DEVELOPMENT OF NATIVE SPECIES AND REVEGETATING OIL & GAS DISTURBANCES IN THE SANDY SOILS OF THE PARKLAND ECOREGION OF ALBERTA

ALBERTA RESEARCH COUNCIL

Development of Native Species Adapted to the Sandy Soils of the Parkland Ecoregion of Alberta

By

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ABSTRACT

Reclaiming oil and gas disturbances in the sandy soils have specific challenges, and research on other type of soils and ecosystems may not be directly applicable. This is confounded by a lack of commercially available indigenous native plant species. The natural ability of the plant species to colonize a disturbed area is equally important but the process may be slow due to the challenges posed by the environment. Contract harvesting of native seed from the sandy soils can prove to be a costly and unreliable method to meet industry's demand for native seeds.

The Alberta Research Council undertook this project to address the lack of commercially adapted native species suitable for reclaiming industrial disturbances in the sandy soils of the Parkland Ecoregion of Alberta. An additional goal was to conduct revegetation trials to increase our understanding of plant community recovery in these types of soils.

The methodology we used to develop adapted plant varieties consisted of collecting seeds of early successional species from various habitats within the sandy soils. We conducted a germination test on each collected sample and planted the germinants in field nurseries; this was followed with multilocation testing, revegetation trial and breeder seed plots establishment. Testing of plant lines were done under both seed production and reclamation conditions.

We collected data on plant performances from multi-environment testing trials established at Ribstone Creek (2002) and Beaverlodge (2003). These trials were used to evaluate selected lines of Canada wild rye, awned wheatgrass, nodding brome, blue grama, and Indian rice grass. We also compared the effectiveness of different seed mixes in reclaiming sites affected by oil and gas activities.

Results to date show superior performance of the ecotypes collected in the sandy soils of the Parkland Ecoregion. Better emergence and adaptability, earlier maturity and morphological differences are some of the characteristics that these native species have

shown. Under reclamation conditions, the local ecotypes matured at least 20 days earlier than the check varieties, with the exception of Tannas brome grass and blue grama, which matured at the same time. Nezpar Indian rice grass actually matured 10 days earlier that the ARC ecotype. The ability of plant lines to produce mature seeds within a short growing season is important in maintaining the sustainability of the ecosystem in this environment. The reclamation seed mix using locally collected ecotypes of 20 grasses and forbs continue to provide a more diverse vegetative cover than the commercially purchased seed mix used on the disturbed surrounding area.

In 2003, we established breeder seed plots of Canada wild rye, awned wheatgrass, nodding brome and Indian rice grass. CFIA inspectors approved these plots in 2004. In 2003,we signed a marketing agreement with Prairie Seeds Inc to grow and distribute the Canada wild rye ecotype. Prairie Seeds Inc has also shown interest in marketing Canada Milk vetch. We are looking to other seed companies to market awned wheatgrass, nodding brome and Indian rice grass. These plant ecotypes will support the re-establishment, maintenance and productivity of native range ecosites and will ensure greater success in restoring the ecology of the landscape.

We also have in storage several other grasses such as the sand nut grass, sand drop seed and dryland sedges as well as many forb species. We invite suggestions from our industry and government partners for direction with the sandy species project.

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1. BACKGROUND

Alberta's vast tracts of public land provide an important role in ranching, oil and gas exploration, wildlife management and recreation. Alberta Sustainable Resource Development (SRD) and Alberta Environment (AENV) are responsible for managing the province's natural resources, while still allowing economic development and promoting good stewardship. In 2001, Talisman Energy Inc was interested in developing their lease holdings in the Ribstone Creek Ecological Reserve. Located in the Central Parkland Subregion of the Parkland Natural Region, the Ribstone Creek Ecological Reserve is composed of some very unique topographic features and is designated a "Protected Area" under the Wilderness Areas, Ecological Reserves and Natural Areas Act. Topographic features included are: important wetland/riparian areas, well-developed dune formations as well as stabilized or less developed dune formations, and some rare plant communities (Figure 1). The Ribstone Creek Natural Area also provides multiple land use activities such as cattle grazing, oil and gas development, wildlife habitat and recreation.

The key concerns to regulatory agencies such as SRD, AENV and oil and gas industries, like Talisman Energy, are the disturbance or loss of native vegetation and habitat and the introduction of weedy/invasive species into native habitat (Tera Environmental Consultants, 2001). Past revegetation efforts were based on general adaptability of introduced grasses and their availability. Because of their competitive nature and persistence, these introduced species have out competed the native species in places where they have been seeded (Adam et al., 2003), resulting in landscape fragmentation, reduced soil quality (Dormaar et al. 1995), reduced range productivity and decreased ecosystem diversity and functioning. The importance of using native species in reclaiming disturbed sites has been emphasized by government guidelines and regulations (Environmental Protection and Enhancement Act, Native Plant Revegetation Guidelines) and by the public's concern to protect the natural environment and conserve biodiversity. The regulations and guidelines define the expectations associated with achieving reclamation success. However, systems (know how) and tools

(plant materials) are required to achieve and to measure or determine reclamation success in these sensitive ecosystems such as the sandy soils.

Figure 1. Important wetland/riparian area, as well as, stabilized dune formation and Lichen-juniper-bearberry community (far right), which are unique to this area

Achieving reclamation success requires appropriate soil treatments and reintroduction of native plant species (Bradshaw 1987). Therefore, to meet regulatory requirements, oil and gas companies must have access to native seeds indigenous to the area in which they are operating. They must also have the knowledge to use these species that will allow them to return the land to a state comparable to its pre-disturbed condition within an acceptable time period. However, a major obstacle in revegetating these disturbed sites is the lack of seed of many of the sandy species indigenous to the area and a lack of information on the recovery of the plant community in that type of

soil. Contract harvesting of native seed from this ecoregion can be costly and unreliable for meeting the needs of industry. The natural rate of recovery of these disturbed sites can be slow and may allow for invasive species (weedy species) to become established. Therefore natural recovery may not be an option for large disturbances. Additionally, sandy soils have specific challenges such as high erodibility, low nutrient status and low water holding capacity. High-stress environments, like those found within these sandy soils are especially difficult to reclaim because non-native species often cannot survive or reproduce in these harsh environments. Where such reclamation plantings fail, disturbed sites are subject to soil erosion resulting in further degradation of the site. If native species are used, there is no or little information on their establishment and development in the plant community.

Through the use of adapted varieties and information generated from the testing of species and seed mixes, we hope that industries will be able to comply with environmental regulations and at the same time attain substantial cost savings. This project's specific goal was to collect, test and commercially release native grass, legume and forb species suitable for reclamation and habitat restoration in the sandy uplands of east central Alberta and to evaluate the effectiveness of the seed mixes in accelerating the recovery of the plant community.

1.1 Objectives

The major objectives were to:

1. Develop native grass, legume and forb species suitable for revegetation in the sandy soil areas of the Parkland Ecoregion.
2. Develop technologies (seeding techniques, weed control, seed processing) to propagate and cultivate these native species under field conditions.
3. Enhance our understanding of plant community recovery in the sandy soils.
4. Release native ecotypes to the market industry, in order to facilitate revegetation projects.

5. Provide information to land managers and industries to support the creation of sustainable plant communities following resource extraction activities such as oil and gas, livestock grazing, and recreation.

2. METHODOLOGY FOR DEVELOPING ADAPTED PLANT VARIETIES

In 2001, the Native Plant Development group at Alberta Research Council Inc (ARC) consulted AENV, SRD, Talisman Energy Inc and Husky Energy and collected seeds from several locations within the sandy uplands of east central Alberta. Most of the species in Table 1 were identified for their role as early colonizers and when used in a reclamation seed mix, they can provide adequate cover and initiate a successional trajectory pathway.

Table 1. List of native species adapted to the sandy soils of the Parkland Ecoregion targeted for development in 2000

Species (Scientific name)	Common name	Successional stage*
Grasses		
Agropyron subsecundum	Awned wheatgrass	Early
Bouteloua gracilis	Blue grama	Early
Calamovilfa longifolia	Sand reed grass	Late
Elymus canadensis	Canada wild rye	Early
Oryzopsis hymenoides	Indian rice grass	Early
Sporobolus cryptandrus	Sand drop seed	Early
Schizachyrium scoparium	Little blue stem	Early
Carex spp	Sedges	Early
Cyperus schweinitzii	Sand nut grass	Late

Forbs		
Arnica fulgens		Early
Chamaerhodos erecta spp. nuttallii	Bunge	Early
Chrysopsis villosa	Golden aster	Early
Cleome serrulata	Bee plant	Early
Erysimum asperum	Prairie Rocket	Early
Glycyrrhiza lepidota	Wild licorice	Early
Haplopappus spinulosus		Early
Heterotheca villosa	Hairy golden aster	Early
Potentilla hippiana		Early
Psoralea argophylla	Silverleaf psoralea	Early
Psoralea esculenta	Indian bread root	Early
Solidago missouriensis	Low golden rod	Early

*Successional stage follows Gerling et al. 1996. A guide to Using Native Plants on Disturbed Lands.

