leaves with dried tips.

Peat (Peers)

The plants in fertilized peat grew almost as well as those in the fertilized tailing sand and sand. The highest biomass was 10.1 g. for *Poa palustris* and the lowest 2.7 g. for *Festuca saximontana.* The T/R ratios were relatively high when compared to those in the other soils. The highest T/R ratio was 4.57 for *Puccinellia sp.* and the lowest was 1.03 for *Poa pratensis.* There were some difficulties encountered in cleaning and collecting the roots because they were finely distributed. This may be a contributing factor to the high T/R ratios. The same four species developed inflorescence as in fertilized tailing sand. The majority of the ten species in unfertilized peat stopped growing one to two weeks after germination. The highest biomass obtained in unfertilized peat was 0.1 g. for *Bromus inermis.*

Clay (Ellerslie)

The plants in fertilized clay produced the highest average biomass that was obtained in the four soils. The highest biomass was 15.9 g. for *Bromus inermis* and the lowest was 3.2 g. for *Festuca saximontana.* The T/R ratios were relatively high, ranging from 2.35 for *Poa palustris* to 0.69 for *Poa pratensis.* Five of the ten species, *Agropyron trachycaulum, Agrostis gigantea, Bromus inermis, Poa palustris,* and *Puccinellia* sp. produced inflorescence.

The plants in unfertilized clay produced the second largest amount of dry matter, following only the unfertilized sand. The highest biomass was 0.5 g. and the lowest was 0.10 g. T/R ratios varied from a high of 3.00 for *Agrostis gigantea* to a low of 0.67 for *Alopecurus pratensis*.

Greenhouse Soil

The fertilized greenhouse soil gave the best plant growth to all species except *Bromus inermis* and *Elymus innovatus*. The biomass varied from a high of 32.8 g. for *Poa palustris* to a low of 3.8 g. for *Festuca saximontana*. The T/R ratios were relatively low on average, ranging from a high of 4.46 for *Bromus inermis* to a low of 0.51 for *Poa pratensis*. Five species, *Agropyron trachycaulum*, *Agrostis gigantea*, *Alopecurus pratensis*, *Poa palustris* and *Puccinellia* sp. developed inflorescence on the fertilized greenhouse soil.

The plants in unfertilized greenhouse soil produced almost the same quantities of biomass as those in fertilized clay. The highest biomass was 20.8 g. for *Poa palustris* and the lowest was 3.1 g. for *Festuca saximontana*. The T/R ratios were low on average varying from a high of 4.00 for *Elymus innovatus* to a low of 0.35 for *Alopecurus pratensis*.

PLANT GROWTH in TAILING SAND (YELLOWKNIFE), TAR SAND, COAL, and CLAY (DIXONVILLE)

The six species tested on these four soils grew much less successfully (Table 22 and Figure 5) than those in the previous four. Only one or two of the six species were able to grow and become sizeable in this group of fertilized soils. The exception here was coal, on which all species could grow. None of the six species developed any inflorescence in these soils during the 76 and 77 days of the experiment.

Tailing sand (Yellowknife)

In the majority of plants growth was greatly retarded in fertilized tailing sand. *Poa palustris* was the only species which managed to grow reasonably well and it had biomass of 3.07 g. The other species had a biomass of less than 1.31 g. The T/R ratios varied from 6.67 for *Festuca saximontana* to 1.19 for *Poa pratensis*.

None of the six species grew well on unfertilized tailing sand, all having a biomass of less than 0.13 g. The T/R ratios ranged from 1.0 to 2.25.

There were no germination difficulties in either fertilized or unfertilized tailing sand, but growth was checked one or two weeks after germination in the unfertilized tailing sand.

TABLE 22

Plant Height in cm. of Six Species in Five Soil Types as Measured 14, 34 (32) and 70 days After Seeding.

	Days After Seeding (Seeded on November 19, 1975)		
Combination	14	34	70
Fertilized Tailing Sand (Yellowknife)			
Agropyron trachycaulum	5.3	13.1	16.7
Festuca saximontana	1.3	2.4	1.9
Poa pratensis	1.3	5.8	19.3
Fertilized Tar Sand			
Agropyron trachycaulum	1.2	5.0	9.8
Festuca saximontana	0	1.8	3.8
Poa pratensis	0.7	3.4	8.5
Fertilized Coal			
Agropyron trachycaulum	7.3	21.8	39.2
Festuca saximontana	3.5	4.9	9.2
Poa pratensis	3.5	9.4	22.3
Fertilized Clay (Dixonville)			
Agropyron trachycaulum	3.7	5.9	3.6
Festuca saximontana	1.4	2.0	4.8
Poa pratensis	1.7	1.9	3.1
Fertilized Greenhouse Soil			
Agropyron trachycaulum	8.0	22.9	80.0
Festuca saximontana	3.0	5.2	12.0
Poa pratensis	2.5	11.2	24.8

Table 22 - continued

Combination	Days After Seeding (Seeded on November 19, 1975) 14	34	70
Unfertilized Tailing Sand (Yellowknife)			
Agropyron trachycaulum	8.3	12.4	8.3
Festuca saximontana	2.1	3.1	1.6
Poa pratensis	1.8	3.2	1.8
Unfertilized Tar Sand			
Agropyron trachycaulum	1.4	3.1	6.3
Festuca saximontana	0	0.8	1.3
Poa pratensis	1.1	2.0	1.4
Unfertilized Coal			
Agropyron trachycaulum	8.6	11.7	14.7
Festuca saximontana	2.7	3.5	1.8
Poa pratensis	2.8	3.7	1.8
Unfertilized Clay (Dixonville)			
Agropyron trachycaulum	2.9	4.6	2.7
Festuca saximontana	2.3	4.3	1.5
Poa pratensis	2.2	2.3	1.2
Unfertilized Greenhouse Soil			
Agropyron trachycaulum	7.2	17.4	52.7
Festuca saximontana	5.5	10.8	18.6
Poa pratensis	2.4	11.6	24.0

Table 22 - continued

Combination	14	34	70
	Days After Seeding (Seeded on November 21, 1975)		
Unfertilized Tailing Sand (Yellowknife)			
Festuca rubra	3.9	6.5	4.3
Agropyron smithii	6.2	10.6	5.9
Elymus innovatus	4.3	6.4	5.6
Festuca rubra	3.6	3.6	5.0
Agropyron smithii	2.9	10.5	13.0
Elymus innovatus	4.1	6.3	13.8
Festuca rubra	5.8	7.2	8.4
Agropyron smithii	7.3	13.4	11.4
Elymus innovatus	6.4	10.4	19.3
Festuca rubra	5.4	6.5	7.7
Agropyron smithii	5.7	6.5	7.6
Elymus innovatus	4.0	4.8	5.1
Festuca rubra	6.4	10.8	14.8
Agropyron smithii	5.5	12.8	17.1
Elymus innovatus	5.5	12.5	22.2

Table 22 - continued

	Days After Seeding (Seeded on November 21, 1975)		
Combination	14	32	70
Unfertilized Tailing Sand (Yellowknife			
Festuca rubra	4.7	5.0	2.5
Agropyron smithii	7.3	11.2	6.9
Elymus innovatus	3.9	6.7	4.4
Festuca rubra	4.3	5.0	1.9
Agropyron smithii	7.4	8.1	6.4
Elymus innovatus	4.0	5.0	3.4
Festuca rubra	4.1	3.9	2.0
Agropyron smithii	7.6	9.6	11.9
Elymus innovatus	4.9	6.6	9.7
Festuca rubra	5.1	6.3	4.1
Agropyron smithii	6.0	7.0	5.4
Elymus innovatus	5.2	6.6	4.3
Festuca rubra	6.0	7.6	6.5
Agropyron smithii	3.6	15.0	16.0
Elymus innovatus	4.0	10.3	18.5

The numbers are the averages of nine measurements in centimeters.

TABLE 23

Top/Root Ratio and Biomass in g. of Six Species in Five Soil Types as Measured 77 and 76 Days After Seeding

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Fertilized Tailing Sand (Yellowknife)				
Agropyron trachycaulum	0.33	0.26	0.59	1.27
Festuca saximontana	0.02	0.003	0.023	6.67
Poa pratensis	1.67	1.4	3.07	1.19
Fertilized Tar Sand				
Agropyron trachycaulum	0.15	0.073	0.223	2.05
Festuca saximontana	0.07	0.02	0.09	3.5
Poa pratensis	0.24	0.25	0.49	0.96
Fertilized Coal				
Agropyron trachycaulum	4.8	3.0	7.8	1.60
Festuca saximontana	0.08	0.14	0.22	0.57
Poa pratensis	3.97	3.7	7.67	1.07
Fertilized Clay (Dixonville)				
Agropyron trachycaulum	0.03	0.007	0.037	4.29
Festuca saximontana	0.07	0.03	0.10	2.33
Poa pratensis	0.02	0.007	0.027	2.86
Fertilized Greenhouse Soil				
Agropyron trachycaulum	12.3	3.8	16.1	3.24
Festuca saximontana	1.8	0.34	2.14	5.29
Poa pratensis	6.95	4.9	11.85	1.42

Table 23 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Unfertilized Tailing Sand (Yellowknife)				
Agropyron trachycaulum	0.09	0.04	0.13	2.25
Festuca saximontana	0.02	0.01	0.03	2.0
Poa pratensis	0.016	0.01	0.026	1.6
Unfertilized Tar Sand				
Agropyron trachycaulum	0.03	0.03	0.06	1.0
Festuca saximontana	0.02	0.01	0.03	2.0
Poa pratensis	0.012	0.013	0.025	0.92
Unfertilized Coal				
Agropyron trachycaulum	0.11	0.15	0.26	0.73
Festuca saximontana	0.03	0.023	0.053	1.30
Poa pratensis	0.023	0.017	0.040	1.35
Unfertilized Clay (Dixonville)				
Agropyron trachycaulum	0.03	0.007	0.037	4.29
Festuca saximontana	0.02	0.013	0.033	1.54
Poa pratensis	0.020	0.006	0.026	3.33
Unfertilized Greenhouse Soil				
Agropyron trachycaulum	6.1	2.7	8.8	2.26
Festuca saximontana	1.25	1.29	2.54	0.97
Poa pratensis	3.27	3.1	6.37	1.05

The plants were seeded on November 19, 1975 and uprooted on February 5, 1976 (77 days). The numbers are averages of three replications.

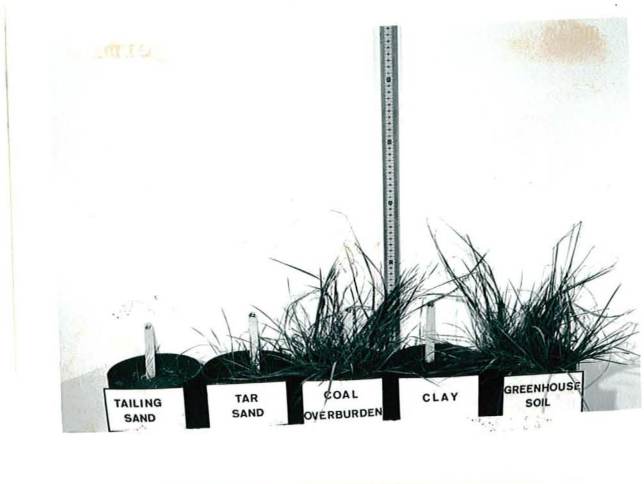
Table 23 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Fertilized Tailing Sand (Yellowknife)				
Festuca rubra	0.57	0.14	0.71	4.07
Agropyron smithii	0.90	0.41	1.31	2.20
Elymus innovatus	0.077	0.023	0.10	3.35
Fertilized Tar Sand				
Festuca rubra	1.09	0.68	1.77	1.60
Agropyron smithii	0.62	0.84	1.46	0.74
Elymus innovatus	0.30	0.14	0.44	2.14
Fertilized Coal				
Festuca rubra	4.79	4.22	9.01	1.14
Agropyron smithii	3.04	3.15	6.19	0.97
Elymus innovatus	2.61	1.83	4.44	1.43
Fertilized Clay (Dixonville)				
Festuca rubra	1.70	1.34	3.04	1.27
Agropyron smithii	0.093	0.06	0.153	1.55
Elymus innovatus	0.043	0.023	0.066	1.87
Fertilized Greenhouse Soil				
Festuca rubra	7.48	8.55	16.03	0.87
Agropyron smithii	5.37	2.46	7.83	2.18
Elymus innovatus	2.71	0.37	3.08	7.32

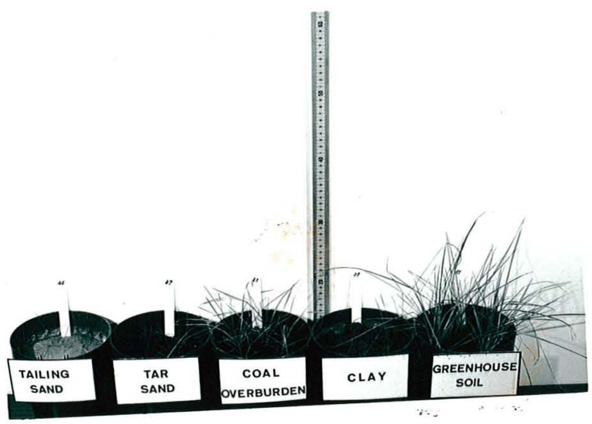
Table 23 - continued

Combination	Top(g)	Root(g)	Biomass(g)	T/R
Unfertilized Tailing Sand (Yellowknife)				
Festuca rubra	0.043	0.023	0.066	1.87
Agropyron smithii	0.067	0.033	0.10	2.03
Elymus innovatus	0.03	0.03	0.06	1.0
Unfertilized Tar Sand				
Festuca rubra	0.037	0.037	0.074	1.0
Agropyron smithii	0.043	0.03	0.073	1.43
Elymus innovatus	0.013	0.01	0.023	1.3
Unfertilized Coal				
Festuca rubra	0.28	0.25	0.53	1.12
Agropyron smithii	0.49	0.50	0.99	0.98
Elymus innovatus	0.17	0.18	0.35	0.94
Unfertilized Clay (Dixonville)				
Festuca rubra	0.17	0.12	0.29	1.42
Agropyron smithii	0.043	0.03	0.073	1.43
Elymus innovatus	0.027	0.013	0.040	2.08
Unfertilized Greenhouse Soil				
Festuca rubra	2.74	3.72	6.46	0.76
Agropyron smithii	2.40	1.27	3.67	1.89
Elymus innovatus	1.45	0.38	1.83	3.82

The plants were seeded on November 19, 1975 and uprooted on February 6, 1976 (76 days).



A



B

Figure 5 Photographs of *Agropyron smithii* in five fertilized and unfertilized soils (January 29, 1976).

A. Fertilized B. Unfertilized

Tar sand (Fort MacMurray)

Observation showed that the water holding capacity of the tar sand was extremely low. As a result the germination of the six species was not uniform. The time required for germination was also longer than in the other soils

The plants in the fertilized tar sand did not grow well. The highest biomass was 1.77 g. for *Festuca rubra* and the lowest was 0.09 g. for *Festuca saximontana*. The highest T/R ratio was 3.5 for *Festuca saximontana* and the lowest was 0.74 for *Agropyron smithii*.

The plants in unfertilized tar sand were very weak and were similar to those in unfertilized tailing sand. The biomass in the unfertilized tar sand was less than 0.074 g.

Coal (Round Hill)

All six species grew fairly well in the fertilized coal when compared to those in the fertilized tailing sand (Yellowknife), tar sand, and clay. *Festuca rubra* had the highest biomass, 9.01 g. and *Festuca saximontana* the lowest, 0.22 g. The T/R ratios were relatively low, ranging from 1.60 for *Agropyron trachycaulum* to 0.57 for *Festuca saximontana*.

None of the six species tested grew well in the unfertilized coal but it was the best unfertilized soil of the four tested (Figure 6). The highest biomass was obtained by *Agropyron smithii* (0.99 g.) and the lowest by *Poa pratensis* (0.04 g.). The T/R ratios varied from 1.35 for *Poa pratensis* to 0.73 for *Agropyron trachycaulum*.

A

B

Figure 6 Photographs of six species on fertilized and unfertilized coal from Round Hill (January 17, 1976).

A. Fertilized B. Unfertilized

Agropyron trachycaulum, Festuca saximontana, Poa pratensis, Festuca rubra, Agropyron smithii and *Elymus innovatus*. Left to right.

Clay (Dixonville)

Most plants in both fertilized and unfertilized clay did not develop their root systems after germination. The roots were short and swollen, remaining near the surface of the clay.

Festuca rubra had the largest biomass of 3.04 g. in the fertilized clay. All of the other species had biomass of less than 0.15 g. Of the six species only *Festuca rubra* could grow on this extremely acidic (pH=3.7) clay. The T/R ratios were generally high.

The plants in the unfertilized clay did not grow either. The highest biomass was 0.29 g. for *Festuca rubra* with all of the remaining five having less than 0.07 g. The average T/R ratio of the six species was 1.65, slightly higher than those of the other unfertilized soils.

Greenhouse soil

The fertilized and unfertilized greenhouse soils gave the best growth of all six species when compared to that of the four preceding soils. Most species, (the exception being *Festuca saximontana*) nearly doubled their biomass when the soil was fertilized.

Among the six species in the fertilized greenhouse soil *Festuca rubra* and *Agropyron trachycaulum* had the largest biomass, each having approximately 16 g. *Festuca saximontana* had the samllest biomass, 2.14 g. The T/R ratios varied from 5.29 for *Festuca saximontana* to 0.87 for *Festuca rubra*.

Most species in the unfertilized greenhouse soil had less biomass than those in the fertilized coal. The biomass ranged from 8.8 g. for *Agropyron trachycaulum* to 1.83 for *Elymus innovatus*. The T/R ratios varied from 3.82 to 0.76.

OBSERVATIONS OF TWELVE INDIVIDUAL SPECIES IN DIFFERENT SOILS

Agropyron trachycaulum (Slender wheat grass)

Agropyron trachycaulum was tested on eight soils. It developed inflorescence in the fertilized sand, tailing sand (Fort McMurray), clay (Ellerslie), and greenhouse soil and in the unfertilized greenhouse soil.

It had about average biomass among the tested species and showed no particular feature in the size of biomass. The T/R ratios in the fertilized sand and tailing sand (Fort McMurray) were approximately 0.9 and 2.1 respectively.

Agropyron smithii (Western wheat grass)

This species was tested on four soils. It grew better than the other species in tailing sand (Yellowknife) and tar sand, but it was not the best species in terms of dry matter production.

Agrostis gigantea (Red-top)

Agrostis gigantea, tested on four soils, developed inflorescence on all fertilized soils with the exception of sand (Devon). It grew well on the fertilized clay (Ellerslie) and had a biomass of 14.9 g. It also proved to be slightly better than other species in unfertilized sand.

Alopecurus pratensis (Meadow foxtail)

Alopecurus pratensis was tested on four soils. It developed inflorescence in only fertilized greenhouse soil. *Alopecurus pratensis* generally had larger than average biomass in fertilized soils, especially in the tailing sand (Fort McMurray) and greenhouse soil, 13.5 and 20.4 g. respectively. The T/R ratios were very low in many soils and varied from 0.3 in unfertilized sand to 1.44 in fertilized peat.

Bromus inermis (Smooth brome)

This species was tested in four soils and had a slightly larger biomass than average in the fertilized soils. It grew better in the fertilized clay (Ellerslie) than did any of the other species. The biomass in the fertilized clay was larger than in the fertilized greenhouse soil. The T/R ratios in the fertilized soils varied from 0.83 in sand to 1.50 in peat. Near the end of the experiment it developed a few panicles in the fertilized clay (Ellerslie).

Deschampsia sp. (Hair grass)

Deschampsia sp. was tested in four soils and did not have any extremely large or small biomass. The biomass in the five fertilized soils varied from 12.2 g. in the greenhouse soil to 6.3 g. in the peat. The T/R ratios in the same fertilized soils varied from 1.44 in the greenhouse soil to 0.84 in the tailing sand (Fort

McMurray). It did not produce any inflorescence during the experiment.

Elymus innovatus (Hairy wild rye)

This species was tested in eight soils but never had the largest or smallest biomass of the twelve species. It generally had slightly smaller biomass than those of the other species in the fertilized soils. It did not produce any inflorescence during the experiment.

Festuca rubra (Red fescue)

This species was tested in four soils in which the other five species could not grow well. It had the largest biomass among the six species tested in the fertilized coal, clay (Dixonville) and tar sand (Fort McMurray), 9.01, 3.04, and 1.77 g. respectively Table 23).

Festuca saximontana (Native fescue)

This species almost always had the smallest biomass in the nine fertilized soils. It also had a smaller biomass in the unfertilized soils with the exception of sand (Devon), in which it had an average biomass of 2.2 g. It's biomass in the fertilized and unfertilized greenhouse soils was 3.8 and 3.1 g. respectively, showing the small growth response of *Festuca saximontana* to the fertilizer application in this particular soil type. *Festuca saximontana* did not develop inflorescence during the experiment.

Poa palustris (Fowl bluegrass)

Poa palustris was tested in five soils. It developed inflorescence in all five fertilized soils and in unfertilized sand and greenhouse soil during the 86 days of the experiment.

Poa palustris grew well in all five fertilized soils and had the largest biomass in the fertilized peat and greenhouse soils; 10.0 and 32.8 respectively. It also had the largest biomass, 3.5 g. with a T/R ratio of 0.35 in the unfertilized sand, but was not successful in the unfertilized tailing sand (Fort McMurray). The T/R ratios in the fertilized soils varied from 0.54 to 2.35.

Poa pratensis (Kentucky bluegrass)

This species was tested in eight soils. *Poa pratensis* had an average size of biomass in many of the fertilized soils with relatively low T/R ratios. It did not develop any inflorescence but produced some rhizomes during the 86 day experiment (Figure 2).

Puccinellia sp. (Alkali grass)

Puccinellia sp. was tested in five soils. It produced inflorescence in all fertilized and unfertilized soils except the unfertilized tailing sand (Fort McMurray) and peat.

This species had small biomass in all five fertilized soils. It had exceptionally high T/R ratios which ranged from a high of 4.57 in peat to a low of 2.78 in sand (Devon). However the T/R ratio in unfertilized sand was only 1.1.

SUMMARY AND CONCLUSIONS

This study was undertaken to collect information about grass species per se and their interaction or relationship with their environment as applicable for revegetating disturbed areas in Alberta. Twelve grass species collected throughout northwest America were tested in nine soil types. The plants were grown in six inch pots with and without fertilizer (14-14-14) in either growth chambers or a greenhouse for between 76 and 86 days. Soil samples were taken and were analyzed for several factors. Plant heights were recorded weekly or biweekly. At the end of the experiment the plants were uprooted and the dry weights of the aerial and underground parts were recorded. Photographs were taken at the end of the experiment. The results of the study may be summarized as follows:

1. Tailing sand (Fort McMurray) had high pH (8.7) and low levels of nitrogen, phosphorus, and potassium: 1, 4, and 18 lbs. per acre respectively.
2. Tailing sand (Fort McMurray), when fertilized had plant growth as pronounced as that in fertilized sand (Devon) in all ten species. The average T/R ratio of ten species in the fertilized tailing sand was lower than that in the fertilized sand (Devon), 0.88 and 1.05 respectively.
3. Tar sand (Fort McMurray) retarded the germination of the majority of the plants tested.

4. The differences in plant growth between the nine fertilized and unfertilized soils was great. With the exception of plants tested in clay (Dixonville) and tailing sand (Yellowknife), all plant species tested in the fertilized soils grew almost normally.
5. *Festuca rubra* and *Poa palustris* were the only species which grew in the fertilized clay (Dixonville) and tailing sand (Yellowknife).
6. Clay (Dixonville) hampered the root development of the seedlings of the tested plants.
7. Most seedlings in the unfertilized soils survived but could not increase their size during the period of the experiment.
8. Four species developed inflorescence within 70 days of the beginning of the experiment. These were *Agropyron trachycaulum*, *Agrostis gigantea*, *Poa palustris*, and *Puccinellia* sp.

TESTING OF LEGUMES ON VARIOUS SOIL TYPES

NORMAN WARRINGTON
ALBERTA ENVIRONMENT
AOSERP

INTRODUCTION

Little is known about the establishment, growth habit, and response to fertilizer of most native legume species in Alberta. The purpose of this study is to provide answers to these questions and also to provide information that will be beneficial in selecting species that may prove satisfactory for use in the revegetation of disturbed soils.

During the summer of 1975 land was cleared and rototilled at the Woodbend Research Station near Devon, Alberta. Three experiments were started in the autumn but the area was mainly prepared as a nursery station in order to begin work in the summer of 1976.

Winter experiments were initiated in October with the planting of various species of legumes. These legumes had been collected in the summer from various disturbed soil types. One-half of the pots of each soil type were fertilized in order to study the effects of fertilization on the growth of these species. Notes were then taken every week until the plants were harvested. The following section of this report presents the findings of these initial revegetation experiments.

II WOODBEND RESEARCH STATION - DEVON, ALBERTA.

A. Preparation of the Area.

Plans were made in May 1975 to use the University of Alberta Woodbend Research Station near Devon, Alberta. This station contains a quarter section of land 6 miles west and 11 miles south of Edmonton on Highway 60 (3 miles north of Devon). It is an area of aeolian sand dunes which are now covered with natural vegetation. The vegetation consists mainly of the following species; *Populus tremuloides*, *Populus balsamifera*, *Betula papyrifera*, *Corylus cornuta*, *Picea glauca*, *Pinus banksiana*, *Rosa spp.*, *Salix spp.*, *Elaeagnus commutata*, *Amelanchier alnifolia*, and *Prunus virginiana*. Also present is an understory of *Arctostaphylos uva-ursi*, *Ledum groenlandicum*, *Lathyrus venosus*, and *Vicia americana*. The dominant grasses include *Bromus inermis*, *Agropyron repens*, *Calamovilfa longifolia*, *Calamagrostis spp.*, and *Phalaris arundinacea*. Finally several species of *Carex* grow in the wet areas.

During the summer five acres of land were cleared of trees and shrubs. This cleared area was the land that was the flattest, the most accessible to the trails, and the easiest to clear by hand. Seven plot areas were rototilled three times during the summer: June 26, July 24, and September 3, 4. (See map). On September 3, 4 additional areas VIII - XI and extensions Ia, IIa, and VIIa were also rototilled. Existing trails were improved and in some cases access trails to the plots had to be cleared and scraped.

A summary of the soil analysis for the first seven areas is shown in Table 24.

Map of Woodbend Research Station,
Devon, Alberta.

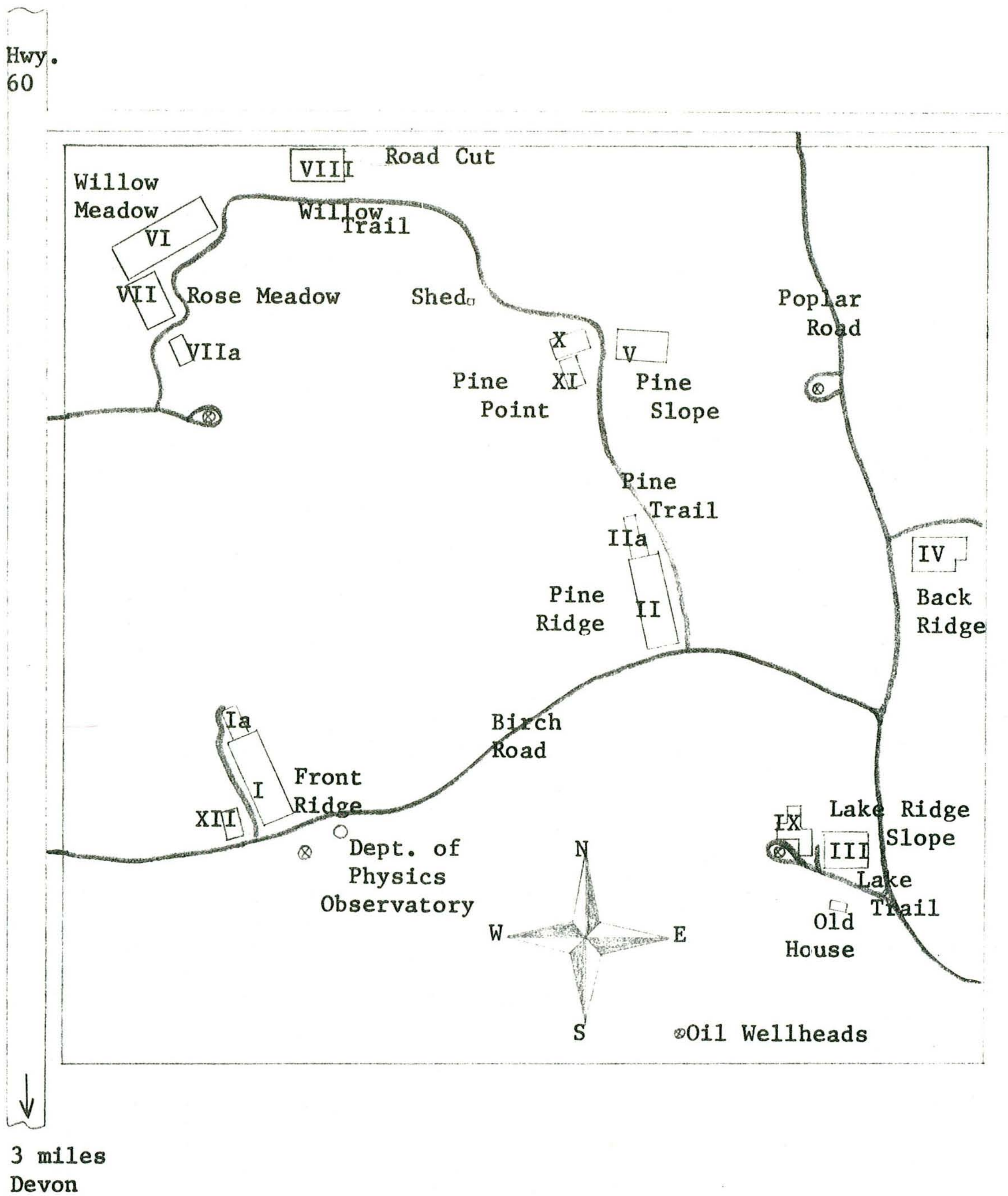


Table 24 SOIL ANALYSIS OF PLOTS AT THE WOODBEND RESEARCH STATION

SOIL SAMPLES 0 - 6"	AVAILABLE PLANT NUTRIENTS lb/A			SULFUR Soluble Sulfates	SOIL REACTION (pH)	SOIL SALINITY		ORGANIC MATTER	FREE LIME	TEXTURE
	N	P	K			Conductivity (mmhos)	Sodium			
Area I Front Ridge	2	118	300	M -	6.6	0.1	L -	L	-	sand
Area II Pine Ridge	7	94	255	M	6.6	0.1	L -	L	-	sand
Area III Lake Ridge Slope	3	36	180	M -	8.1	0.2	L -	L -	H +	sand
Area IV Back Ridge	17	89	325	-	6.6	0.3	L -	L	-	sand
Area V Pine Slope	5	99	285	M -	6.5	0.1	L -	L	-	sand
Area VI Willow Meadow	1	32	240	-	7.0	0.3	L -	L	-	sand
Area VII Rose Meadow	1	8	180	-	8.1	0.3	L -	L -	H +	sand

B. Transplanting of Shrubs and Legumes.

On August 12, 30 ecotypes of legume seedlings, grown from seed in the greenhouse of the Provincial Laboratory (O. S. Longman Building), were taken to Woodbend and transplanted on Area III (Lake Ridge Slope) (See map). On August 20, 8 ecotypes of shrub and legume seedlings were also transplanted to Area III. This is only a temporary location as the seedlings will be moved to a nursery plot in the spring of 1976. A list of these species is presented in Table 25.

D. Fall Seeding of Legumes.

An area designated as Area IV (Back Ridge) (See map) was rototilled three times during the summer: June 26, July 24, and September 3. Also roots were removed and the soil was smoothed by raking. A plot 31 feet by 60 feet was established with rows 14 feet long and 3 feet apart. (See plot diagram).