Nomenclature follows Moss, E.H. 1992. Flora of Alberta.

The methodologies were described in Woosaree et al., (2004) and included the following steps:

2.1 Seed Collection

The Native Plant staff, along with Pat Porter (Public Lands, Wainwright) collected key, early successional species within the sandy uplands of the Parkland Ecoregion (Figure 2). Mature seed heads of a number of species (Appendix 1) were systematically collected throughout the region in order to gather enough diversity within and among the species found in the region. A site description form was prepared for each collected species. Seeds were processed and a small amount (<100 g) of seed was placed in a seed envelope and stored in a freezer at –18 ^{o}C. Collected seeds were tested for germination according to the protocol established by the Canadian Methods and Procedures for Seed

Testing (1977). Seeds were germinated in a 9 cm petri-dish on two Whatman #2 filter papers moistened with distilled water and incubated at 22°C/15°C [day/night], 8 hr day, diurnal cycles. Two replicates, each containing 25 seeds were used. We recorded germination at 7, 14, and 21 days, transplanted the germinants into root-trainers and allowed them to grow in the greenhouse for transplanting into field nurseries in the following summer months.

Figure 2. Collecting Indian rice grass (*Oryzopsis hymenoides*) in Ribstone Creek Ecological Reserve

2.2 Nursery Testing

Plant growth and development traits such as plant vigor, winter hardiness, phenology and seed production were recorded. Plants of the same species with similar characteristics were bulked to form plant lines. Populations with different performances were grown separately.

2.3 Progeny Testing

The bulked seeds were used to establish a progeny trial either for more comparison or for cultural study. The plant lines were also evaluated to ensure that plant performances were in fact hereditary and stable.

2.4 Multi-location Testing

Before a variety is released, thorough testing is essential to ensure reliable performance. Measures of performance may include plant vigour, overall plant growth, winter survival, maturity and seed yield. The plant lines are tested in multiple environments representing different climatic and soil conditions. This is an important step before releasing any of the ecotypes as it assures the performance of the plant material over a wide range of environmental conditions (Allard, 1960). Testing sites were established at Vegreville, the Ribstone Creek Ecological Area (Figure 1) and Beaverlodge (established in 2003, Figure 3) for evaluating characteristics important for commercial seed production and adaptability under reclamation conditions.

Five native grasses including Canada wild rye (*Elymus canadensis* L.), awned wheatgrass (*Agropyron subsecundum* Link A. S. Hitch. of Ed. 1), nodding brome (*Bromus anomalus* Rupr. ex Fourn), blue grama (*Bouteloua gracilis* [HBK] Lag.) and Indian rice grass (*Oryzopsis hymenoides* Michx.) were used in this study. Production characteristics of these native grasses were compared to already available varieties or common seed. These include varieties originating from the United States such as 'North Dakota' Canada wild rye and 'Nezpar' Indian rice grass.

Figure 3. Comparing ARC test lines along with their checks in provenance trial at Beaverlodge

All trials were direct seeded using a Fabro plot seeder. A randomized complete block design plot with six blocks was used. Plots in Vegreville consisted of eight 6 m long rows per plot, with 40 cm row spacing. The six inside rows were used for evaluation. The multilocation trial at Edgerton (seeded on May22nd, 2002) and Beaverlodge (seeded on May, 2003) consisted of four 6 m rows arranged in a randomized complete block design, replicated four times. Plots were maintained in the summer of 2003 and seeds harvested in 2004.

2.5 Data Analysis

Data were analyzed using Proc GLM (SAS Institute Inc., 2002) of analysis of variance (ANOVA) to determine genotype differences in emergence, plant cover, plant height, seed yield and 1000-kernel weight. Data were also combined for both locations to study genotypes and location interaction using ANOVA.

2.6 Evaluating the Performance of Native Seed Mixes on wellsites disturbances

On May 22, 2002, we seeded an evaluation trial to an indigenous native seed mix, composed of species common to the sandy soils on a Talisman Energy lease. The species included in the seed mix were based on their role in the early stages of plant community development in the sandy uplands of the Central Parkland Sub-region (Gerling et al. 1996) and seed availability. The seed mix consisted of 19 plant species (Table 2).

Table 2. Species used in the reclamation seed mix at Edgerton

Species	Common name	Pure live seeds/m²	Percent of mix
Bouteloua gracilis¶	Blue grama	50	10
Calamovilfa longifolia	Sand grass	50	10
Cyperus schweinitzii	Sand nut grass	25	5
Elymus canadensis	Canada wild rye	50	10
Festuca saximontana	Rocky Mountain fescue	50	10
Koeleria macrantha	June grass	50	10
Oryzopsis hymenoides	Indian rice grass	50	10
Schizachne purpurascens	Purple oat grass	25	5
Sporobolus cryptandras	Sand dropseed	50	10
Achillea millefolium	Common yarrow	10	2
Gaillardia aristata	Blanket flower	10	2
Heterotheca villosa	Hairy golden aster	10	2
Linum lewisii	Wild blue flax	10	2
Penstemon gracilis	Lilac-flowered beardtongue	10	2
Penstemon procerus	Slender blue beardtongue	10	2
Petalostemon candidum	White prairie clover	10	2
Ratibida columnifera	Prairie coneflower	10	2
Solidago missouriensis	Low goldenrod	10	2
Solidago rigida	Stiff goldenrod	10	2

¶ In this report, nomenclature follows Moss "Flora of Alberta", 1992.

The total seeding rate was 500 pure live seeds/m^2 (PLS), which equated to a seeding rate of 9.9 kg/ha. The test plot was seeded using a Fabro plot seeder at 20 cm row spacing. After seeding, straw was crimped into the site to prevent erosion. The site was extremely dry at the time of seeding, but received some rainfall (no data available) during the month of August.

Table 3. Composition of the seed mix used by Talisman Energy Inc.

Species	Common name	Percent of mix based on pure live seeds/m^2
Agropyron trachycaulum	Slender wheatgrass	5
Agropyron subsecundum	Awned wheatgrass	5
Bouteloua gracilis	Blue grama	5
Calamovilfa longifolia	Sand grass	25
Elymus canadensis	Canada wild rye	10
Festuca hallii	Plain rough fescue	5
Festuca saximontana	Rocky Mountain	10
Koeleria macrantha	June grass	5
Oryzopsis hymenoides	Indian Rice grass	25
Stipa spartea	Western porcupine grass	5

Three, 12 m long transects were placed in the plot area. Sampling points were marked at 4 m intervals along these transects and these 12 sampling points were used as permanent data collection points. In 2003 and 2004, the percent cover of individual plant species, total plant cover, litter cover, bare ground showing, and amount of biomass produced was recorded using a Daubenmire quadrant placed at each sampling point. We collected similar data from the remaining disturbed area seeded by Talisman Energy (Table 2) at a rate of 16 kg/ha.

In 2002, we seeded a plot at the Wainwright Army Base and collected data in 2003 and 2004. Depending on availability of seeds, we included the same species in the seed mix as in the Talisman seed mix, Ribstone Creek site. The only changes to the seed mix

were that Purple oat grass (*Schizachne purpurescens*) was dropped and White cinquefoil (*Potentilla arguta*) was added.

2.7 Data Analysis

The species performance in the reclamation seed mix were determined through species composition, percent cover, plant litter, bare ground showing and aboveground biomass using a Daubenmire quadrant. Analysis of variance of all data was conducted by averaging data yearly for each site then using the general linear models (GLM) procedure of the SAS statistical package (SAS 8.01, SAS Institute, Inc. 2000). Mean separation of treatments was accomplished using the Tukey's test.

2.8 Production of Breeder Seed

Breeder seed plots of Canada wild rye, awned wheatgrass, nodding brome, blue grama and Indian rice grass were created at Vegreville in 2003. These plots were established according to the guidelines set by the Canadian Seed growers Association (Canadian Seed Growers' Association, 1989). In 2004, CFIA (Canadian Food Inspection Agency) inspectors inspected the breeder seed plots. The plant lines will be named and registered with CSGA. The varieties will be released to seed companies for seed production and marketing. The named varieties will be sold as certified seed, a superior seed grade over common seed. This provides assurances regarding purity (freedom from weeds) and seed viability - important considerations for reclamation and revegetation success.