On September 22, seeds of 37 legume ecotypes were planted with several seeds being placed at one foot spacings in the row (See list - Table 26). The seeds were then covered with one-eighth to one-quarter inch of soil.

The purpose of this experiment is to determine if any of the selected legume species or ecotypes require vernalization. This will be shown by the increased germination of these seeds in the spring as compared to germination of spring planted seeds. Should this occur it can be concluded that a major contributing factor was the cold treatment received by these seeds over the winter.

Plot Diagram for the Fall Seeding of Legumes
on Back Ridge

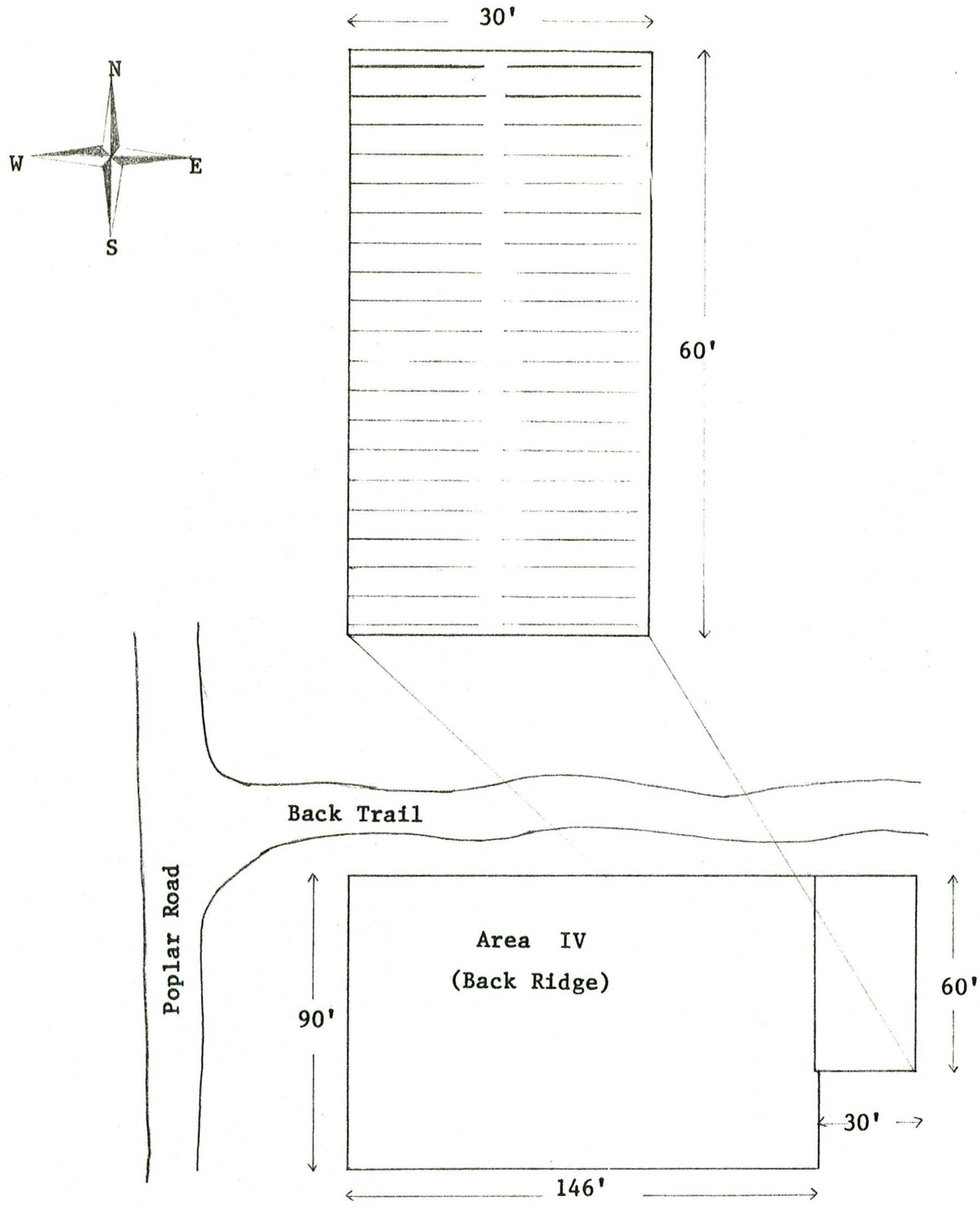


Table 25

LIST OF SHRUB AND LEGUME SEEDLINGS

TRANSPLANTED AT WOODBEND

Legume Species	Botany Collection Number	Number of Plants Transplanted
Astragalus crassicarpus	212	38
" *sinicus*	318	127
" *spp.*	207	1
" *spp. var. tenellus*	209	27
Glycyrrhiza lepidota	227	94
Hedysarum spp.	204	2
" *spp.*	213	2
" *spp.*	214	42
" *spp.*	349	28
Lathyrus latifolius	317	73
" *ochroleucus*	216	6
" *spp.*	215	4
" *sylvestris*	319	126
" *tuberosus*	320	3
Oxytropis splendens	222	1
" *spp.*	157	4
" *spp.*	218	5
" *spp.*	220	4
" *spp.*	221	9
" *spp.*	222	8
Trifolium hybridum	117	58

Table 25 - continued

Trifolium pratense	120	119
" "	121	271
" "	122	1
" "	260	2
Vicia americana	225	4
" "	226	2
" "	315	10
" *spp.*	228	22
" *spp.*	371	55
" *unijuga*	321	19

Shrub Species

Amelanchier alnifolia	125	8
Elaeagnus commutata	166	93
" "	167	96
Lonicera tatarica	170	7
Potentilla fruticosa	173	2
Shepherdia argentea	184	73
" *canadensis*	185	15

Table 26 Ecotypes of Legumes Planted in the Fall on Area IV (Back Ridge)

Species	Botany Number	Collection Date
Astragalus americanus	375	20 - 8 - 75
" "	376	28 - 8 - 75
Astragalus canadensis	377	13 - 9 - 75
" "	378	28 - 8 - 75
Astragalus eucosmus	380	13 - 8 - 75
" "	381	28 - 8 - 75
Astragalus flexuosus	382	13 - 8 - 75
Glycyrrhiza lepidota	404	10 - 9 - 75
" "	405	9 - 9 - 75
Hedysarum alpinum	409	27 - 8 - 75
" "	411	20 - 8 - 75
" *mackenzii*	413	27 - 8 - 75
" *spp.*	418	2 - 9 - 75
" *spp.*	408	4 - 9 - 75
" *spp.*	419	30 - 8 - 75
" *spp.*	420	28 - 8 - 75
" *sulphurescens*	423	3 - 8 - 75
" "	425	1 - 8 - 75
Lathyrus ochroleucus	428	24 - 7 - 75
" "	429	31 - 8 - 75
Lathyrus venosus	432	20 - 8 - 75
" "	433	27 - 8 - 75

Table 26 - continued

Species	Botany Number	Collection Date
Lupinus spp.	437	5 - 9 - 75
" *spp.*	438	8 - 9 - 75
Oxytropis campestris	441	8 - 9 - 75
" "	442	14 - 8 - 75
" *splendens*	445	2 - 9 - 75
" "	446	30 - 8 - 75
" "	447	5 - 9 - 75
" *spp.*	450	28 - 8 - 75
Thermopsis rhombifolia	451	14 - 8 - 75
" "	452	6 - 8 - 75
Vicia americana	457	8 - 9 - 75
" "	455	27 - 8 - 75
Vicia cracca	458	7 - 9 - 75
" *spp.*	461	14 - 8 - 75
" *spp.*	462	30 - 8 - 75

D. Vegetative Propagation

An area, designated as Area V (Pine Slope), (See map), was rototilled twice during the summer, specifically on July 24 and September 3. Roots were removed and the soil was then smoothed by raking. A plot 14 m by 26 m was staked out with small plots 1 m by 2 m (See plot diagram).

Plant material that had been collected during the summer from different sites in Alberta was used for some of the cuttings. Other plant material was obtained from the Woodbend Research Station on the same day as the planting occurred.

On September 23, cuttings from one year old wood (hardwood cuttings) were made from the shrub species. An exception was *Rosa spp.* from which cuttings of the rootstocks were taken. The sizes of the cuttings depend on the size of the woody species. Rhizomes of the grasses and sedge were dug and cut into lengths containing 3 to 4 nodes. Also small clumps of *Equisetum* and moss were planted. Finally other species were added on September 30 and October 2 (See species list - Table 27). In most cases 30 pieces of plant material were planted in each plot in 3 rows - 10 per row.

The purpose of this experiment is to determine the rooting ability of these species when reproduction is attempted by cuttings. Cuttings will be made at various times during the year to see how the time of year affects rooting ability.

Plot Diagram for Vegetative Propagation
Experiment on Pine Slope

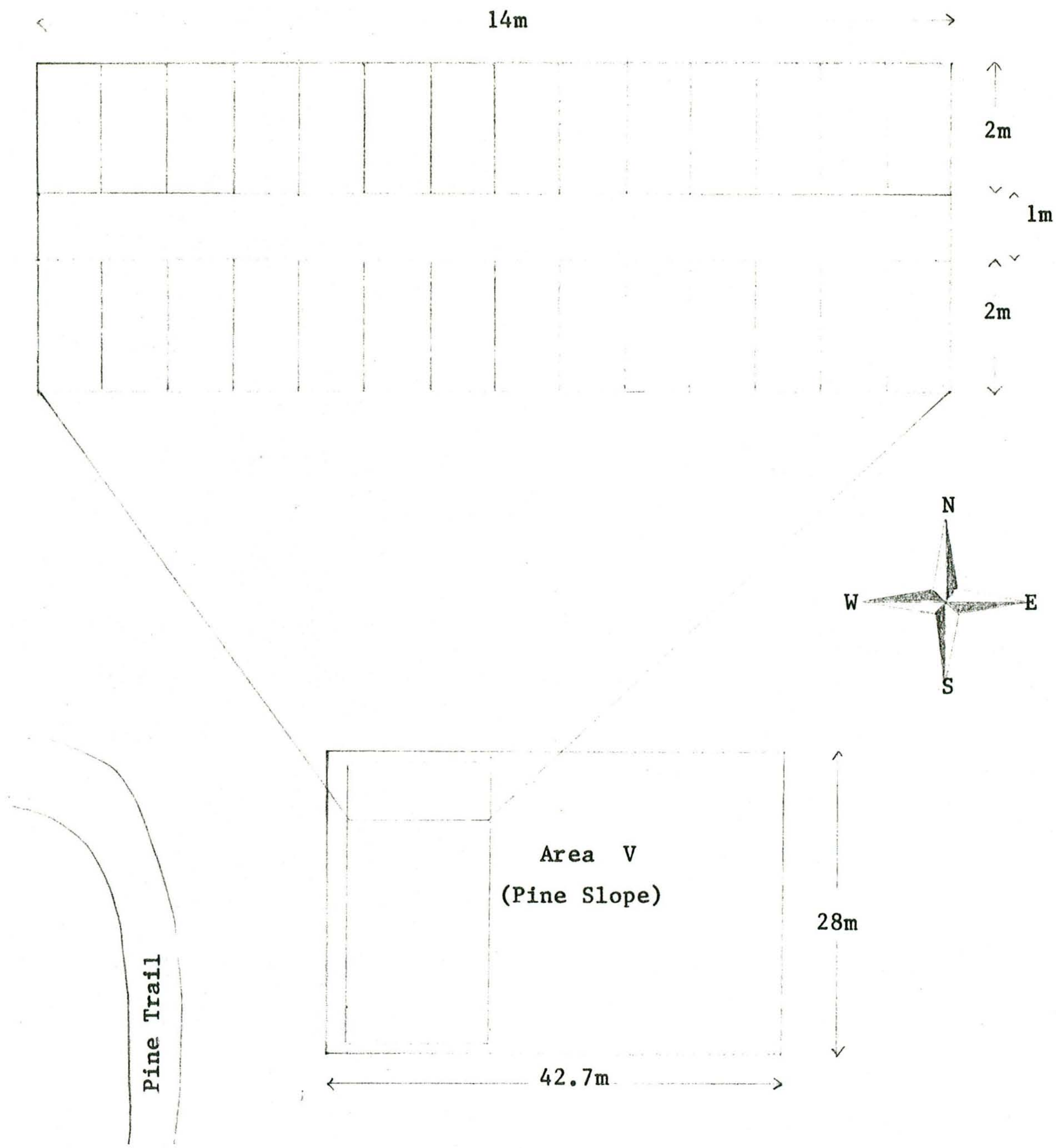


Table 27

SPECIES USED IN VEGETATIVE PROPAGATION

EXPERIMENT

Species	Cutting Size (cm)	Collection Date	Collection Location
Arctostaphylos rubra	7-10	27-8-75	Yellowknife
" *uva-ursi*	4-7	23-9-75	Devon
Calamagrostis canadensis	(3-4 nodes)	23-9-75	Devon
" *inexpansa*	(3-4 nodes)	23-9-75	Devon
Calamovilfa longifolia	(3-4 nodes)	23-9-75	Devon
Carex atherodes	(3-4 nodes)	23-9-75	Devon
Dryas spp.	7-12	16-9-75	Big Horn
Elaeagnus commutata	10	23-9-75	Devon
Equisetum spp.	(clump)	9-9-75	Peers
Ledum groenlandicum	7	23-9-75	Devon
Moss spp.	(3-5 stalks)	30-9-75	Peers
" "	(3-5 stalks)	30-9-75	Peers
Rosa spp.	10-12	23-9-75	Devon
Salix spp.	15	23-9-75	Devon
" "	15	23-9-75	Devon
" "	15	23-9-75	Devon
Shepherdia canadensis	10	23-9-75	Devon
Vaccinium spp.	4-7	30-9-75	Peers
" *vitis-idaea*	10-12	27-8-75	Yellowknife

E Future for Woodbend Research Station

In the spring of 1976 a legume nursery plot will be established here. Most of the legume species collected in the autumn of 1975 will be planted directly into the field. Some species may be started in the greenhouse and then transplanted into the field in the spring. From the nursery plot we will be able to harvest seed which will be used in future experiments.

Provision has also been made for research experiments at the Woodbend Station. These experiments may include projects to study the effects of different soil preparation, methods of seedings, and rates of fertilizer on the establishment and production of native grasses and legumes.

III GROWTH CHAMBER AND GREENHOUSE EXPERIMENTS

A. Completed Experiments

Three legume species were planted on 8 disturbed soil types. These species were tested on 4 disturbed soil types, plus greenhouse potting soil for a control, in two separate experiments. Since these two experiments were conducted in a similar fashion they will be treated more or less as one in the following report.

1. Methods and Materials

Eight types of soil were collected from disturbed areas in the fall of 1975 (Table 28). The soils were analysed by the Soil and Feed Testing Laboratory before the experiment was started and after it was completed (Table 30). Regular greenhouse soil mix 3:2:1 (loam: sand: peat) was used for comparison to indicate how well the plants would grow on a good soil.

Pots 15 cm in diameter and 15 cm high were filled to within 3 cm of the top with the different soil types. Gravel was placed in the bottom of each pot for drainage. A paper towel was also placed in the bottom of the pots containing the tailing sand from Ft. McMurray. This sand was so fine that, upon watering, it tended to be lost out of the drainage holes in the bottom of the pots. The pots were watered for several days before planting to allow for good moisture distribution in the soils. Just before planting 800 kg/ha of 14-14-14 controlled release fertilizer was applied to half the pots containing each soil type (1.2g/pot).

The fertilizer was incorporated into the soil do a depth of 2 to 3 cm.

Seeds of the 3 species of legumes (Table 29) were sown at a rate of 50 seeds per pot. The seeds were covered with a layer of soil no greater than 3 times the thickness of the seed. Each treatment was replicated 3 times in one growth chamber. The pots were randomized within each replicate.

Two growth chambers were used. One contained the soils: sand, tailing sand (Ft. McMurray), clay (Ellerslie), peat, and potting soil. The environment in this chamber was regulated at 20°C day temperature and 12°C night temperature with a relative humidity of 65 - 70%. The photoperiod was 15 hours at 2000 foot-candles.

The other chamber contained the soils: coal, tailing sand (Yellowknife), tar sand, clay (Dixonville), and also potting soil. The environment in this chamber was identical to the first one, except that the light intensity was only 1800 foot-candles.

Germination percentages were recorded for the first month and then the pots were thinned to about 6 plants per pot. The average heights of the plants were taken every week until harvest time. This height was the average length of the plants when held upright.

The plants in the first growth chamber were harvested 82 days after planting and those in the second chamber 77 days after planting. When harvested, the top growth of the plants was measured and cut at about 1 cm above the soil level. The tops were then placed in paper bags for drying. The roots were separated from the soil, washed, measured, and placed in bags for drying. The plant material was dried in an oven at 100°C for about 24 hours. Dry weights of the material were taken immediately upon removing the bags from the oven. Photographs of the roots and tops were taken at harvest time.

Table 28

DISTURBED SOIL TYPES

Soil Type	Type of Disturbance	Location
clay	road cut	Dixonville
clay	road cut	Ellerslie
coal (slag)	strip mine	Round Hill
peat	peat bog	Peers
sand	cultivation	Devon
Tailing sand	gold strip mine	Yellowknife
tailing sand	tar sand (extracted)	Ft. McMurray
tar sand	strip mine	Ft. McMurray

Table 29

LEGUME SPECIES

Species	Collection Date	Location
Hedysarum alpinum	20-8-75	Peers
Lathyrus venosus	20-8-75	Edmonton
Vicia cracca	7-9-75	Chip Lake

Table 30

Test Results on Soil Samples

	Pounds per Acre											
SOIL	Nitrogen			Phosphorus			Potassium			Sodium		
	A*	B*	C*	A	B	C	A	B	C	A	B	C
Clay (D)	2	2	71	24	20	76	310	281	460	L	L	L
Clay (E)	12	14	71	1	1	44	459	408	691	H-	L-	L+
Coal	1	4	98	1	4	115	129	121	449	H+	H+	H+
Peat	1	12	61	18	13	111	79	95	345	L	L	H+
Sand	13	13	40	24	21	49	154	118	210	L-	L-	L-
Tailing Sand (Ft. McM.)	1	6	72	4	7	127	18	18	186	L	L-	L+
Tailing Sand (Yk.)	3	3	65	1	0	0	250	63	181	H	L	L
Tar Sand	1	1	52	4	5	166	22	27	245	L-	L-	L-
Greenhouse Soil	100+	19	78	38	30	75	245	307	485	L-	L	L

A. Test before starting experiment.

B. Test after experiment completed (unfertilized).

C. Test after experiment completed (fertilized).

(D) Dixonville

(E) Ellerslie

Table 30 - continued

Test Results on Soil Samples

SOIL	Soil Reaction (pH)			Conductivity			Organic Matter			Texture
	A	B	C	A	B	C	A	B	C	
Clay (D)	3.7	3.9	3.6	0.4	0.2	0.8	L+	L+	L+	very fine
Clay (E)	8.3	8.4	8.1	0.6	0.4	0.8	L+	M-	M-	very fine
Coal	6.1	6.7	6.2	2.3	0.4	1.2	Coal	Coal	Coal	Coal
Peat	5.4	5.7	5.6	0.2	0.4	1.3	H-	H-	H-	organic
Sand	8.1	8.2	8.0	0.3	0.3	0.5	L-	L	L-	very coarse
Tailing Sand (Ft.McM.)	8.7	8.6	6.7	0.2	0.2	0.8	L-	L-	L-	very coarse
Tailing Sand (Yk.)	8.4	7.2	7.5	5.2	3.3	3.5	L	L	L	coarse
Tar Sand	7.5	7.5	6.6	0.2	0.3	0.8	M	M	M	very coarse
Greenhouse Soil	5.8	6.0	5.7	0.6	0.3	0.8	M-	M	M	greenhouse Soil

A. Test before starting experiment

B. Test after experiment completed (unfertilized).

C. Test after experiment completed (fertilized).

(D) Dixonville

(E) Ellerslie

2. Results

a. Germination

Hedysarum alpinum germinated rapidly and had a relatively high percentage of germination. *Lathyrus venosus* and *Vicia cracca* were slow to germinate and had a very low percentage of germination.

b. Description

The descriptions of the species used are taken from *Flora of Alberta* by E. H. Moss plus observations on the roots of plants grown in the greenhouse potting soil.

(i) *Hedysarum alpinum* (American Hedysarum) is a perennial herb with erect or ascending stems and odd-pinnate leaves, broadly lanceolate to oblong leaflets. The roots are long thick tap roots with many main branch roots. Buds form on the upper portion of the tap root.

(ii) *Lathyrus venosus* (Purple vetchling or purple wild pea vine) is a perennial herb with stout climbing stems. It has small stipules, narrowly lanceolate; leaflets usually in 4-6 pairs, narrowly to broadly elliptic, and very veiny beneath. Leaves have tendrils at the tips. The roots consist of a short or very thin long tap root system. Plants also have horizontal rootstocks. (Figure 9).

(iii) *Vicia cracca* (Tufted vetch) is a perennial herb with weak climbing or trailing stems. Leaves are pinnate, stipulate, with tendrils at the tips. The leaflets are 10-20, linear to narrowly oblong. Roots consist of a very small tap root forming an extensive fibrous root system. Plants also have horizontal rootstocks.

c. Disturbed Soils

Harvest data are presented in Tables 31, 32 and 33. Each soil will be discussed separately.

(i) Clay (Ellerslie). Although all species had some germination on the Ellerslie clay there were no plants that survived. It was discovered that the road side near Ellerslie, where the clay had been obtained, had been sprayed with 1 lb/A of picloram for weed control during the summer of 1975. Picloram is a herbicide that is known to have a long persistence time in the soil.

(ii) Sand (Devon). All species did fairly well on the Devon sand and all had some root nodulation (Figure 8). There were about 2 to 6 fold increases in plant growth (dry weight) with the addition of fertilizer (Figures 10 and 11). The *Lathyrus* and *Vicia* species grew better than the *Hedysarum* species.

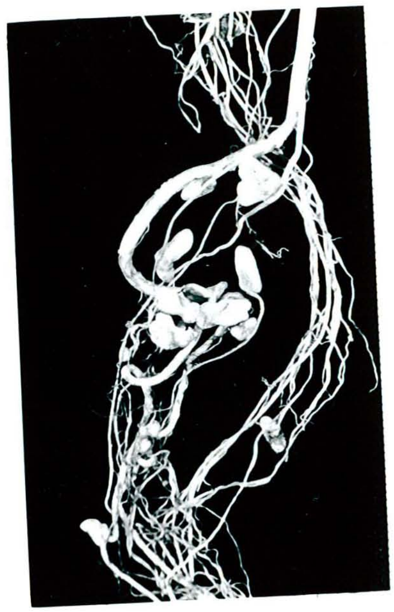
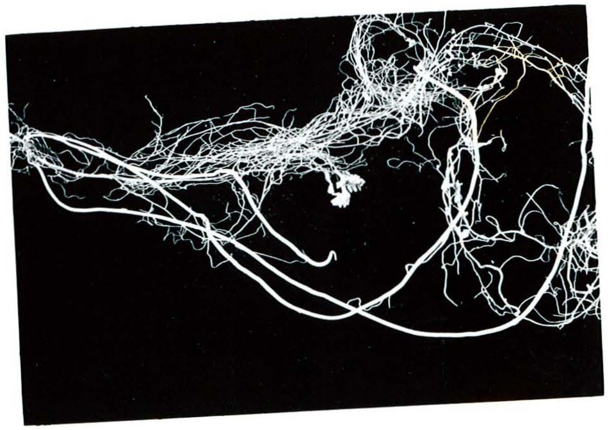


Figure 7 Nodules on *Hedysarum alpinum* grown on unfertilized greenhouse soil.



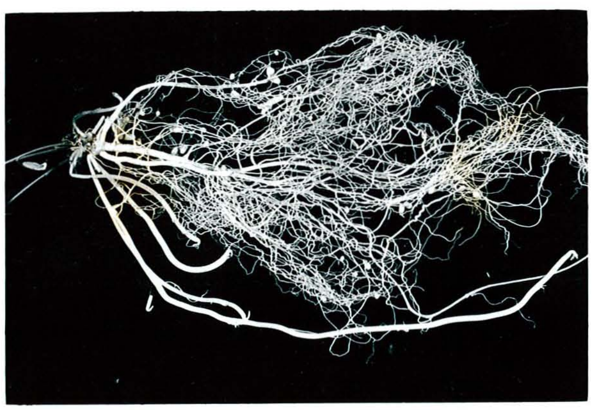


Figure 8 Nodules on *Vicia cracca* grown in unfertilized Devon sand. Note the long rhizomes.

Figure 9 Nodules on *Lathyrus venosus* grown in fertilized tailing sand from Ft. McMurray. Note the rhizomes.

Figure 10 *Lathyrus venosus* grown in unfertilized soils. Left to right: Devon sand, Ft. McMurray tailing sand, peat, greenhouse soil.

Figure 11 *Lathyrus venosus* grown in fertilized soil. Left to rights: Devon sand, Ft. McMurray tailing sand, peat greenhouse soil. Compare with Figure

Table 31

Evaluation of *Hedysarum alpinum* (Peers) in Various Soil Types

SOIL TYPES	Fertilization	Average Height of Tops (cm)	Average Length of Roots (cm)	* Average Weight of Tops (g)	* Average Weight of Roots (g)	Top:Root Ratio (by weight)	Root Nodulation
Sand (Devon)	unfert.	3.7	19.3	0.17	0.56	0.30	few
	fert.	6.5	25.3	0.82	1.91	0.43	v.few
Tailing Sand (Ft. M.)	unfert.	3.1	15.5	0.04	0.13	0.31	none
	fert.	4.8	25.3	0.38	0.85	0.45	none
Peat (Peers)	unfert.	3.1	24.4	0.09	0.33	0.27	few
	fert.	7.0	27.6	0.82	1.72	0.48	some
Potting Soil	unfert.	9.2	20.7	0.93	2.51	0.37	many
	fert.	10.2	24.5	1.53	3.45	0.44	some
Coal (Round Hill)	unfert.	3.3	21.0	0.03	0.19	0.16	v.few
	fert.	7.8	26.6	0.52	0.94	0.55	v.few
Tailing Sand (Yellowknife)	unfert.	3.4	4.4	0.02	0.07	0.29	none
	fert.	4.0	2.6	0.03	0.10	0.30	none
Tar Sand (Ft.M.)	unfert.	2.4	15.1	0.01	0.08	0.12	none
	fert.	2.7	14.5	0.02	0.08	0.25	none
Clay (Dixonville)	unfert.	1.8	1.9	0.01	0.04	0.25	none
	fert.	2.4	1.6	0.03	0.06	0.50	none

* Based on 6 plants per pot.

Table 32

Evaluation of *Lathyrus venosus* (Edmonton) in Various Soil Types

SOIL TYPES	Fertilization	Average Height of Tops (cm)	Average Length of Roots (cm)	* Average Weight of Tops (g)	* Average Weight of Roots (g)	Top:Root Ratio (by weight)	Root Nodulation
Sand (Devon)	unfert.	17.2	27.5	0.14	0.24	0.58	some
	fert.	19.9	25.7	0.27	0.38	0.71	many
Tailing Sand (Ft. M.)	unfert.	6.1	24.4	0.02	0.05	0.40	few
	fert.	28.0	28.8	0.43	0.62	0.69	some
Peat (Peers)	unfert.	15.0	25.1	0.13	0.27	0.48	some
	fert.	30.0	22.7	0.46	0.90	0.51	many
Potting Soil	unfert.	34.3	21.6	0.79	1.26	0.63	some
	fert.	48.3	29.0	1.32	2.13	0.62	many
Coal (Round Hill)	unfert.	10.2	20.8	0.020	0.030	0.67	none-v.few
	fert.	32.9	27.0	0.570	0.283	2.01	none-many
Tailing Sand (Yellowknife)	unfert.	5.0	7.0	0.010	0.015	0.67	none
	fert.	11.4	8.2	0.018	0.022	0.82	none
Tar Sand (Ft.M.)	unfert.	8.0	19.8	0.011	0.032	0.34	none-few
	fert.	9.7	30.5	0.013	0.026	0.50	few
Clay (Dixonville)	unfert.	7.3	8.7	0.012	0.032	0.38	none-v.few
	fert.	12.6	5.5	0.045	0.055	0.82	none

* Based on one plant per pot.

Table 33

Evaluation of *Vicia cracca* (Chip Lake) in Various Soil Types

SOIL TYPES	Fertilization	Average Height of Tops (cm)	Average Length of Roots (cm)	* Average Weight of Tops (g)	* Average Weight of Roots (g)	Top:Root Ratio (by weight)	Root Nodulation
Sand (Devon)	unfert.	24.1	31.4	0.16	0.24	0.67	many
	fert.	57.2	38.1	0.79	1.75	0.45	many
Tailing Sand (Ft.M.)	unfert.	9.4	19.8	0.01	0.02	0.50	v.few
	fert.	44.8	31.3	0.52	1.02	0.51	some
Peat (Peers)	unfert	12.2	20.2	0.02	0.09	0.22	some
	fert.	40.6	24.5	0.41	1.28	0.32	many
Potting Soil	unfert.	60.8	22.0	0.82	1.79	0.46	many
	fert.	70.0	21.9	1.34	1.63	0.82	many
Coal (Round Hill)	unfert.	14.2	31.8	0.012	0.068	0.18	none
	fert.	47.2	31.1	0.481	0.574	0.86	many
Tailing Sand	unfert.	14.2	13.1	0.011	0.019	0.58	v.few
	fert.	-	-	-	-	-	-
Tar Sand (Ft.M.)	unfert.	8.2	17.7	0.006	0.011	0.55	none
	fert.	16.4	30.4	0.017	0.022	0.77	none-v.few
Clay (Dixonville)	unfert.	3.9	1.5	0.004	0.010	0.40	none
	fert.	7.8	0.8	0.009	0.015	0.60	none

* Based on one plant per pot.

(iii) Tailing sand (Ft. McMurray). Without fertilizer all species grew poorly on the Ft. McMurray tailing sand. Addition of fertilizer tended to increase dry weight of plant material from 6 to 50 fold (Figures 12, 13 and 14). *Vicia cracca* had the greatest increase. With the exception of *Hedysarum*, all species had nodules. *Lathyrus* had quite a few nodules as well as extensive rhizome production (Figure 9).

(iv) Peat (Peers). Of the species tested, only *Lathyrus* did well on the unfertilized peat, but addition of fertilizer increased dry weights by 3 to 15 times. *Vicia* had the greatest response to fertilizer and *Lathyrus* the least (Figures 10 and 11). All species had some nodules.

(v) Coal (Round Hill). In the unfertilized coal treatment, all species did poorly. Roots were fairly long but were not extensively branched. Addition of fertilizer increased dry weight from 6 to 17 times. *Lathyrus* had the greatest response to fertilizer. Nodulation was quite variable but there tended to be more nodules in the fertilized treatments.

(vi) Tailing sand (Yellowknife). All species grew very poorly on the Yellowknife tailing sand. The top growth was increased slightly by adding fertilizer but roots were much the same with *Lathyrus* and shorter with *Hedysarum* (Figure 15). None of the *Vicia* plants survived in the fertilized tailing sand. There were only 2 nodules in the *Vicia* unfertilized treatment and none with the rest of the species in fertilized or unfertilized soil.

(vii) Tar sand (Ft. McMurray). None of the species did well in the Ft. McMurray tar sand. Fertilization did not increase *Hedysarum* but did increase both top and root growth (length) of *Lathyrus* and *Vicia*, although differences in dry weight were small. There was variable nodulation. *Lathyrus* had the most nodules while *Hedysarum* did not produce any.

(viii) Clay (Dixonville). There was very poor growth in all of the species in the Dixonville clay and fertilizer had little effect. Roots were very short and did not penetrate very deeply into the soil (Figure 16). There was only one nodule with *Lathyrus* on unfertilized clay.