3. PROGRESS TO DATE

3.1 Seed Collection

From the early stages of the project, we collected many species (Appendix 1) found within the sandy soils of the Parkland Ecoregion. These collections allowed us to study population variation among the various collections of similar species and to provide the

project with sufficient seeds for various trials. Although all the seeds from these species were not used in this project, they were collected for other reasons.

Under climate change scenarios, Environment Canada predicts Canada to be among the nations that will experience the greatest temperature change. Environment Canada records shows air temperatures in the Prairie Provinces have warmed by approximately 1.2°C over the last 50 years (Environment Canada, 2002). Climate change scenarios show that the grasslands might move further north, resulting in increased desertification and loss of many plant species. By collecting the seeds and storing them in our native plant repository, we hope that in the future, should such climate change events occur, we will not have irreversibly lost many species that are indigenous to this landscape.

3.2 Plant Nurseries

In 2004, we maintained and harvested seeds from all plots in the plant nurseries. Table 4 shows the species in the nurseries in 2004.

3.3 Seed Increase Plots

In 2003, we established a number of forbs species and some additional grasses in small seeded plots (2 x 1 metre), depending on the amount of seeds available for each species.

In 2004, we hand harvested and cleaned the seeds. We now have sufficient seeds of various species for seeding larger size plots. Table 3 lists all species that were seeded into small plots.

Table 4. New nursery plots at Vegreville, in 2004

Forbs		Grasses and legumes	
Scientific name	**Common name**	**Scientific name**	**Common name**
			Drummond's milk
Campanula rotundifolia	Hare bell	*Astragalus drummondii*	vetch
Corydalis aurea	Golden corydalis	*Hedysarum sulphurescens*	Yellow sweetbroom
Fragaria virginiana	Wild strawberry	*Hierochloe odorata*	Sweet grass
Gaillardia aristata	Blanket flower	*Lathyrus ochroleucus*	Creamy peavine
Helianthus couplandii	Annual prairie	*Oryzopsis asperifolia*	White-grained
	sunflower		mountain rice grass
Helianthus subrhomboideus	Beautiful sunflower	*Vicia americana*	American vetch
Heuchera richardsonii	Alum root		
Linum lewissii	Wild Blue flax		
Linum rigidum	Yellow flax		
Oenothera biennis	Yellow Evening primose		
Oenothera nuttallii	White primrose		
	Lilac flowered		
Penstemon gracillis	beardstongue		
Penstemon procerus	Slender Beard's tongue		
Solidago missouriensis	Low goldenrod		
Solidago rigida	Stiff goldenrod		

Table 5. Seed production of small seeded plots (established in 2003) at Vegreville, in 2004

Scientific name	Common name	Seeds harvested (g)
Astragalus canadensis	Canadian milk vetch	666
Bouteloua gracilis	Blue grama	161
Carex sp	Sedge Collection 2	1.6
Carex sp.	Sedge Collection 6	51
Carex sp.	Sedge Collection 9	164
Cyperus schweintzii	Sand nut grass	7
Hierochloe odorata	Sweet grass	2
Sporobolus cryptandrus	Sand Dropseed	0
Stipa virdula	Green needle grass	48
Gaillardia aristata	Blanket flower	81
Linum lewsii	Wild blue flax	20
Mirabilis hirsuta	Hairy Umbrellawort	28
Potentilla arguta	White cinquefoil	290
Potentilla pennsylvanica	Pennsylvania cinquefoil	140
Ratibida columnifera	Prairie coneflower	230
Solidago rigida	Stiff goldenrod	123

3.4 Multilocation Performance Testing

Plots were maintained in 2004 and the seeds harvested. The plots were harvested and seeds were cleaned. At Ribstone Creek (representing reclamation conditions), we noticed considerable differences among the locally collected species and their check varieties (Table 6). The prairie awned wheatgrass differed in plant height, number of heads, and matured earlier compared to ARC Hillcrest ecotype (Table 6). The plants also differ in colour. ARC Hillcrest is an ecotype adapted to the foothills and mountain regions of Alberta, is bluish- green in colour and has an average height of 45 cm. When tested in the prairies ARC Hillcrest shows an average height of 64-71 cm. The prairie ecotype has an average height of 79-86 cm and is green coloured.

Table 6. Emergence, percent row covered, mean seed yield, number of heads, plant height, and 1000 seed weight for awned wheatgrass, blue grama, nodding brome, Canada wild rye, and Indian rice grass in the first year of seed production at Ribstone Creek, Alberta

Species	Line/Variety	Emergence plants per metre	Plant height (cm)	Number of heads/m	Days to harvest (as of April 15)	Seed yield (kg/ha)
Elymus canadensis	101-1	6a	107a	45a	148a	178.2a
	101-2	8a	104a	38a	148a	177.4a
	'North Dakota'	1b	-	-	-	-
Agropyron subsecundum	102-1	4a	79a	35a	118a	100.9a
	'AEC Hillcrest'	6a	71a	17b	141a	32.6a
Bromus anomalous	103-1	9a	66	33	118a	92.5a
	'Tannas'	1b	-	1	118a	0.1a
Oryzopsis hymenoides	104-1	2a	77a	3	128a	1.4a
	'Nezpar'	3a	87a	1	118a	0.4a
Bouteloua gracilis	105-1	3b	34	39a	148	7.1a
	105-2	4b	28	32.7a	148	2.3b
	105-3	7ab	16.3	35.7a	148	1.5b
	'Bad River'	12a	15	46.9a	148	0.7c

*Numbers with different letters are significantly different using Tukey's multiple range test of the SAS statistical package (SAS Institute Inc, 2002).

Among the blue grama collections, all native blue grama had similar head counts and maturity dates. The Bad River ecotype had better emergence, was 13 to 19 cm shorter, had similar maturity dates and produced more seed heads compared to the locally collected ecotypes.

The locally collected ecotypes of Canada wild rye have similar plant heights, seed heads and maturity, but differed considerably from the 'North Dakota' ecotype. 'North Dakota' Canada wild rye had poor emergence, which resulted in poor stand showing.

The native brome grass collection performed considerably better than the 'Tannas' brome grass collection (Table 6). The 'Tannas' brome grass collection had poor emergence, which resulted in poor plant performance. Nine plants per metre were recorded for ARC native brome grass line compared to none for Tannas brome grass. The seeds we received were three years old and we did not check for germination prior to planting, which resulted in poor seedling emergence.

Comparing 'Nezpar' to ARC line 104-1, we noticed that the locally collected ecotype was shorter in height, produced more seed heads and matured 10 days later than 'Nezpar' Indian rice grass.

The Vegreville site showed good stand vigor in 2004, but was abandoned due to contamination by other grasses. A new trial was seeded in 2004 and shows good seedling emergence.

The species seeded at Beaverlodge did well, with the exception of blue grama, which failed to mature before it snowed. This location was chosen as it is within a major seed production region.

Table 7. Emergence, plant vigor, mean seed yield, number of heads, plant height, and 1000 seed weight for awned wheatgrass, blue grama, nodding brome, Canada wild rye, and Indian rice grass in the first year of seed production at Beaverlodge, Alberta in 2004

Species	Line/Variety	Emergence plants per metre	Plant vigor	Plant height (cm)	Days to harvest (as of April 15)	Seed yield (kg/ha)
Elymus canadensis	101-1	12a*	5a	151a	127a	1330a
	101-2	9a	5a	151a	123a	1480a
	'North Dakota'	1b	1b	-	-	-
Agropyron subsecundum	102-1	31a	5a	121a	102a	447b
	'AEC Hillcrest'	26a	5a	101b	110a	693a
Bromus anomalous	103-1	24a	5a	96a	116a	1175a
	'Tannas'	1b	1b	-	-	0b
Oryzopsis hymenoides	104-1	43a	5a	72a	123a	681a
	'Nezpar'	35a	5a	80a	123a	523b
Bouteloua gracilis	105-1	3b	1.3b	.	32b	0
	105-2	3b	1.3b	.	25b	0
	105-3	11ab	2.0ab	.	36b	0
	'Bad River'	12a	2.3a	.	45a	0

*Numbers with different letters are significantly different using Tukey's multiple range test of the SAS statistical package (SAS Institute Inc, 2002).