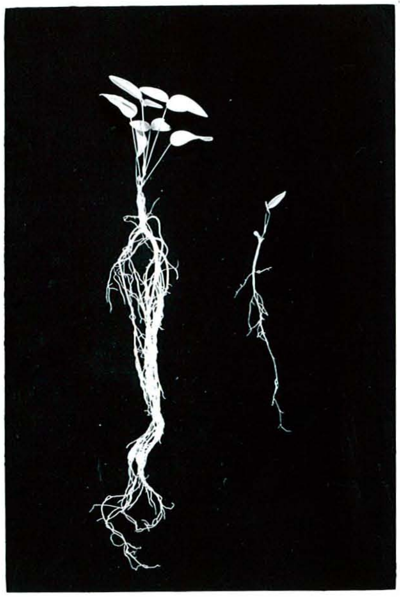
Some general observations common to all soils and all species are:

(1) root dry weight was greater than top dry weight.

(2) with fertilizer top weight increased more than root weight thus larger top/root ratios in fertilized treatments.

(3) plants in fertilized treatments had more leaves or branches as well as being taller.

(4) there tended to be more nodulation in the fertilized treatments.



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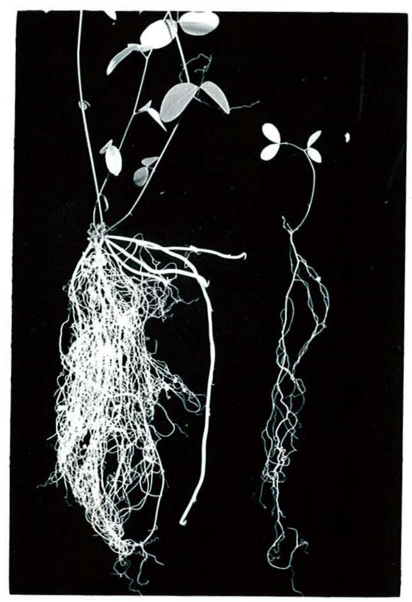

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Figure 12 *Hedysarum alpinum* grown in tailing sand from Ft. McMurray. Unfertilized on the right and fertilized on the left.

Figure 13 *Lathyrus venosus* grown in Ft. McMurray tailing sand. Unfertilized on the right and fertilized on the left.

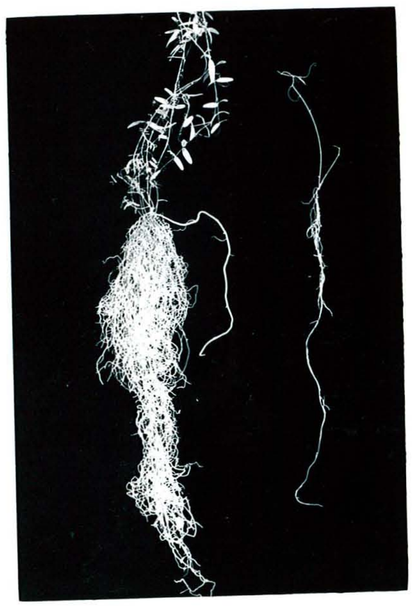

Figure 14 *Vicia cracca* grown in Ft. McMurray tailing sand. Unfertilized on the right and fertilized on the left. There was a 50 fold increase in root growth by adding fertilizer.

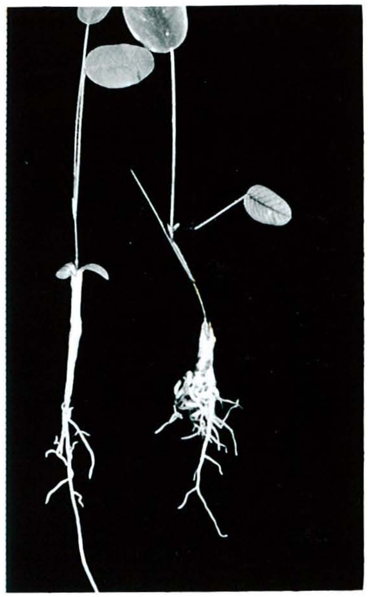

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Figure 15 *Hedysarum alpinum* grown in Yellowknife tailing sand. Unfertilized on the left and fertilized on the right. Note the short, deformed root from the fertilized tailing sand.

Figure 16 *Hedysarum alpinum* grown in Dixonville clay. Unfertilized on the left and fertilized on the right. Note that there was little penetration of the roots into the clay.

(5) where there were numerous nodules there were many rhizomes.

3. Discussion

No information can be gained from the Ellerslie clay because of the herbicide residue.

Fertilizer seems to be all that is required to get good plant growth on Devon sand, Ft. McMurray tailing sand, peat, and coal. The fertilizer had its greatest effect on plants grown in tailing sand. There was up to a 50 fold increase with the addition of fertilizer in both the tops and roots of *Vicia cracca* grown in tailing sand.

Plants growing in tar sand do respond to fertilizer but there is a wetting problem with this soil. Once the soil is wetted though, plants will grow fairly well, but not nearly as well as in the sand with the oil removed; that is the tailing sand when fertilized.

There are problems with the Yellowknife tailing sand and Dixonville clay. The problem with the Yellowknife tailing sand may be due to the high salt content (conductivity 5.2 mmhos), or possibly due to the high sodium and sulphate content. There is also a fairly high potassium content and more was added in the fertilizer. This might account for the reduction of growth in the fertilized treatment. The Dixonville clay also has a high potassium content, but the main problem is probably the very low pH (3.7). It was also found to have a high aluminum content. There will have to be further tests on these two soils to be able to determine if any legumes will grow well on them.

B. Experiments in Progress

There are eighteen more species that are being tested on the various soil types. Not all species are being tried on all soil types due to an insufficient supply of some of the soils (Table 34). Three of the species are being grown in soil that was used for the first experiment. There may be differences for these species due to residual fertility and organic matter.

Observations from these experiments indicate similar results as those obtained from the experiments already completed. These observations show that fertilizer greatly increases growth in Ft. McMurray tailing sand, peat, coal, and to a lesser extent in Devon sand. Once again nothing grew on the Ellerslie clay due to the herbicide residue. Plants growing in the fertilized treatments of the Yellowknife tailing sand have poorer growth than in the unfertilized treatments. There are very few plants that actually survive in these fertilized pots. *Hedysarum sulphurescens* is the only species that is surviving in the Dixonville clay. All species are generally doing well on greenhouse potting soil.

Table 34

Legumes and Soils that are Being Used in the Present Experiments

	Botany No.	Sand (Devon)	Tailing Sand (Ft. M.)	Clay (Ellerslie)	Peat (Peers)	Potting Soil	Coal (Round Hill)	Tailing Sand (Yk.)	Tar Sand (Ft. M.)	Clay (Dixonville)
Astragalus americanus	376	X	X	X	X	X	X	X	X	X
Astragalus canadensis	377	X	X	X	X	X	X			
Astragalus eucosmus	380	X	X	X	X	X	X			
Astragalus spp.	396	X	X	X	X	X				
Astragalus spp.	389	X	X	X	X	X				
Hedysarum alpinum	409	X	X		X	X				
Hedysarum alpinum	408	X	X	X	X	X	X			
Hedysarum mackenzii	413	X	X	X	X	X	X			
Hedysarum spp.	419	X	X	X	X	X				
Hedysarum sulphurescens	423	X	X	X	X	X	X	X	X	X
Lupinus spp.	437	X	X	X	X	X	X			
Lupinus spp.	438	X	X	X	X	X				
Oxytropis campestris	442	X	X	X	X	X	X	X	X	X
Oxytropis splendens	445	X	X	X	X	X				
Oxytropis splendins	446	X	X		X	X				
Oxytropis splendens	447	X	X	X	X	X	X			
Thermopsis rhombifolia	452	X	X	X	X	X	X			
Vicia americana	631	X	X		X	X				

C. Future Experiments

One experiment that is planned is the testing of Yellowknife tailing sand and Dixonville clay with different levels of fertilizer. This fertilizer will contain only nitrogen and phosphorus, but not potassium. A liming treatment is also going to be tried. Different rates of fertilizer are going to be used on the Ft. McMurray tailing sand and coal to determine the optimum level of fertilizer.

Another possible experiment is to test different herbicides for weed control in legumes and grasses.

IV SUMMARY

During the summer of 1975, five acres of land were cleared and rototilled in preparation for fall experiments and for the legume nursery plot that will be established in the spring of 1976. Fall experiments consisted of (a) transplanting some legume and shrub species that were started in the greenhouse, (b) fall seeding of legumes to test vernalization, and (c) planting of cuttings of woody species and rhizomes of grasses to determine survival.

Various experiments which used legume species on different disturbed soil types were started in the growth chambers and greenhouse. Measurements on completed experiments and observations on experiments in progress indicate that plants can be grown quite well on Ft. McMurray tailing sand, peat, coal, and Devon sand with just the addition of fertilizer at 800 kg/ha of 14-14-14. There seems to be a problem with the wetting of the tar sand, but once the soil is wetted plants do grow, although not very well. The Yellowknife tailing sand and Dixonville clay have some toxicity problems that will have to be studied further before establishment of plants will be possible on these soils. Information that will be obtained when the rest of the experiments are completed may lead to a better indication as to which species grow best on a particular soil and under what conditions.

STUDY OF MICROORGANISMS ASSOCIATED WITH SEEDS AND SEEDLINGS

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INTRODUCTION

Pathogenic and saprophytic microorganisms play a dynamic role in the establishment of vegetation in a given area or location. The absence or presence of pathogenic microorganisms can determine the success or failure in the establishment of a given plant species. Pathogenic fungi and bacteria can be soil borne or seed borne. Little can be done to control soil borne pathogens if susceptible plant species are introduced to an area where the pathogen may be endemic. In the case of seed borne pathogens selection of clean seed or seed treatment may mean the difference between success or failure in the establishment of a given plant species.

Saprophytic fungi, bacteria and other microorganisms, many of which may be seed borne are involved in breakdown and recycling of organic matter. In the more acid soils fungi predominate in this process whereas in the alkaline soils this primary role is assumed by bacteria.

STUDY OF MICROORGANISMS ASSOCIATED WITH SEEDS AND SEEDLINGS

Initial attempts were made to determine the occurrence and frequency of bacteria and fungi infesting the seed or seed coats of a selection of shrubs and legumes of importance to the revegetation program. Clean (freshly harvested) seed was invariably infested with a number of fungal anc bacterial species.

Table 35 Frequency and occurrence of fungi and bacteria associated with seed.

Seed Sample	No Surface Ster.**		Surface Ster.*	
	Fungal Isolates	Bacterial Isolates	Fungal Isolates	Bacterial Isolates
Astragalus sp.	6	3	-	-
Astragalus americanus	16	-	2	2
Astragalus americanus	2	-	1	-
Glycyrrhiza lepidota	1	-	-	-
Hedysarum sp.	2	1	2	-
Hedysarum sulphurescens	4	-	2	-
Lethyrus sp.	1	-	2	-
Lathyrus venosus	3	-	1	-
Lupinus sp.	4	2	1	-
Oxytropis campestris	4	3	2	2
Thermopsis rhombifolia	6	-	6	-
Vicia sp.	3	1	1	-
Alnus sp.	-	1	-	-
Amelanchier alnifolia	3	-	-	-
Amelanchier alnifolia	2	-	-	-
Arctostaphylos uva-ursi	2	-	4	-
Shepherdia canadensis	4	-	2	-
Viburnum edule	1	2	-	-

* Surface sterilization 3 minutes in 10% sodium hypochlorite followed by three sterile distilled water rinses. ** Where possible seeds of these species were aseptically removed from the seed pot or fruit.

The study was an attempt to catalogue fungal species associated with legumes and shrubs intended for revegetation studies in order to identify, if possible, pathogens that could seriously or markedly impede seedling establishment. Species of *Alternaria*, *Fusarium* and *Botrytis* as well as at least four other fungi which are in the process of being identified, were prevalent on a number of the seeds.

Unfortunately many of the fungi associated with processed seed are probably saprophytic contaminants. Fungi present following surface sterilization are likely to be of more importance since these fungi may already be inside the seed coat and could be pathogenic in nature. Procedures are underway to determine the identity and possible pathogenic role of this latter group of fungi.

REVEGETATION SPECIES INVOLVED IN SYMBIOTIC NITROGEN FIXATION

All legumes and five of the shrubs; by genus *(Alnus, Elaeagnus, Shepherdia, Dryas, Arctostaphylos)*; in the revegetation study are recognized as being capable of fixing nitrogen in symbiotic association with microorganisms. This nitrogen fixation is of primary importance in revegetation of nutrient poor soils. Legumes fix nitrogen in association with species of *Rhizobia*. Some species of *Rhizobia* will form effective nodulation with several different species of legumes (cross inoculation groups) but are ineffective on others. It is known that the seed coats and sometimes the seed itself of many legumes may be contaminated or infested with effective *Rhizobia* (Faba bean, soybeans - I.R. Evans personal communication).

A study was initiated to determine how many species of the legumes in this collection have seeds that are naturally infested with effective *Rhizobia*. The *Rhizobia*, if present will then be isolated and cultured from nodules of these leguminous species and will be later inoculated onto nodule free seedlings. The possibility of obtaining commercial strains of *Rhizobia* is being looked into.

Some non-leguminous shrubs also fix atmospheric nitrogen by a root-nodule symbiosis, as in legumes, but *Actinomycetes* are believed to be involved rather than *Rhizobial sp.*

CLASSIFICATION OF NON-LEGUMINOUS NODULE BEARING PLANTS

Genus	Family	Order
Casuarina	*Casuarinaceae*	*Casuarinales*
Myrica		
Gale	*Myricacea*	*Myricales*
Camptonia		
Alnus	*Betulaceae*	*Fagales*
Elaeagnus		
Hippophae	*Elaeagnaceae*	
Shepherdia		*Rhamnales*
Ceanothus	*Rhamnaceae*	
Discaria		
Coriaria	*Coriaraceae*	*Coriarales*
Dryas		
Purshia	*Rosacea*	*Rosales*
Cercocarpus		

Ref: Plant and Soil 32:61 (1970) page 613.

Only one third of the 300 species belonging to the above fourteen genera have been recorded as bearing root nodules.

The genus *Arctostaphylos (Ericaceae)* is not included in the list, since it is possible that the root nodules observed in *Arctostaphylos uva-ursi* are mycorrhizal (Bond 1967).[6] In Alaska, Allen et al (1964)[1] observed for the first time nodulation of this species when growing on very poor soils, often as pioneer vegetation. The nitrogen fixing capacity of *Arctostaphylos* root nodules has not yet been examined.

As far as is known, all *Alnus* spp. examined and all three species of Shepherdia are nodulated but for a considerable number of species of *Elaeagnus* no information exists.

Nodulated non-legumes comprise cross inoculation groups similar to legumes. Within the genus *Elaeagnus*, effective root nodules on *Shepherdia canadensis* were obtained with a suspension of ground *Hippophae rhamnoides* nodules.(9) *H. rhamnoides* inoculated with nodules suspensions of *Shepherdia canadensis* from Edmonton formed effective nodules, (13) though grades of incompatibility do exist.

Alnus glutinosa seedlings grown from sterilized seeds grown in sterile soil showed signs of nitrogen deficiency and had no root nodules. The endophyte was also shown to be absent from many natural soils. (3)

Alnus glutinosa grown in molybdenum deficient peat had yellowish leaves indicative of nitrogen deficiency and small nodules distributed over the entire root system while molybdenum fed plants were vigorous and had few crown nodules on the root near the stem.(2)

Haemoglobin was not detected in nodules on *Alnus sp.*, *Elaeagnus commutata*, and *Shepherdia canadensis* as it was in legumes.

The red color of nodules and root tips was due to anthocyanine pigments. (5)

A cobalt requirement for nitrogen fixation was demonstrated in *Alnus glutinosa*. (4). Lack of cobalt showed symptoms of severe nitrogen deficiency, while no requirements were observed in non-nodulated plants supplied with combined nitrogen.