At Beaverlodge (Table 7) date of maturity was most notable in the Canada wild rye as it matured noticeably earlier than the North Dakota variety. The adaptation of the experimental lines to northern Alberta conditions was remarkably better than 'North Dakota' wild rye, 'Tannas' brome grass, 'AEC Hillcrest', and 'Bad River' blue grama. These lines need a longer growing season to produce mature seeds.

3.3 Evaluating And Monitoring The Performance And Reclamation Success Of Native Seed Mixes Adapted To Sandy Soils

Of the 19 species seeded in 2002, 12 species emerged by August 2002. We also recorded three other native species and one weedy species. In 2002, an average total vegetative cover of 35.4% was recorded, of which 25.3% was from seeded species. In 2003, the total plant cover increased to 64% of which 31% was annual weeds such as Russian pigweed and stinkweed. Total plant cover of forbs in the ARC seed mix increased slightly in 2003. That increase is mostly due to forb recruitment from areas adjacent to the plot.

Figures 4 and 5 show species richness and percent cover by plant group from 2002 to 2004

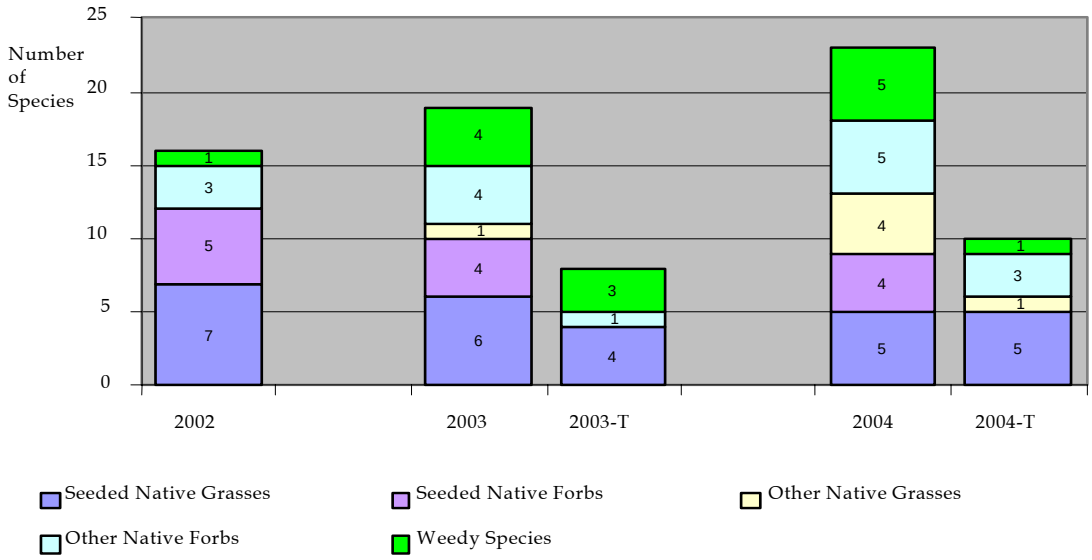

Figure 4. Species richness comparison between the ARC seed mix and the industry seed mix

In 2004, we saw a marginal recruitment of native grass and forb species. The ARC designed seed mix remains more diverse than the Talisman seed mix. Weed species in year 2 and 3 increased, but were not a concern as all of them were annual weeds such as Russian pigweed and stinkweed. By year 3 (2004) we still did not observe any problem

weed in the plots. Total number of weed species decreased in the Talisman seeded plot as they were outcompeted by the vigorous growth of the Canada wild rye.

Talisman Energy did not include any forb species in their seed mix, as the seeds were not commercially available. As a result the plot shows a less diverse plant community and may require a longer time to meet reclamation criteria.

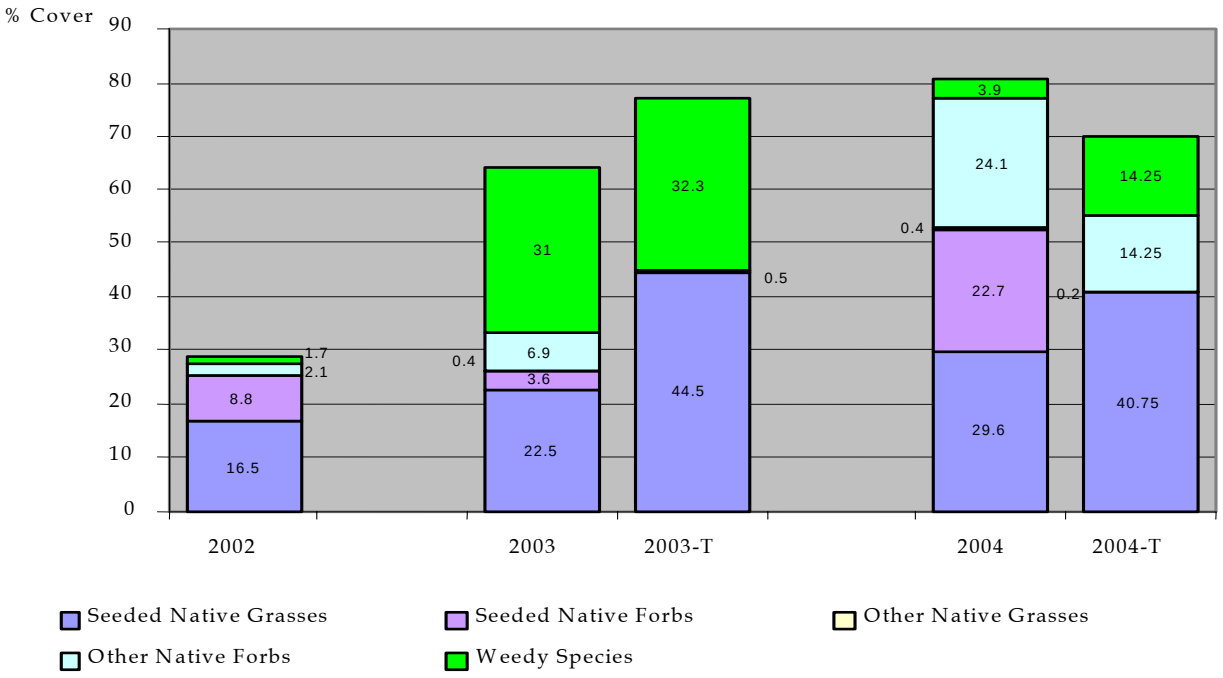

Figure 5. Percent plant cover by plant group in Ribstone Creek Ecological Reserve

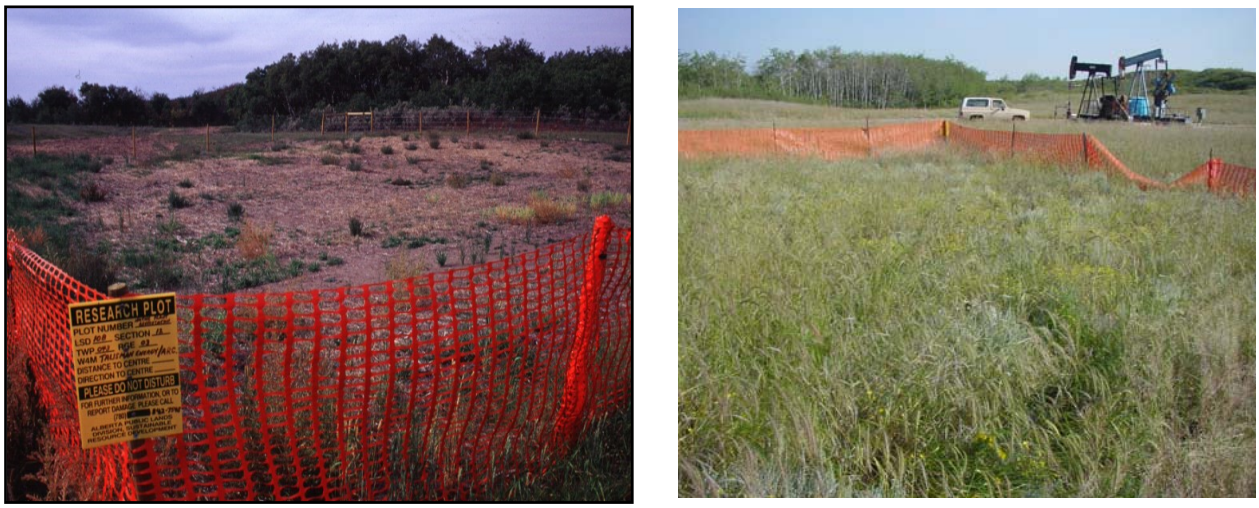

Figure 6. Performance of ARC seed mix on a wellsite disturbance in the Ribstone Creek Ecological Reserve in 2002 (year of seeding) and in 2004 (year 3)

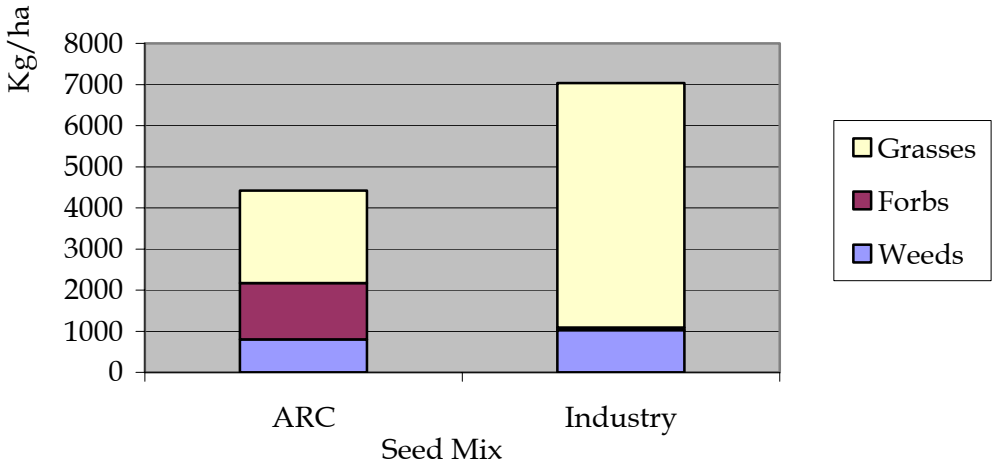

Figure 7. Dry matter production among the various plant groups at Ribstone Creek Ecological Reserve

The Talisman seed mix produced 59% more biomass, (7035 kg/ha) compared to the ARC seed mix (4421 kg/ha). This is mostly attributable to greater grass species in the seed mix whereas the ARC seed m ix contains more forbs and the forb species produced a lot less biomass. Forb biomass accounted for only 0.8% (57 kg/ha) in the Talisman Energy seed mix and 31% (1371 kg/ha) in the ARC seed mix. However in year 3, *Artemesia* species (pasture sagewort) and *Heterotheca villosa* (Hairy golden aster) were apparent in the disturbed area close to the fence line. They will serve as seed sources for further seed dispersal into the Talisman seeded area.

Figure 8. Recruitment of *Artemesia* species (pasture sagewort) and *Heterotheca villosa* (Hairy golden aster) in year 3 in the Talisman Energy seeded area

Table 8 and Figure 9 summarize the data collected in 2003 and 2004 at the Wainwright Army Training Centre (WATC). Twenty-five plant species were found in the quadrant within the seeded plot area, compared to only 11 species in the outside plot. Of the 20 species included in the seed mix, 9 were found growing in at least one of the sampling points. Average total cover was 47% within the plot area compared to 33% on the outside of the plot.

Table 8 shows the species found within the seeded area in July 2003 and the percentage of sampling points in which they were found. The only species found growing outside of the seeded area that was not found in the seeded area was *Fragaria virginiana* (wild strawberry). *Bromus inermis* (smooth brome) and *Artemisia frigida* (pasture sagewort) were the most prominent species outside of the seeded area.

Table 8. Species found and percentage of sampling points at which they were found in 2003

Species	Treatment	Percent of sampling points
Elymus canadensis	Seeded	92
Koeleria macrantha	Seeded	25
Festuca saximontana	Seeded	17
Oryzopsis hymenoides	Seeded	8
Festuca hallii	Seeded	8
Agropyron subsecundum	Naturally occurring	8
Agrostis scabra	Naturally occurring	8
Poa palustris	Naturally occurring	8
Poa sandbergii	Naturally occurring	8
Heterotheca villosa	Seeded	33
Potentilla arguta	Seeded	25
Achillea millefolium	Seeded	17
Gaillardia aristata	Seeded	8
Artemisia frigida	Naturally occurring	92

Artemisia campestris	Naturally occurring	58
Rosa woodsii	Naturally occurring	25
Chamaerhodos erecta	Naturally occurring	25
Unknown *Brassica*	Naturally occurring	17
Lactuca pulchella	Naturally occurring	8
Galium boreale	Naturally occurring	8
Androsace occidentalis	Naturally occurring	8
Campanula rotundifolia	Naturally occurring	8
Melilotus officinalis	Introduced	17
Bromus inermis	Introduced	8
Chenopodium alba	Introduced	8

Figure 8 shows the percent cover of seeded native species, naturally occurring native species, introduced weed species, and total cover by all species in the plot at WATC Wainwright for 2002, 2003 and 2004. We recorded data from the outside plot only in 2003; in 2004, cattle grazing in the area had eaten most of the vegetative cover. Year 2004 shows increased total species cover values compared to 2003 (56 % vs. 45%). The seed mixture did not appear to suppress the naturally occurring native species as we recorded a remarkable increase in the percent cover of indigenous forbs and grasses. Indigenous forb species increased from approximately 2% in 2002 to 28% in 2003 and to 37% in 2004 (Figure 8). Indigenous grasses increased from 4% in 2002 to 13% in 2003 and deceased to 8% by 2004.

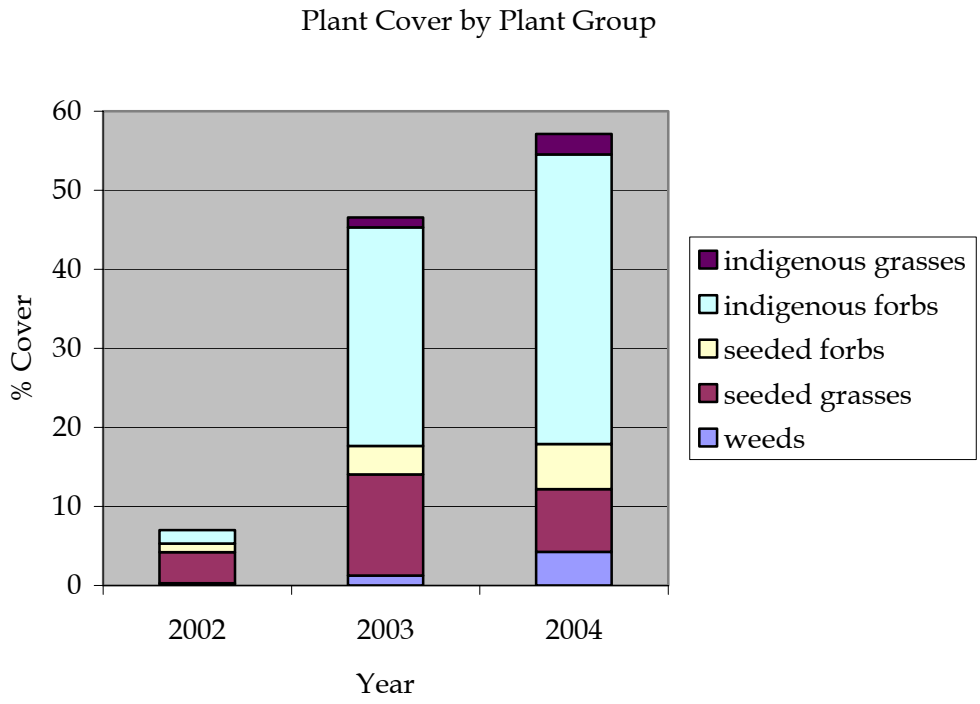

Figure 8. Percent cover of seeded native species on a disturbed site previously seeded to brome grass

Average litter cover was 11% in 2003 and 12% in 2004. Average bare ground showing decreased from 48% to 31% in2004. The bare ground showing had decreased almost in proportion to the amount of vegetative cover produced at this site. Litter cover is expected to increase over time.