The reduction of acetylene to ethylene has been used as a criterion for nitrogen fixation in legumes. Root nodules of *Alnus sp.* were capable of this chemical reaction. (8)

The importance of non-legumes for the nitrogen status of soils is illustrated by a number of examples that will be cited here. Virtanen (15) calculated that a grove of *Alnus glutinosa* trees with a density of 5 plants/sq.m. gave a nitrogen gain to the soil of 70 g. per sq.m. or 700 kg. per ha.

Crocker and Major (1955)[7] studied plant succession and soil formation in recently deglaciated areas at Glacier Bay in Alaska. Under *Alnus crispa* cover, the reaction of the uppermost horizons of the glacial till was a reduction from pH 8.0 to less than pH 5.0 in 35 to 50 years. Within this period 5 to 6 kg. per sq.m. of above-surface organic residues 6 to 7 cm. deep, with pH 4.2-4.6 had accumulated almost 4 kg. of organic carbon and 300 g. of N. per sq.m. beneath 50 year old alder growth. They calculated that leaf fall contributed about 61.5 kg. N to the soil per ha. per year.

Lawrence (11,12) observed that plants associated with *Alnus crispa* such as *Populus trichocarpa* saplings, weighed 22.5 times as much as those of equal age in non-alder areas. *Alnus crispa* thickets five years old and 1.5 m. tall were calculated to add 157 kg.N. per ha. each year by leaf fall alone.

There can be no doubt that nitrogen fixation by shrubs and legumes is important in revegetation studies. The factors that might affect successful revegetation by nodule forming species must be studied.

A number of problems may be encountered in establishing legumes: failure of the seed to germinate, no nodulation, ineffective nodulation, nutritional deficiencies essential to nodule formation, and plant competition. The presence of effective *Rhizobia* in the soil or on the seed must first be discovered as this will lead to the possibilities for inoculation or cross inoculation.

The same types of problems will be encountered for nonlegume establishment. The determination of effective *Actinomycetes* in the soil or seed is the first step but inoculation will probably not be as simple as in legumes since little is known or understood about this process.

IMPORTANCE OF VESICULAR-ARBUSCULAR MYCORRHIZAE IN REVEGETATION

It has been demonstrated in recent years that numerous species of grasses, herbs and shrubs form mycorrhizal associations with species of fungi *(Glomus sp. Endogone sp.)* (14). These mycorrhizal fungi have been shown to play an important role in phosphorous uptake. In soils deficient in phosphate dramatic increases in growth have been documented in several crop species as attributable to mycorrhizal association. Micronutrients are also implicated in this association.

Stunted and chlorotic citrus seedlings growing in fumigated nurseries in California and Florida were nonmycorrhizal, and *Endogone* spores were present. Stunted plants grew normally after inoculation with *Endogone mosseae*, an endomycorrhizal fungus. Noninoculated citrus seedlings grew poorly in steamed, autoclaved, or methyl-bromide-treated soil in greenhouse experiments. Plants inoculated with *E. mosseae* produced excellent growth in these treated soils. All mycorrhizal plants had a greater dry weight and a higher percentage of phosphorus than did nonmycorrhizal plants. Stunting and chlorosis of citrus in fumigated or heat-treated soils have been previously attributed to soil toxicity. This evidence indicates that the major cause of this problem is inadequate nutrition brought about by the killing of mycorrhizal fungi. (10)

In revegetation studies absence of suitable vesicular-arbuscular mycorrhizae could be of initial importance in revegetation of sub surface soils or soil that has undergone an extraction treatment such as will be the case in oil sands extraction processes.

PROPOSED RESEARCH

To study the growth and establishment of legumes and non legumes in disturbed soils in the presence or absence of *Rhizobia sp.*, non legume endophytes and vesicular-arbuscular mycorrhizae.

References

1. Allen, E.K., Allen, O.N., and Klebesadel, L.J., (1964). An insight into symbiotic nitrogen-fixing plant associations in Alaska. Proc. 14th Alaskan Science Conference, Anchorage, Alaska. Publ. Alaska Division Am Assoc. Adv. Sc. 54063

2. Becking, J.H. (1961), Molybdenum and symbiotic nitrogen fixation by alder (Alnus glutinosa gaertn.) Nature 192, 204-1205.

3. Becking, J.H., (1970). Plant endophyte symbiosis in non-leguminous plants. Plant and Soil 32:611-654.

4. Bond, G. and Hewitt, E.J. (1962). Cobalt and the fixation of nitrogen by root nodules of *Alnus* and *Casuarina*. Nature 190,1033-1034.

5. Bond, G. (1958). Symbiotic nitrogen fixation by non-legumes. In E.G. Hallsworth, ed. Nutrition of the Legumes, Proc. Univ. Nottingham, 5th Easter School Agri. Sci. Butterworths Sci. Publ., London; 216-231.

6. Bond, G. (1967). Fixation of nitrogen by higher plants other than legumes. Ann. Rev. Plant Physiol. 18, 107-126.

7. Crocker, R.L. and Major, J. (1955). Soil development in relation to vegetation and surface age at Glacier Bay, Alaska J. Ecol. 43, 427-428.

8. Dilworth, M.J. (1966). Acetylene reduction by nitrogen-fixing preparations from *Clostridium pasteurianum*. Biochem. Biophys. Acta. 127, 285-294.

9. Gardner, I.C. and Bond, G. (1957). Observations on the root nodules of Shepherdia, Can. J. Botany 35, 305-314.

10. Gerdemann, J.W. and Kleinschmidt, G.D. (1974). Stunting of Citrus seedlings in fumigated nursery soils related to the absence of Endomycorrhizae. Phytopath 62: 1447-1453.

11. Lawrence, D.B. (1953). Development of vegetation and soil in southeastern Alaska with special reference to the accumulation of nitrogen. Final Report O.N.R. Project Nr. 160-183, Washington.

12. Lawrence, D.B. (1958). Glaciers and vegetation in south-eastern Alaska. Am. Scientist 46, 89-122.

13. Moore, A.W. (1964). Note on non-leguminous nitrogen fixing plants in Alberta. Can. J. Botany 42, 952-955.

14. Moss, B. (1973). Advances in the study of vesicular-arbuscular mycorrhiza, Ann. Rev. Phytopathology 11, 171-196.

15. Virtanen, A.E. (1962). On the fixation of molecular nitrogen in nature. Commun. Inst. Forest Fenniae 55.22, 1-11.

A PRELIMINARY VEGETATION SURVEY OF THE ALBERTA OIL SANDS AREA - BRYOPHYTES AND LICHENS

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INTRODUCTION

A detailed description of the vegetation of the Alberta Oil Sands and a brief description of the topography, surficial geology, and soils of the area were given in an earlier report (Stringer, 1975).

The Alberta Oil Sands area is located in northeastern Alberta adjacent to the Canadian Shield and including a large proportion of the lower watersheds of two major rivers, the Athabasca and the Clearwater. Because of time and access constraints, the boundaries for the preliminary vegetation survey were set at approximately 56° 21' - 58° 00' N. and 110° 50' - 112° 00' W. (townships 85-103, ranges 6-12, west of the 4th meridian), and centering on the sites of maximum development, namely Fort McMurray and the G.C.O.S. and Syncrude leases.

The following principal vegetaion types within the A.O.S. area were described in the preceding report (Stringer, 1975).

1. Fen
2. Sandbar willow scrub
3. Tall willow-river alder scrub
4. Tall willow scrub

5. Bottomland balsam poplar forest
6. Upland white spruce-aspen forest
7. Black spruce bog forest
8. Semi-open black spruce-tamarack bog forest and muskeg
9. Lightly-forested tamarack and open muskeg
10. Jack pine forest.

A search of the literature reveals that there are no accounts of the bryophytes or lichens of this area per se. However, much useful information is contained in descriptions of vegetation types in areas similar to or adjacent to the A.O.S. area. For example, La Roi and Stringer (1976) give an analysis of the bryophyte flora of the boreal spruce-fir forests of the North American taiga. Also, the habitats of the principal bryophytes and lichens are described for forest communities in northeastern Alberta (Moss, 1953a), for marshes and bogs in central Alberta (Moss, 1953b), for bryophytes of the Edmonton region (Moss and Turner, 1961), and for poplar forests of central Alberta (1932). Bird and his associates have published many invaluable accounts of the whole bryophyte and lichen flora of the three prairie provinces, but principally of Alberta, the most pertinent of which is Bird (1962, 1968, 1969, 1970, 1972, 1973).

However, many studies of plant communities and vegetation types in areas adjacent to the Alberta Oil Sands at best mention only a few of the largest, most conspicuous or most easily identified moss and lichen species and are, therefore, of limited use, e.g. Dirschl (1970, 1973), Dirschl, Dabbs and Gentle (1974), Duffy (1965, 1965), Lewis and Dowding (1926), Lewis, Dowding and Moss (1928), Moss (1955), Raup (1946) and Swan and Dix (1971).

Several other publications are pertinent to this study although they deal with study sites outside Alberta. These include Argus (1964, 1966, 1968) on the bryophytes of boreal Saskatchewan, Heinselman (1963, 1970) on the peatland ecology of mosses and lichens in Minnesota, Jesberger and Sheard (1973) on corticolous lichen communities in the boreal forest of Saskatchewan, Jonescu (1970) on lichens on aspen in west-central Canada, and Looman (1964) on bryophytes and lichen communities in Saskatchewan.

In the initial vegetation survey, it was apparent that bryophytes and lichens formed in many vegetation types an important component of the understory. There is thus clearly a need for more definitive studies on the flora and ecological relationship of bryophytes and lichens of the Alberta Oil Sands area.

O B J E C T I V E S

1. To identify the bryophytes and lichens collected during the field studies phase of the Preliminary Vegetation Survey of the Alberta Oil Sands area carried out during August 1975.
2. To describe the habitats and community relationships of these bryophytes and lichens.

FIELD METHODS

The bryophytes and lichen specimens dealt with in this report were collected during the field studies phase of the preliminary vegetation survey of the Alberta Oil Sands area. Several samples were taken from each of the principal substrate types having bryophyte and lichen populations, e.g. rotting logs, tree bases, litter and humus, exposed mineral soil. These samples which generally consisted of species mixtures were dried and stored for later conformation or identification.

There was no attempt made at the time to make a comprehensive collection of all bryophyte and lichen species in the whole area or even in the communities themselves. A number of minor vegetation types and other possibly species-rich habitats were not sampled at all, e.g. roadsides, wasteground, ditches, most riverine habitats, steep banks, rock outcrops, aquatic habitats. Minute crustose lichens were almost completely omitted, and species growing on the bark of living trees (corticolous species) were neglected.

Thus this collection is by no means a comprehensive list of the species in the area. It does, however, indicate the more frequent species in the major vegetation types, their habitat preferences and community relationships.

BRYOPHYTES AND LICHENS COLLECTED

A total of 56 taxa of lichens, 27 taxa of liverworts and 76 taxa of mosses were collected. They are listed alphabetically on pages 327 to 334. The numbers in brackets following the species names refer to the sites described in the first report (Stringer, 1975). The following symbols are used to indicate the usual substrate type on which the species occurred.

m = mineral soil, sometimes with a very thin humus-litter layer

h = loose humus and litter

w = dead wood, with or without bark

b - live bark of shrubs and trees

t = on or in thick moss turf and humus which may or may not be of that species

Species with names preceded by a question mark are in difficult groups. Identifications of these were tentative because of lack of fruiting plants or lack of sufficient material.

LICHENS

Nomenclature follows Bird (1972).

Alectoria glabra Mot. (8,15,73,81,82) b.

Alectoria nadvornikiana Gyeln. (81) b.

Cetraria ericetorum Opiz (9) m,h.

Centraria halei W. Culb. & C. Culb. (2,8,9,11,35,73,66,80) b,w.

Cetraria merrillii Du Rietz (77) b.

Cetraria nivalis (L.) Ach. (4,9,35,46,81) m,h.

Cetraria pinastri (Scop.) S. Gray (2,6,9,11,13,15,26,35,40,43, 75,76,79) b.

Cetraria sepincola (Ehrh.) Ach. (13,75) b.

Cladina alpestris (L.) Harm. (20,23,35,46,48,49,75,81) m,h.

Cladina arbuscula (Wallr.) Rabenh. (7,23,28,35,65,66,74,78,79) m,h.

Cladina mitis (Sandst.) Hale & W. Culb. (4,5,7,9,11,13,15,20,46, 48,49,51,71,75,80,81) m,h.

Cladina rangiferina (L.) Harm. (46,81) m,h.

Cladonia chlorophaea (14,71) h,w.

Cladonia coccifera (L.) Willd. (9,11) m,h,w.

Cladonia coniocraea (Flörke) Spreng. (14,25,51,62) w.

Cladonia cornuta (L.) Hoffm. (4,7,13,14,22,52,75) h,m.

Cladonia crispata (Ach.) Flot. (7) h.

Cladonia cristatella Tuck. (71) h.

Cladonia deformis (L.) Hoffm. (4,13,51,55,75) h.

Cladonia ecmocyna (Ach.) Nyl. (22) w.

Cladonia fimbriata (L.) Fr. (2,71) h.

Cladonia gracilis (L.) Willd. var. *dilatata* (Hoffm.) Schaer. (4,7,13,14,15,22,25,45,51,52,55,58,75,79) h,m,w.

Cladonia phyllophora Hoffm. (11,52) h,m.

Cladonia pyxidata (L.) Hoffm. (46) h,m.

Cladonia uncialis (L.) Wigg. (9,11,13,35,48,57) m,h.

Cladonia verticillata (Hoffm.) Schaer. (20,45) m,h.

Evernia mesomorpha Nyl. (2,11,14,15,18,26,35,66,67,73,79,81,82,83) b.

Hypogymnia physodes (L.) Nyl. (2,6,11,15,18,23,25,26,28,40,47,66, 75,79,80,82,83,94) b.

Hypogymnia vittata (Ach.) Gas. (77) b,w.

Icmadophila ericetorum (L.) Zahlbr. (15,55,75) h (over mosses).

Nephroma resupinatum (L.) Ach. (27) h.

Pannaria microphylla (Sw.) Mass. (72) b,w.

Parmelia elegantula (Zahlbr.) Szat. (3,47) b.

Parmelia flaventior Stirt. (3) b.

Parmelia olivacea (L.) Ach. (14) b.

Parmelia subolivacea Nyl. (26) b.

Parmelia sulcata Tayl (2,3,8,14,15,16,18,26,47,66,67,79,80,82, 83,84) b.

Parmeliopsis aleurites (Ach.) Nyl. (8) s,b.

Parmeliopsis ambigua (Wulf.) Nyl. (2,8,9,11,13,35,75) w,b.

Parmeliopsis hyperopta (Ach.) Arn. (11,13,18,65) w,b.

Peltigera aphthosa (L.) Willd. (7,13,17,23,46,66) h,m.

Peltigera aphthosa (L.) Willd. var. *varioloso* (Mass.) Thoms. 2,5,6,12,16,20,22,23,25,27,28,47,49,58, 62,63,72,74,77,80,81,84) h,m.

Peltigera canina (L.) Willd. (14,45) h,m.

Peltigera canina (L.) Willd. Var. *rufescens* (Weiss) Mudd. (2,3,5,6,17,27,45,47,63,79,80) h,m.

Peltigera canina (L.) Willd. var. *spongiosa* Tuck. (7,65) h,m.

Peltigera canina (L.) Willd. var. *spuria* (Ach.) Schaer. (42) h,m.

Peltigera canina (L.) Willd. var. *ulorriza* (Flörke) Schaer. (62) h,m.

Peltigera horizontalis (Huds.) Baumg. (25,83) h,m.

Peltigera malacea (Ach.) Funck (13,23,35,46,81) h,m.

Peltigera polydactyla (Neck.) Hoffm. (7,16,22,28,47,62) h,m.

Ramalina farinacea (L.) Ach. (2,3,47,84) b.

Usnea cavernosa Tuck. (47) b.

Usnea dasypoga (Ach.) Röhl. (2,8,14,80) b.

Usnea glabrata (Ach.) Vain. (47) b.

Usnea scabrata Nyl. var. *nylanderi* Mot. (82) b.