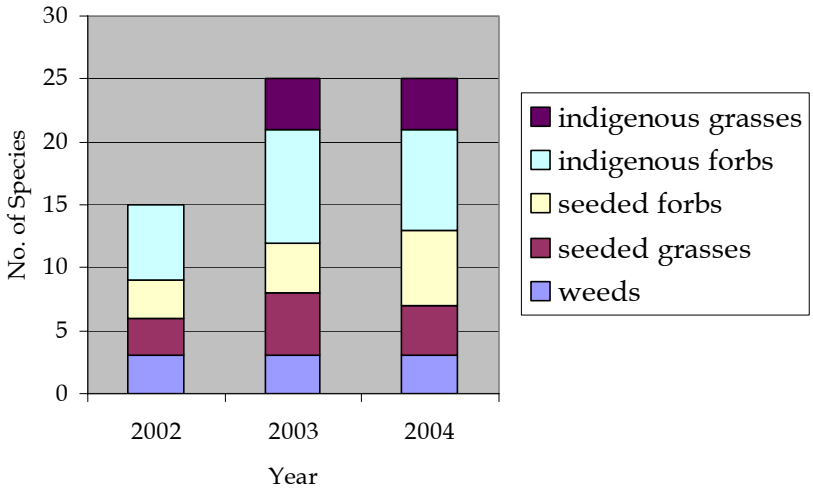

Figure 9. Species richness of a seeded site at the Wainwright Army Training Centre

Number of seeded grass species increased from three species to five species in 2003 (Figure 9) and decreased slightly to four species by year 3 (2004). Seeded forbs increased to 6 species by year 3 and indigenous forb species followed a similar trend. The remarkable event indicated by this graph is that we did not observe an increase in the amount of smooth brome grass occurring on this site.

3.4 Natural Recovery

The natural ability of the plant species to colonize disturbed areas, also known as natural recovery, has gained a great deal of attention lately. A narrow pipeline, 50 metres long by 4 metres wide was left to revegetate naturally. Flax straw was incorporated into the sandy soil to control erosion, increase stability of the soil, and improve water holding capacity and fertility of the soil.

In year 1, following construction of the pipeline, we found the site was dominated by *Artemesia frigida* and *Artemesia ludoviciana* (Figure 10). In year 2 and 3, the site was still dominated by these two *Artemesia* species. We also noticed several native species

naturally occurring on the site (Figure 11). These included *Fesctuca saximontana*, *Rosa woodsi*i, *Ratibita columnifera*, *Heterotheca villosa* and various *Carex* spp.

Figure 10. Natural Recovery Year 3 (2004), showing pipeline dominated by *Artemesia* spp.

Figure 11. Natural Recovery Year 3 (2004), showing several native species occurring naturally under the canopy of *Artemesia* spp**.**

3.4 Breeder Seed Plots

We established breeder seed plots of Canada wild rye, awned wheatgrass, blue grama, nodding brome and Indian rice grass at Vegreville. All plots passed inspection by the Canadian Food Inspection Agency. All seeds were cleaned. Indian rice grass and blue grama did not produce sufficient seeds to make it worth applying for a breeder seed certificate. This Indian rice grass took two years to establish and should produce a good seed crop in 2005. Blue grama plots showed good stand vigor but due to an early frost, the seed did not completely mature.

Table 9. Amount of breeder seeds obtained from breeder seed plot in 2004

Species	Amount of seeds (kg)
Elymus canadensis	30
Bromus anomalus	19
Agropyron subsecundum	23
Oryzopsis hymenoides	<0.5
Bouteloua gracilis	<0.5

4. DISCUSSION

The continued loss of native rangelands to industrial disturbances and the resulting reduction in biodiversity is cause for concern to land managers and industries. Revegetation criteria require a minimum of 80% plant cover for the site to be considered reclaimed. The goals of rapid plant establishment, biodiversity conservation and the need to reduce the impact of industry's footprint on native landscapes make land managers and industry view the lack of adapted indigenous species, specific seeding techniques and seed mixes as barriers to effectively create sustainable plant communities (Richards et al., 1998).

We want to ensure that disturbed lands are restored to a condition comparable to the ecosystem of the area. Some of the commercially available native sandy soils species may not be suitable to our climate and site conditions. Depending on the industry's

reclamation goal, locally adapted and proven plant materials can be used to restore varying degrees of plant community diversity. The ARC test lines show better emergence and earlier maturity compared to the check varieties with the exception of 'Nezpar' Indian rice grass and Bad River blue grama. These two species, which when grown under reclamation conditions at Ribstone Creek Ecological Reserve showed better emergence and have similar or earlier maturity dates compared to ARC plant lines. Using available commercial native species in reclamation projects may cost the industries more dollars due to the poorer establishment and later maturity of some of these varieties. Plant lines that fail to mature and produce viable seeds within the short growing season cannot contribute to the long-term sustainability of the plant community. Industries tend to use to a heavier seeding rate to attain an 80% or better plant cover. In this study we seeded our test plot at a seeding rate of approximately 10 kg/ha compared to 16 kg/ha used by Talisman Energy. Choosing appropriate plant materials to reclaim man-made disturbances can have important consequences such as short-term success versus long-term failures; the plants appear vigorous in the first few years and die back slowly. Furthermore, well-adapted plants in reclamation projects not only survive and reproduce under existing conditions, but they are more adapted to the rare and infrequent events such as drought or climate change.

Table 6 shows varying diversity for all plant characteristics recorded between the ARC lines and the check varieties. These varieties and plant lines differ for characteristics such as plant height, maturity dates, seed yield and leaf colour. For example, 'ARC Hillcrest', which is an ecotype originating from the foothills and mountain regions of Alberta, is bluish-green in colour and has an average height of 45 cm (Darroch & Acharya, 1996). When tested in the prairies 'ARC Hillcrest' shows an average height of 64 cm where as the prairie ecotype has an average height of 86 cm and is green coloured. Similarly, 'Bad River' blue grama is 19 cm shorter, produced nearly the same number of seed heads but significantly less amount of seed. Many land managers and industries recognize the importance of plant biodiversity in maintaining the functions of the ecosystems and therefore we should avoid the inadvertent introduction of non-indigenous ecotypes in regions where they are not suitable.

Our attempts to reconstruct rangeland disturbances in the sandy soils make use of early successional species. Our knowledge in terms of how many species are needed to make up a seed mix is limited and this subject is open to debate. Bush and Naeth (1996) suggested a minimum of 10 species while others (Dillard, unknown date) argued in favor of a minimum of four climax species only. Prodgers and Martin (1996) found that a diverse vegetation mix is unlikely to develop rapidly unless strategies to initiate diversity are incorporated in the reclamation planning. Such strategies include seedbed preparation, controlling soil erosion, enhancing the soil chemical and physical properties and improving the nutrient cycle. In this project, the addition of straw mulches may have provided a safe environment for the seeded materials in 2002, when Alberta experienced the worse drought on record.

In this project we used 19 species, including ten forbs to seed the disturbed site. The ARC seed mix continues to be more diverse and have more indigenous grasses and forbs. Consequently, in year 3, we recorded two forb species (pasture sagewort and hairy golden aster) occurring naturally in the Talisman seeded area. Both the ARC seed mix and the Talisman seed mix provide adequate biomass (4421 kg/ha and 7035 kg/ha respectively). These values compare favourably to those obtained from native rangelands with similar type of soils and environment. However, we expect these values to decrease with time as the plant community matures. Forage production data collected by Public Lands (Wainwright) under optimal range conditions at Amisk showed an average yield of 2500 kg/ha (H. Loonen, personal communications; 2005). Forb species alone contribute to 300 kg/ha compared to 57 kg/ha in the ARC seed mix.

At the WATC study area, we recorded 13 naturally occurring indigenous species (unseeded) in the seeded area. The seed mix did not seem to suppress the recruitment of native species. One remarkable event is that the seed mix seems to prevent brome grass from invading the seeded area. Whittaker (1970) suggested plant communities that have niche-differentiated species tend to complement each other rather than competing with each other. Also, Tilman (1996) and Smith (1996) stated that a plant rich community confers stability and resiliency against natural and artificial perturbations. Others will

argue that we need both species and functional diversity to build a sustainable ecosystem following disturbances (Van Voris et al., 1980). Hence we should continue to monitor these sites to determine if these theories hold under our environmental conditions and if the use of a diverse seed mix can prevent tame forages from invading the reclaimed area.

Reclamationists often argue that a site, if left alone, it could revegetate naturally from the soil seed bank and propagules that come onto the site from adjacent undisturbed areas. However, public opinion on natural recovery is mixed and our experiences show that site conditions, size of disturbance and location to nearby agricultural land may impede the natural ability of the plant species to colonize the disturbed area.

Structure of the native plant community should indicate if natural recovery is feasible. The presence of early successional species is acceptable, but they must be compatible with adjacent plant species and land use. In the natural recovery area, pasture sagewort dominated the plant community and one might argue that its presence contributes to decreased forage value of the plant community.