Usnea subfloridana Stirt. (2,3,8,14,15,26,47,63,66,67,68,73, 82,83,84) b.

LIVERWORTS (*Hepaticae*)

Nomenclature follows Bird (1973)

Blasia pusilla (L.) Micheli (29,30,34) m.

Blepharostoma trichophylla (L.) Dum. (12,26,42) w.

Calypogeia muelleriana (Schiffn.) K. Müll. (75) t. (Sphagnum and bog mosses).

Calypogeia sphagnicola (Arn. and Pers.) Warnst. and Loesk. (15,20, 71,74,82) t. (Sphagnum and bog mosses).

Cephalozia media Lindb. (20,64,71,73,74,75,77) t. (Sphagnum and bog mosses).

Cephalozia pleniceps (Aust.) Lindb. (38) h.

Cephaloziella hampeana (Nees) Schiffn. (38) h.

Cephaloziella rubella (Nees) Warnst. (20,42,77,80,81) t. (moss turf).

Chiloscyphus pallescens (Erhr.) Dum. (33) t. (moss turf).

Isopaches hellerianus (Nees) Buch. (14,28,62,80) w.

Jamesoniella autumnalis (Cand.) Steph. (3,14,26,27,28,31,47,62, 63,64,78,80,83) w.

Lepidozia reptans (L.) (Dum. (64,82) t. (Spagnum and bog mosses).

Lophocolea heterophylla (Schrad.) Dum. (17,24,38,42,58,72) h.w.

Lophozia longidens (Lindb.) Macoun (24,27,80,83) w.

Lophozia obtusa (Lindb.) Evans (15,22) t. (Sphagnum hummocks).

Lophozia porphyroleuca (Nees) Schiffn. (28) w.

Lophozia ventricosa (Dicks.) Dum. (12,38) h.

Marchantia polymorpha L. (46) t. (moss turf).

Mylia anomala (Hook.) S.F. Gray (8,13,15,20,24,51,54,55,65,71, 74,75) t. (Sphagnum and bog mosses).

Orthocaulis kunzeanus (Hueb.) Buch. (42) t. (moss turf).

Plagiochila asplenioides (L.) Dum. (42,76) t. (moss turf).

Ptilidium ciliare (L.) Hampe (7,23,47) h.

Ptilidium pulcherrimum (Web.) Hampe (2,6,13,14,18,25,26,28,45,47,59,64,67,78,79,80,83) w,h,b.

Riccardia latifrons Lindb. (38,74) t. (moss turf).

Scapania irrigua (Nees) Dum. (38) w.

Scapania paludicola Loesk. and K. Müll. (42) t. (moss turf).

Tritomaria excestiformis (Breidl.) Schiffn. (14,28) w.

MOSSES *(Musci)*

Nomenclature follows Bird (1973).

Amblystegium juratzkanum Schimp. (6,17,24,33,50,58,63,72,79) h,w,b.

Amblystegium serpens (Hedw.) B.S.G. (63) w.

Aulacomnium palustre (Hedw.) Schwegr. (1,5,6,7,8,12,16,17,20,22,26,36,38,41,43,49,56,58,63,64,66,67,69,70,73,74,77,82) t.

Barbula fallax Hedw. (29,30,34) m.

Brachythecium curtum (Lindb.) Limpr. (7,62) h.

Brachythecium nelsonii (Grout) (36,40,60) h. (Drepanocladus mat.).

Brachythecium rutabulum (Hedw.) B.S.G. (3,6,21,26,32,46,58,64) h,w.

Brachythecium salebrosum (Web. and Mohr) B.S.G. (2,6,17,24,27,28,31,32,33,37,39,45,50,58,62,63,72,79,83) h,w,b.

Brachythecium velutinum (Hedw.) B.S.G. (2,28,31,63,67,79,80) h.

Bryum creberrimum Tayl. (74) h.

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer and Scherb. (2,14) h,t.

Calliergon cordifolium (hedw.) Kindb. (64) t.

Calliergon richardsonii (Mitt.) Kindb. ex Warnst. (12) t.

Calliergon stramineum (Brid.) Kindb. (42,77) t.

Campylium hispidulum (Brid.) Mitt. (e,6,17,24,27,32,33,62,63, 67,72,80,83) h,w.

Campylium polygamum (B.S.G.) C. Jens (33) w.

Ceratodon purpureus (Hedw.) Brid. (15,33,47,79) h,w.

Climacium dendroides (Hedw.) Web. and Mohr (17,21,22,26,27,50, 72) h.

Dicranella schreberiana (Hedw.) Schimp. var. *robusta* Schimp. ex. Braithw. (12) h.

Dicranella varia (Hedw.) Schimp. (29,30,34) m.

Dicranum acutifolium (Lindb. and H. Arnell) C. Jens. ex Weinm. (5,26,31,62,63,64,71,75) t.

Dicranum flagellare Hedw. (26,27,28,31,62,63,64,78) w.

Dicranum fragilifolium Lindb. (25,26,47,63,79) w,t.

Dicranum fuscescens Turn. (23,26,28) w,t.

Dicranum polysetum Sw. (2,3,5,6,13,16,18,19,23,25,26,28,31,46, 64,66,67,73,78,79,80,81) t.

Dicranum undulatum Brid. (4,12,13,15,20,22,25,26,27,51,52,55,61, 64,65,73,74,75,78,79,82) t.

Ditrichum flexicaule (Schwaegr.) Hempe (23) h.

Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland. ex Voit) Roth 36,37,38,39,43,46) t.

Drepanocladus revolvens (Sw.) Warnst. (12,73) t.

Drepanocladus uncinatus (Hedw.) Warnst. (7,16,17,18,22,33,42,45, 47,50,62,63,64,77,78,79,82,84) h,w.

Drepanocladus vernicosus (Lindb. ex. C. Hartm.) Warnst. (1,36,37, 38,60) t.

Eurhynchium pulchellum (Hedw.) Jenn. (2,3,6,14,17,18,24,27,31,32, 47,62,63,64,68,80,83,84) h,b.

Funaria hygrometrica Hedw. (29) m.

Haplocladium microphyllum (Hedw.) Broth. (6,17,24,27,32,33,34,62, 63,72) h,w.

Helodium blandowii (Web. and Mohr) Warnst. (42,59,69,76) t.

Herzogiella turfacea (Lindb.) Lindb. (62,62) w.

Hylocomium splendens (Hedw.) (2,3,5,6,7,12,14,16,17,18,20,22, 23,25,26,27,28,31,42,46,47,49, 59,62,63,64,66,68,69,77,78,79, 80,81,82,83,84) h.

Hypnum callichroum Funck ex Brid. (25) h.

Hypnum lindbergii Mitt. (21,26,50,64,69,73,76,77,82) h,t.

Hypnum pallescens (Hedw.) P. Beauv. (62) b.

Hypnum pratense Koch ex Brid. (32,33) h,m.

Leptobryum pyriforme (Hedw.) Wils. (2) w.

Leptodictyum trichopodium (Schultz) Warnst. (34) m.

Meesia longiseta Hedw. (38) t.

Meesia triquetra (Richt.) Ongstr. (37) t.

Mnium spinulosum B.S.G. (63) h.

Myurella julacea (Schwaegr.) B.S.G. (72) h.

Oncophorus wahlenbergii Brid. (3,6,14,17,24,26,272,31,33,62,63, 78,80,83) w.

Orthotrichum obtusifolium (2,14) b.

Plagiomnium cuspidatum (Hedw.) Kop. (2,6,24,27,32,33,50,58,62, 63,67,72,83,84) h,w,b.

Plagiomnium drummondii (Bruch and Schimp.) Kop. (27,63) h,w.

Plagiomnium medium(B.S.G.) Kop. (3) h.

Plagiomnium rugicum (Laur.) Kop. (3,12,17,39,41,47,59,64,82) h.

Platygyrium repens (Brid.) B.S.G. (26,62,63) w,b.

Pleurozium schreberi (Brid.) Mitt. (2,3,4,5,6,7,8,12,13,14,15, 16,17,18,19,20,22,23,25,26,27,28, 42,46,47,51,52,62,64,65,66,67,73, 78,79,80,81,82,83,84) h.

Pohia nutans (Hedw.) Lindb. (5,7,8,14,25,26,31,45,62,63,67,69, 78,80,81) h,w.

Pohlia wahlenbergii (Web. and Mohr) Andr. (29,30,34) m.

Polytrichum commune Hedw. (2,7,8,49,55,62,65,66,67) t.

Polytrichum juniperinum Hedw. (1,2,7,13,15,20,26,28,45,47,49, 50,51,52,53,54,55,56,58,62,65, 66,69,71,73,74,75,77,79,82) t,m,h.

Polytrichum piliferum Hedw. (9,11) m,h.

Ptilium crista-castrensis (Hedw.) De Not. (2,3,4,6,12,13,16,18, 19,26,27,28,31,47,59,62,63,64, 66,67,80,83,84) h.

Pylaisiella polyantha (Hedw.) Grout (2,6,14,18,24,27,28,32,33,45, 47,50,63,83) b.

Rhytidiadelphus triquetrus (Hedw.) Warnst. (31,63) h.

Sphagnum capillaceum (Weiss) Schrank (4,13,15,20,22,51,53,54,65, 66,71,75,80) t.

Spagnum fuscum (Schimp.) Klinggr. (1,4,8,12,15,20,42,51,55,58,61, 65,70,71,74,75,77) t.

Sphagnum magellanicum Brid. (4,8,53,73) t.

Sphagnum recurvum P. Beauv. var. Tenue Klinggr. (8,54,58,73,76, 82) t.

Sphagnum squarrosum Crome (38,42) t.

Sphagnum warnstorfii Russ. (8,12,65,69,70,73,76,77,82) t.

Tetraphis pellucida Hedw. (31,62,64) w.

Tetraplodon angustatus (Hedw.) B.S.G. (15) h. (dung).

Thuidium recognitum (Hedw.) Lindb. (5,22,82) h.

Timmia megapolitana Hedw. (32,33) h,m.

Tomenthypnum nitens (Hedw.) Loeske (5,12,16,20,22,36,42,43,56,58, 61,69,70,72,73,74,76,77,82) t.

Tomenthypnum nitens (Hedw.) Loeske var. *falcifolium* (Ren. ex. Nich.) Podp. (77) t.

HABITAT RELATIONS

FEN.

Although this vegetaion type was extrmely poor in numbers of bryophyte species, the biomass of mosses was high.

Drepanocladus vernicosus and *Drepanocladus aduncus* var. *polycarpus* formed almost continuous, thick spongy, unstable water-logged mats, and thus constituted a very important and prominent component of this vegetation type. All other species were relatively unimportant. *Brachythecium nelsonii, Campylium stellatum, Meesie triquetra* and *Meesia longiseta* were occasionally to be found within the *Drepanocladus* mat, probably in the slightly drier microsites. Conspicuous hummocks of *Aulacomnium palustre* and *Tomenthypnum nitens* were occasionally found especially towards the margins of the fens. *Spagnum* species were rare.

Liverworts were generally absent. However, six small liverworts were found in stand 38 on slightly raised hummocks formed by the bases of low willows and dead wood *(Lophocolea heterophylla, Lophozie ventricosa, Riccardis latifrons, Cephalozia pleniceps, Cephaloziella hampeana,* and *Scapania irrigua).* The latter three species were not found elsewhere in this study.

Lichens were infrequent and were found usually on the bark of shrubs, principally low willows. The most common was the bright yellow *Cetraria pinastri.*

SANDBAR WILLOW SCRUB

The intense shade provided by the dense willows together with the unstable nature of the river-deposited silt at the ground surface excluded all but a few opportunistic mineral soil colonizers, principally the mosses *Dicranella varia*, *Barbula fallax* and *Pohlia wahlenbergii*, and the thallose liverwort *Blasia pusilla*. The few other species present were found as small, scattered patches on shrub bases and dead wood above the ground surface. These appear to represent partially, communities more typical of nearby forest habitats.

TALL WILLOW AND TALL WILLOW-RIVER ALDER SCRUB

Habitat conditions in this vegetation type are very similar to those in sandbar willow scrub. However, flooding disturbance on these sites may be somewhat less because of their greater distance from surface water. Thus, the dense shade and generally low moisture availability at the ground surface exclused all but a few species. Lichens and liverworts were vertually absent. Mosses were found mainly on shrub bases and dead wood, and were apparently poorly-developed specimens of species more characteristic of nearby forest habitats.

The only prominent species on the ground was a conspicuous, robust moss, *Climacium dendroides*. *Hypnum lindbergii* and *Polytrichem juniperinum* were also frequent. Occasional patches of *Aulacomnium palustre* and *Tomenthypnum nitens* were found in wetter microhabitats and under openings in the canopy.

BOTTOMLAND BALSAM POPLAR FOREST

The principal species were mosses that are more usually found in upland mixed wood and aspen forests. Thus, *Pylaisiella polyantha* was the dominant species on bark towards the bases of trees, while further down the trunk and on the humus and litter at the tree base *Eurhynchium pulchellum, Plagiomnium cuspidatum,* and *Brachythecium salebrosum* formed a continuous "stocking". Several species were frequent but not prominent on litter, twigs, fragmented wood, and dead logs on the forest floor. The principal species in this group were *Brachythecium rutabulum, Brachythecium salebrosum, Amblystegium juratzkanum, Campylium, Drepanocladus uncinatus, Haplocladium microphyllum,* and *Oncophorus wahlenbergii.*

Hypnum pratense and *Timmia megapolitana* were found only in this vegetation type. They occurred on thin humus over mineral soil. Liverworts were rare and lichens appeared to be absent from this vegetation type.

UPLAND WHITE SPRUCE-ASPEN FOREST

The bryophyte and lichen component of these forests varied widely. The species and their abundance at any one site apparently depended upon the availability of various substrates as most of the species seemed to be substrate-specific. Forests with a large proportion of coniferous trees generally had a high species diversity because of greater range of substrates available and less chance of smothering by deciduous leaf fall.

In aspen and other hardwood forests, bryophytes, and lichens were confined to substrates above the forest floor, i.e. to those sites which are not smothered by leaf fall, e.g. tree bases, stumps, logs.

Continuous mats of *Pylaisiella polyantha* covered the bases of trees such as aspen, poplar, and white birch. Below the *Pylaisiella*, other mosses, principally *Brachythecium salebrosum, Plagiomnium cuspidatum, Eurhynchium pulchellum* and *Haplocladium microphyllum* occurred at the tree base where some humus had collected. Mature white birch and most coniferous trees carried a variety of epiphytic lichens chiefly *Evernia mesomorpha, Ramalina farinacea, Usnea subfloridana, Hypogymnia physodes,* and *Parmelia sulcata.* In these forests, aspen and balsam poplar rarely bore epiphytes, although moss species of the genus *Orthotrichum*, e.g. *Orthotrichum obtusifolium* were often present as small dark-green patches on poplar as well as coniferous tree bark.

On rotting deadfall on the forest floor there were a large number of species. These form a complex series of successional communities as the wood rots and additional humus accumulates. The most frequent colonizers of this deadfall were the mosses *Amblystegium juratzkanum, Campylium hispidulum, Dicranum flagellare, Dicranum fragilifoliu, Dicranum fuscescens, Herzogiella turfacea, Oncophorus wahlenbergii, Pohlia nutans,* and *Tetraphis pellucida;* the liverworts *Isopaches hellerianus, Jamesoniella autumnalis, Lophozia longidens, Ptilidium pulcherrimum* and *Tritomaria exsectiformis*; and the small yellow lichen *Cetraria pinastri.* As humus accumulates on the rotting wood these colonizers are replaced by other more vigorous species, e.g. *Brachythecium salebrosum, Brachythecium velutinum, Brachythecium rutabulum, Climacium dendroides, Drepanocladus uncinatus, Plagiomnium cuspidatum, Plagiomnium drummondii.* In forests with a high proprotion of coniferous tres, these successional species are, in their turn, eventually over grown by a thick continuous feathermoss carpet dominated by *Hylocomium splendens* and *Pleurozium schreberi.*

On the forest floor as a whole, a bryophyte-lichen carpet occurred only where there was a high proportion of coniferous trees in the canopy. In such forests the smothering effect of leaf fall from deciduous trees and shrubs was slight.

Thus, in mature, closed-canopy white spruce forests, there was a continuous carpet of the feathermosses *Pleurozium schreberi* and *Hylocomium splendens,* occasionally with scattered plants of the mosses *Ptilium crista-castrensis* and *Rhytidiadelphus triquetrus,* and the large lichens *Cladina arbuscula, Peltigera aphthosa* var. *variolosa, Peltigera Canina* var. *rufescens* and *Peltigera polydactyla.*

BLACK SPRUCE-TAMARACK BOG FOREST AND MUSKEG.

Large areas of poorly-drained uplands in the Alberta Oil Sands area are covered with thick peat deposits derived from Sphagnum and other bog mosses. Here, only two tree species - black spruce and tamarack - can thrive. In these areas there is a complete gradient from dense mature bog forest at the mesic extreme, through lightly treed black spruce-tamarack muskeg to open muskeg at the hydric extreme. These open muskegs are poorly-drained and acid, and differ markedly from the open fens which are freely drained though water-saturated and neutral to alkaline. In both fens and muskegs, a thick, spongy, continuous surface layer of mosses is characteristic, but the species involved are quite different. *Drepanocladus* species are characteristic of fens while muskegs usually have thick, peat-forming hummocks composed of *Sphagnum* species, with *Aulacomnium palustre* and *Tomenthypnum nitens*. To call these muskegs "*Sphagnum* bogs" may be a misnomer as *Aulacomnium* and *Tomenthypnum* may often be more important.

Of the five principal *Sphagnums* found, *Sphagnum capillaceum* was more prominent in the drier bog forests whereas *Sphagnum fuscum* and *Sphagnum warnstorfii*, and to a lesser extent, *Sphagnum magellanicum* and *Sphagnum recuruum* var. *tenue* were most prominent in the open muskeg. *Aulacomnium palustre* and *Tomenthypnum nitens* were also prominent in the open muskegs.

Growing within and on the surface of the *Sphagnum - Aulacomnium - Tomenthypnum* hummocks were a number of inconspicuous but characteristic liverworts. The more important of these were *mylia anomala*, *Calypogeia sphagnicola*, *Lophozie obtus*, *Cephalozia media* and *Cephaloziella rubella*.

Two prominent turf-forming mosses *Polytrichum juniperinum* and *Dicranum undulatum*, were frequently found as small cushions amond the larger *Sphagnum* hummocks, and several other mosses, e.g. *Hypnum lindbergii*, *Drepanocladus revolvens*, and *Calliergon* species often occupied moister, muck-filled hollows.

On the tops and sides of old, disintegrating *Sphagnum* hummocks several fruticose lichens formed a conspicuous crust.

These were invariably species of *Cladonia* and *Cladina*, especially *Cladonia deformis* and *Cladina mitis*. Most dead and rotting wood on the ground especially in semi-open areas, also bore several *Cladonia* species, e.g. *Cladonia gracilis*, c.f. liverworts and moss communities on deadfall in forests.

The bark of tress, again especially in semi-open areas, often bore colonies of other lichens profusely the most abundant of which were *Parmelia sulcata*, *Hypogymnia physodes*, *Evernia mesomorpha*, *Alectoria glabra*, *Usnea subfloridana* and several other species of *Usnea* and *Alectoria*.

In denser bog forests, all the foregoing species occurred besides many species more typical of mesic upland coniferous forest. Thus, *Sphagnum* hummocks were often found alternating with sheets of *Peltigera aphthosa* var. *variolosa*, and mats of the feathermosses *Hylocomium splenens*, *Pleurozium schreberi*, *Ptilium crista-castrensis*, with *Plagiomnium rugicum* sometimes prominent in wet, shady hollows.

JACK PINE FOREST

On upland, sandy and well-drained sites is Jack pine forest, the most zerophytic vegetation type represented in the area. This vegetation type occurs on large areas of aeolian sand, and provides a very distinctive habitat for a number of lichens. However, few mosses were present and no liverworts.

The ground within pure Jack pine forests usually had a prominent cover of fruticose lichens. By far the most important of these was *Cladina mitis*, but *Cladina arbuscula*, *Cladina rangiferina*, *Cladina alpestris*, *Cladonia uncialis*, *Cladonia cornuta*, *Cladonia gracilis*, *Cladonia phyllophora* and *Cetraria nivalis* were also common. Occasionally, sheets of *Peltigera* species, principally *Peltigera malacea* were also prominent. The only noticeable mosses were *Polytrichum junipernum* and *Polytrichum piliferum* which occurred as occasional tufts.

The following lichens were the principal colonizers of deadfall: *Cetraria halei*, *Parmeliopsis ambigue*, *Cetraria pinastri*, and *Cladonia coccifera*. Corticolons lichens were rare or absent. *Evernia mesomorpha* was the only common species.

DISCUSSION

Bryophytes and lichens are important components of plant communites in three respects. As sensitive indicators of the total environment they are, therefore, of considerable use in plant community classifcation. They also constitute a significant proportion of the non-woody plant biomass in many communities. Finally many species, particularly lichens, are sensitive indicators of air pollution.

Because of their sensitivity to environmental factors, many bryphytes and lichens are characteristic of the vegetation type in which they occur. This is particularly true of those occurring on the ground surface, i.e. on litter, humus, and bare mineral soil, where minor differences in moisture regime, humidity and the pH and mineral nutrient regime of the soil in physiogramically similar ecosystems are reflected in marked differences in the bryophyte and lichen floras (Stringer and Stringer, 1973, 1974a). In the stands studied in this project for example, *Dicranella varia* is characteristic of bare, disturbed, calcareous and fine-textured soil, *Drepanocladus vernicosus* and *D. aduncus* var. *polycarpus* of calcereous fens, *Barbula fallax* of moist calcareous soil, and *Polytrichum piliferum* of dry, sandy or gravelly mineral soil in open situations (Crum, 1973).

Thus, terrestrial bryophyte and lichen species in particular can be and often are just as important as vascular plants in community classification (Stringer and Stringer 1974a, LaRoi and Stringer 1976). Their use for this purpose in forestry in conjunction with vascular understory species has been advocated by Rowe (1956).

However, most non-terrestrial species are more specific to substrate type than vegetation type and therefore are of much less use in community classification; bryophyte-lichen communities in rotten logs, tree bases, and tree bark tend to be similar across a range of vegetation types. For example, in this study rotten wood in mesic habitats was colonized by a very specific group of species, the most prominent of which were the small turg mosses *Pohlia nutans*, *Tetraphis pellucida*, *Oncophorus wahlenbergii*, *Dicranum flagellare*, *D. Fragilifoliu*, *D. Fuscescens*, and the liverworts *Ptilidium pulcherrimum*, *Jamesoniella autumnalis* and *Lophozie longidens*. Most tree bases, but especially hardwoods, had a "stocking" of mosses principally *Brachythecium salebrosum*, *Plagiomnium cuspidatum* and *Eurhynchium pulchellum* with *Pylaisiella polyantha* usually forming a continuous band just above them. Most tree species had a distinctive community of epiphytic, corticolous lichens on their bark often regardless of tree species, principally *Evernia mesomorpha*, *Ramalina farinacea*, *Hypogymnia physodes*, *Parmelia sulcata* and *Usnea subfloridana*.

Several of the terrestrial bryophyte and lichen species played a very prominent quantitative role in many plant communities often forming the bulk of the terrestrial plant biomass. A number of species were sometimes quantitatively more important than the vascular species, e.g. *Spagnum* species, *Aulacomnium palustre* and *Tomenthypnum nitens* in muskegs, *Drepanocladus* species in fens, *Pleurozium schreberi* and *Hylocomium splendens* in mesic, closed-canopy coniferous forests, and *Cladina* species in zeric Jack pine forests.

Finally, many lichens and bryophytes are known to be sensitive indicators of air pollution (Stringer and Stringer 1974b, LeBland and De Sloover 1970), and the large corticolour foliose and fruiticose lichens just mentioned are particularly sensitive, particularly to sulphur dioxide. Their presence on or absence from selected tree trunks around the G.C.O.S., Syncrude and other future plants could be used to monitor air pollution levels in the Alberta Oil Sands area. Physiological changes in the lichen colonies would be readily apparent and their disintegration and death could be correlated with the results of specifically located air pollution instrumentation to give an accurate picture of pollution dispersion patterns, as has been done from Winnipeg (Stringer and Stringer, 1974b), Montreal (Le Blanc and De Sloover, 1970), Sudbury, Ontario (Le Blanc, Rae and Comeau 1972), Wawa, Ontario (Gordon and Gorham 1963), and Tyne Valley, England Gilbert, 1965, 1968).

Small foliose and crustose lichens which are often less sensitive have not been adequately sampled in this study and any future work using lichens as pollution indicators will necessitate that this should be done.

In conclusion, not only are lichens and bryophytes often very important members of the communities in which they occur, but also some of the less quantitatively important species may be potentially important in other respects. They may be used as sensitive indicators of specific environmental factors so that subtle changes in those factors will be quickly reflected in detectable changes in the lichen-bryophyte populations. Thus, increasing air pollution will certainly be reflected in various obvious changes in the corticolous lichen population before pollution affects the less sensitive vascular plants of the community. Visual monitoring will show that most lichen species will decline and eventually die, although a few tolerant species may actually increase for some time.

Similarly, subtle changes in ground water regime caused by disturbance will be reflected in visual changes in the terrestrial bryophyte populations even at considerable distance from the source of disturbance.

Therefore, it is as vitally important to know the bryophytelichen component of plant communities as it is to know the vascular species.

A knowledge of the lichens and bryophytes, often neglected in many studies, should be an integral part of any comprehensive vegetation survey of the Alberta Oil Sands.

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LITERATURE CITED

Argus, G.W. (1964). Plant collections from Carswell Lake and Beartooth Island, northwestern Saskatchewan, Canada. Canad. Field-Nat. 78(3): 139-149.

Argus, G.W. (1966). Botanical investigations in northeastern Saskatchewan: the subarctic Patterson-Hasbala Lakes Region. Canad. Field-Nat. 80(3): 119-143.

Argus, G.W. (1968). Contributions to the flora of boreal Saskatchewan. Rhodora 70: 200-214.

Bird, C.D. (1962). Mosses of the prairies of west-central Canada. Canad. J. Bot. 40: 35-47.

Bird, C.D. (1968). A preliminary flora of the Alberta Sphagna and Musci II. Dept. Biology, University of Calgary.

Bird, C.D. (1969). Bryophytes of the aspen parkland of west-central Canada. Canad. J. Bot. 47: 187-212.

Bird, C.D. (1970). Keys to the lichens of west-central Canada. Biology Dept., University of Calgary.

Bird, C.D. (1972). A catalogue of the lichens reported from Alberta, Saskatchewan and Manitoba. Biology Dept., University of Calgary.

Bird, C.D. (1973). A new catalogue of the bryophytes reported from Alberta, Saskatchewan and Manitoba. Biology Dept., University of Calgary.

Crum, H. (1973). Mosses of the Great Lakes Forest. Contributions from the University of Michigan Herbarium, 10: 1-404.

Dirschl, H.J. (1970). Ecological evaluation of the Peace-Athabasca Delta. Annual Progress Report 1969-70. Canad. Wild. Service, P.66.

Dirschl, H.J. (1973). Trends in vegetation succession in the Peace-Athabasca Delta. In Peace-Athabasca Delta Project. Technical Appendices, Vol. II, Ecological Investigation, Secion J.

Dirschl, H.J., D.L. Dabbs and G.C. Gentle (1974). Landscape classification and plant successional trends in the Peace-Athabasca Delta. Canad. Wildl. Serv., Report Series No.30, p.34.

Duffy, P.J.B. (1964). A proposed forest land classification for the Mixedwood Section of Alberta. Canad. Dept. Forestry, Forestry Research Program, p.34.

Duffy, P.J.B. (1965). A forest land classification for the Mixedwood Section of Alberta. Canad. Dept. Forestry, Publ. No.1128. P.23.

Gilbert, O.L. (1965). Lichens as indicators of air pollution in the Tyne Valley. pp.34-47 in G.T. Goodman et al. (editors), "Ecology and the Industrial Society", Oxford.

Gilbert, O.L. (1968). Bryophytes as indicators of air pollution in the Tyne Valley. New Phytol., 67: 15-30.

Gordon, A.G. and E. Gorham (1963). Ecological aspects of air pollution from an iron-sintering plant at Wawa, Ontario. Canad. J. Bot., 41: 1063-1078.

Heinselman, M.L. (1963). Forest sites, bog processes and peatland types in the Glacial Lake Agassiz Region, Minnesota Ecol. Monogr., 33: 327-374.

Heinselman, M.L. (1970). Landscape evolution, peatland types, and the environment in the Lake Agassiz Peatlands Natural Area, Minnesota. Ecol. Monogr., 40: 235-261.

Jesberger, J.A. and J.W. Sheard (1973). A quantitative study and multivariate analysis of corticolous lichen communities in the southern boreal forest of Saskatchewan. Canad. J. Bot., 51: 185-201.

Jonescu, M.E. (1970). Lichens on Populus tremuloides in west-central Canada. The Bryologist, 73: 557-578.

La Roi, G.H. and M.H.L. Stringer (1976). Ecological studies in the boreal spruce-fir forests of the North American Taiga. II Analysis of the bryophyte flora. In press (Canada.J. Bot.).

Le Blanc, F. and J. DE Sloover (1970). Relation between industrialization and the distribution and growth of epiphytic lichens and mosses in Montreal. Canad. J. Bot., 48: 1485-1496.

Le Blanc, F., D.N. Rao, and G. Comeau (1972). The epiphytic vegetation of Populus balsamifera and its significance as an air pollution indicator in Sudbury, Ontario. Canad. J. Bot., 50: 519-528.

Lewis, F.J. and E.S. Dowding (1926). The vegetation and retrogressive changes of peat areas (muskegs) in central Alberta. J. Ecol., 14: 317-341.

Lewis, F.J., E.S. Dowding and E.H. Moss (1928). The vegetation of Alberta. II The swamp, moss and bog forest vegetation of central Alberta. J. Ecol., 16: 19-70.

Looman, J. (1964). Ecology of lichen and bryophyte communities in Saskatchewan. Ecology, 45: 481-491.

Moss, E.H. (1932). The vegetation of Alberta. IV The poplar association and related vegetation of central Alberta. J. Ecol., 20: 380-415.

Moss, E.H. (1953a). Forest communities of north-western Alberta. Canad. J. Bot., 31: 215-252.

Moss, E.H. (1953b). Marsh and bog vegetation in north-western Alberta. Canad. J. Bot., 31L 448-470.

Moss, E.H. (1955). The vegetation of Alberta. Bot. Rev., 21: 493-567.

Moss, E.H. and G.H. Turner (1961). Bryophytes from the Edmonton region, Alberta. Canad. J. Bot., 39: 1177-1193.

Ramp, H.M. (1946). Phytogeographic studies in the Athabasca-Great Slave Lake Region. II. J. Arnold Arboretum, 27: 1-85.

Rowe, J.S. (1956). Uses of undergrowth plant species in forestry. Ecology, 37: 461-473.

Stringer, P.W. (1975). A preliminary vegetation survey of the Alberta Oil Sands area. Vegetation Committee, Alberta Oil Sands Environmental Research Programme.

Stringer, P.W. and M.H.L. Stringer (1973). Studies on the bryophytes Southern Manitoba. VII. Distribution of terrestrial bryophytes in a black spruce bog in Bird's Hill Provincial Park. The Bryologist, 76: 252-259.

Stringer, P.W. and M.H.L. Stringer (1974a). Studies on the bryophytes of Southern Manitoba. VI. An ecological study of the bryophytes of coniferous forests in Bird's Hill Provincial Park. The Bryologist, 77: 1-16.

Stringer, P.W. and M.H.L. Stringer (1974b). Air pollution and the distribution of epiphytic lichens and bryophytes in Winnipeg, Manitoba. The Bryologist, 77: 405-426.

Swan, J.M.A. and R.L. Dix (1966). The phytosociological structure of upland forest at Candle Lake, Saskatchewan. J. Ecol., 54: 13-40.