5. CONCLUSION

Choice of plant materials is important in balancing reclamation goals and biodiversity issues in a native plant community. We saw some marked differences among the test lines and their check varieties. In the absence of genetic data on these ecotypes, we should use these findings as a guideline to use native species indigenous to the area.

The reclamation seed mix containing locally collected ecotypes has initially provided a more diverse vegetative cover than the commercially purchased seed mix used on the surrounding area. Therefore, using appropriate seed mixes may help to attain the desired plant community at an accelerated rate. Of course the seed availability of these forbs and cost of the seeds may be an issue.

Amendments such as the use of straw mulches serve to reduce erosion, increase stability of the soil, provide safe niches and improve soil moisture and fertility characteristics of the soil. These factors facilitate the rapid establishment on the plant community. However straw mulches may also contaminate the previously undisturbed native rangeland with introduced weedy species, depending on the source of the straw.

The seeded area does not closely resemble the surrounding area, as the plants are much taller than the surrounding area. In 2005, we need to encourage cattle grazing to open up the plant canopy. This may facilitate further recruitment of indigenous species.

Natural recovery can work on small-scale disturbances, but it may takes a much longer time to reach the climax plant community.

Breeder seed plots of Canada wild rye, awned wheatgrass, nodding brome, blue grama and Indian rice grass are well underway and the release of new varieties of these ecotypes are expected in 2005.

We need to continue the monitoring of these sites to determine the effectiveness of these seed mixtures in creating sustainable plant communities and meeting the needs to conserve biodiversity.

6. INFORMATION TRANSFER

In 2004, we presented our research findings at the:

- 2004 Soils Issues Forum & Poster Session, PTAC Environment Forum: "Plant species selection for revegetation of sandy soils" at the Hyatt Regency, Calgary. March 23-24, 2004.
- Progress report to CAPP, December 31st, 2004.
- Native Plant Society of Saskatchewan, Inc.'s Workshop and Annual General Meeting. "Native plant research at the Alberta Research Council". February 3-5, 2005, Park Town Hotel, Saskatoon, Saskatchewan.
- 2005 Canadian Land Reclamation (Alberta Chapter) winter conference and AGM: "Revegetating oil & gas disturbance in the sandy soils of the Aspen Parkland Ecoregion". Radisson hotel, Calgary, AB. February 17-18, 2005.

7. BENEFITS

This project will provide seed growers and the reclamation industry with proven and reliable seed varieties for which no local seed source exists. This will facilitate changes in reclamation practices and increasing success in achieving long-term environmental and reclamation goals. It will help to create integrated solutions to meet biodiversity objectives and reduce the impact of industry's footprint on the public lands.
In developing locally adapted native plant varieties of the Parkland Ecoregion, the ARC's Native Plant Program increases the availability of native seed on the commercial market and the knowledge gained will provide support to land managers and industries to create sustainable plant communities following resource extraction activities such as oil and gas, livestock grazing and recreation.

This reduces the spread of unrestricted wild harvesting that can lead to degradation of the remaining natural habitats or the importation of undisclosed varieties that can lead to reduced diversity of the ecosystem and also in some cases the introduction of undesirable weeds. These plant ecotypes will support the re-establishment, maintenance

and productivity of native range ecosites and will ensure greater success in restoring the ecology of the landscape.

8. WORK PLAN

Work Plan (2005/06)

- Continue with plot maintenance and data collection from multilocation trial and seed mix evaluation trial.
- Harvest all plots and clean all seeds.
- Prepare variety releases of awned wheatgrass, nodding brome and Canada wild rye.
- Prepare breeder seed plots of Canada wild rye, awned wheatgrass, nodding brome and Indian rice grass for inspection by CFIA inspectors.
- Establish new breeder seed plots.
- Release of three ecotypes, possibly Canada wild rye, awned wheatgrass and Canada milk vetch.
- Harvest seed increase plots of sedge species and other forb species.
- Analyze data and prepare report; and
- Provide seminars to client departments or at CLRA conference.
- Prepare progress report.

2006/07

- Continue with plot maintenance and data collection.
- Maintain all plots, harvest plots and clean seeds.
- Analyze data.
- Prepare variety releases of Indian rice grass, blue grama, green needle grass.
- Consult with clients and evaluate the need for continued work on the forbs and other grass and sedge species.
- Prepare a final report, which will provide us with a six-year look at the performance of these species in reclamation trials.

- Prepare variety description of the released varieties for publication in the Canadian Journal of Plant Science.

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10. APPENDICIES

APPENDIX 1

Seed of native species (grasses, forbs and legumes) collected from the sandy uplands of the Parkland Ecoregion of Alberta, in 2001 and 2002.

Scientific Name	Common Name	No.	Site	Available Seed (g)
Grasses				
Agropyron dasystachyum	Northern wheatgrass	Coll:1WWAB99PP	Wainwright	63.44
Agropyron dasystachyum	Northern wheatgrass	Coll:2WWAB99PP	Wainwright	78.66
Agropyron smithii	Western wheatgrass	Coll:1WWAB99PP	Wainwright	19.4
Agropyron smithii	Western wheatgrass	Coll:2WWAB99PP	Wainwright	44.91
Agropyron spicatum	Bluebunch wheatgrass	Coll:1WWAB01PP	Kamloops	0.2
Agropyron subsecundum	Awned wheatgrass	Coll:1WWAB97PP	Wainwright	1.3
Agropyron subsecundum	Awned wheatgrass	Coll:2WWAB98PP	Wainwright	.
Agropyron subsecundum	Awned wheatgrass	Coll:3WWAB99PP	Wainwright	13.8
Agropyron subsecundum	Awned wheatgrass	Coll:4WWAB99PP	Wainwright	1.54
Agropyron subsecundum	Awned wheatgrass	Coll:5WWAB99PP	Wainwright	16.06
Agropyron subsecundum	Awned wheatgrass	Coll:6WWAB99PP	Wainwright	6.21
Agropyron subsecundum	Awned wheatgrass	Coll:7WWAB99PP	Wainwright	15.31
Agropyron subsecundum	Awned wheatgrass	Coll:8BFAB99NP	Brownfield	56.68
Agropyron subsecundum	Awned wheatgrass	Coll:9WWAB00PP	Wainwright	29.93
Agropyron subsecundum	Awned wheatgrass	Coll:10WWAB00PP	Wainwright	11.01
Agropyron subsecundum	Awned wheatgrass	Coll:11WWAB00PP	Wainwright	53.67
Agropyron subsucumdum	Awned wheatgrass	Coll:12WWAB01PP	Irma	13.62
Agropyron trachycaulum	Slender wheatgrass	Coll:1WWAB98PP	Wainwright	.
Agrostis scabra	Rough hair grass	Coll:1WWAB00PP	Wainwright	8.27
Agrostis spp.	Bent grass	Coll:1WWAB00PP	Wainwright	17.21
Agrostis stolenfera	Red top	Coll:1WWAB01PP	Irna	33.93
Beckmannia syzigachne	Slough grass	Coll:1WWAB00PP	Wainwright	166.58
Bouteloua gracilis	Blue grama	Coll:1SK98DW	SK(DWviaDean)	17.17
Bouteloua gracilis	Blue grama	Coll:2WWAB98PP	Wainwright	2.69
Bouteloua gracilis	Blue grama	Coll:3NHAB98NP	Neutral Hills	2.82
Bouteloua gracilis	Blue grama	Coll:4WWAB99PP	Wainwright	4.51
Bouteloua gracilis	Blue grama	Coll:5WWAB00PP	Wainwright	2.46
Bouteloua gracilis	Blue grama	Coll:6WWAB00PP	Wainwright	1
Bouteloua gracilis	Blue grama	Coll:7WWAB00PP	Wainwright	0.83
Bouteloua gracilis	Blue grama	Coll:8WWAB00PP	Wainwright	7.16
Bouteloua gracilis	Blue grama	Coll:9WWAB00PP	Wainwright	6.83
Bouteloua gracilis	Blue grama	Coll:10WWAB01PP	Irma	7.22
Bromus anomalus	Nodding brome	Coll:1NHAB97NP	Neutral Hills	32.75
Bromus anomalus	Nodding brome	Coll:2AB96TANNIS	Tannas Rangeland	100
Bromus anomalus	Nodding brome	Coll:3WWAB97PP	Battle River ridge	.
Bromus anomalus	Nodding brome	Coll:4WWAB99PP	Wainwright	30.57

Bromus anomalus	Nodding brome	Coll:5WWAB99PP	Wainwright	19.84
Bromus anomalus	Nodding brome	Coll:6WWAB99PP	Wainwright	36.23
Bromus anomalus	Nodding brome	Coll:7WWAB00PP	Wainwright	4.31
Bromus anomalus	Nodding brome	Coll:8WWAB01PP	Riverdale	41.6
Bromus anomalus	Nodding brome	Coll:9WWAB01PP	Irma	38.02
Bromus anomalus	Nodding brome	Coll:10WWAB00NP	WWB, Coyote Hill	12.82
Bromus carinatus	Mountain brome	Coll:1AB96TANNIS	Tannas Rangeland	55.4
Bromus carinatus	Mountain brome	Coll:2WNP400PKS	Wateton/Parks	0.21
Bromus carinatus	Mountain brome	Coll:3WNP500PKS	Wateton/Parks	1.74
Bromus ciliatus	Fringed brome	Coll:1AB96TANNIS	Tannas Rangeland	18.28
Bromus ciliatus	Fringed brome	Coll:2PC200PKS	Pincher Creek/Parks	.
Bromus ciliatus	Fringed brome	Coll:3WWAB00PP	Wainwright	49.56
Bromus ciliatus	Fringed brome	Coll:4WWAB01PP	Irma	111.97
Bromus ciliatus	Fringed brome	Coll:5WWAB01PP	Irma	87.22
Bromus ciliatus	Fringed Brome	Coll:6WWAB02PP	Morecrambe	0.88
Bromus spp.	Brome	Coll:2PC200PKS	Lee Lake	2.33
Calamagrostis canadensis	Marsh reed grass	Coll:1WWAB00PP	Wainwright	2.57
Calamagrostis inexpansa	Northern reed grass	Coll:1WWAB99PP	Wainwright	7.4
Calamagrostis inexpansa	Northern reed grass	Coll:2WWAB00PP	Wainwright	1.5
Calamagrostis inexpansa	Northern reed grass	Coll:3WWAB01PP	Innifree	0.36
Calamagrostis rubescens	Pine reed grass	Coll:1WWAB01PP	Kamloops	0.62
Calamagrostis spp.	Reed grass	Coll:1LUS100PKS	Luscar/Parks	2.4
Calamovilfa longfolia	Sand grass	Coll:1WWAB97PP	Wainwright	7.9
Calamovilfa longfolia	Sand grass	Coll:2WWAB98PP	Wainwright	2.7
Calamovilfa longfolia	Sand grass	Coll:3WWAB99PP	Wainwright	8.4
Calamovilfa longfolia	Sand grass	Coll:4WWAB00PP	Wainwright	11.59
Calamovilfa longfolia	Sand grass	Coll:5WWAB00PP	Wainwright	36.9
Calamovilfa longfolia	Sand grass	Coll:6WWAB00PP	Wainwright	22.5
Calamovilfa longfolia	Sand grass	Coll:7WWAB00PP	Wainwright	14.7
Calamovilfa longifolia	Sand grass	Coll:8WWAB00PP	Wainwright	23.5
Calamovilfa longifolia	Sand grass	Coll:9WWAB00PP	Wainwright	22.1
Calamovilfa longfolia	Sand grass	Coll:10WWAB00PP	Wainwright	13.38
Calamovilfa longfolia	Sand grass	Coll:11WWAB00NP	Wainwright Native plant	7.56
Calamovilfa longifolia	Sand grass	Coll:12WWAB00NP	Wainwright Native plant	14.85
Calamovilfa longifolia	Sand grass	Coll:13WWAB00NP	Wainwright Native plant	4.35
Calamovilfa longfolia	Sand grass	Coll:14WWAB00NP	Wainwright Native plant	14.9
Calamovilfa longifolia	Sand grass	Coll:15WWAB01PP	Edgerton	1.77
Calamovilfa longifolia	Sand grass	Coll:16WWAB01PP	Irma	8.9
Calamovilfa longifolia	Sand grass	Coll:17WWAB01PP	Wainwright	16.66
Calamovilfa longifolia	Sand grass	Coll:18WWAB02PP	Bodo	43.39
Calamovilfa longifolia	Sand grass	Coll:19WWAB02PP	Gilt Edge	10.8
Calamovilfa longifolia	Sand grass	Coll:20WWAB02PP	Edgerton	4.79
Calamovilfa longifolia	Sand grass	Coll:21WWAB02PP	Sounding Lake	7.35
Calamovilfa longifolia	Sand grass	Coll:22WWAB02PP	Edgerton	4.9

Carex obtusata	Blunt sedge	Coll:1WWAB00PP	Wainwright	5.28
Carex obtusata	Blunt sedge	Coll:2WWAB00PP	Wainwright	4.38
Carex obtusata	Blunt sedge	Coll:3WWAB00PP	Wainwright	3.66
Carex obtusata	Blunt sedge	Coll:4WWAB00PP	Wainwright	7.5
Carex obtusata	Blunt sedge	Coll:5WWAB01PP	Wallaby Lake	10.77
Carex pensylvanica	Sun loving sedge	Coll:1WWAB00PP	Wainwright	27.56
Carex siccuta	Hay sedge	Coll:1WWAB01PP	Irma	0.85
Carex spp.	Sedge	Coll:1WWAB99PP	Wainwright	11.15
Carex spp.	Sedge	Coll:2WWAB99PP	Wainwright	100.26
Carex spp.	Sedge	Coll:3WWAB99PP	Wainwright	16.11
Carex spp.	Sedge	Coll:4WWAB99PP	Wainwright	NIL
Carex spp.	Sedge	Coll:5WWAB99PP	Wainwright	2.55
Carex spp.	Sedge	Coll:6WWAB99PP	Wainwright	1.9
Carex spp.	Sedge	Coll:7WWAB99PP	Wainwright	5.58
Carex spp.	Sedge S1	Coll:8WWAB99PP	Wainwright	0.29
Carex spp.	Sedge S2	Coll:9WWAB99PP	Wainwright	0.42
Carex spp.	Sedge S3	Coll:10WWAB99PP	Wainwright	12.16
Carex spp.	Sedge	Coll:11WWAB00PP	Bodo	4.96
Carex spp.	Sedge	Coll:12WWAB00PP	Bruce	2.4
Carex spp.	Sedge	Coll:13WWAB00PP	Bodo	7.75
Carex spp.	Sedge	Coll:14WWAB00PP	Bruce	0.42
Carex spp.	Sedge	Coll:15CRD100PKS	Cardinal River Divide	0.28
Carex sp.	Sedge	Coll:16LUS100pks	Luscar	2.82
Carex spp.	Sedge	Coll:17WWAB01PP	Metiskow	0.89
Carex spp.	Sedge	Coll:18WWAB01PP	Heinsburg	1.48
Carex spp.	Sedge	Coll:19WWAB01PP	Irma	2.95
Carex spp.	Sedge	Coll:20WWAB01PP	Edgerton	0.09
Carex spp.	Sedge	Coll:21WWAB01PP	Edgerton	1.66
Carex spp.	Sedge	Coll:22WWAB01PP	Riverdale	29.71
Carex spp.	Sedge	Coll:23WWAB01PP	Paradise Vallley	9.48
Carex spp.	Sedge	Coll:24WWAB01PP	Paradise Vallley	88.35
Carex spp.	Sedge	Coll:25WWAB01PP	Czar	2.99
Carex spp.	Sedge	Coll:26WWAB00NP	Cadogan	2.51
Carex sprengellii	Sprengel's sedge	Coll:1WWAB01PP	Edgerton	4.87
Carex stenophylla	Low sedge	Coll:1WWAB01PP	Metiskow	0.2
Cyperus schweinitzii	Sand nut grass	Coll:1WWAB97PP	Wainwright	2.66
Cyperus schweinitzii	Sand nut grass	Coll:2WWAB98PP	Wainwright	3.97
Cyperus schweintzii	Sand nut grass	Coll:3WWAB99PP	Wainwright	3.15
Cyperus schweintzii	Sand nut grass	Coll:4WWAB00PP	Wainwright	3.01
Cyperus schweintzii	Sand nut grass	Coll:5WWAB00PP	Wainwright	3.67
Cyperus schweintzii	Sand nut grass	Coll:6WWAB00PP	Wainwright	1.58
Cyperus schweintzii	Sand nut grass	Coll:7WWAB00PP	Wainwright	1.95
Cyperus schweintzii	Sand nut grass	Coll:8WWAB01PP	Wainwright	2.33
Cyperus schwienitzii	Sand nut grass	Coll:9WWAB02PP	Cadogan	15.03

Danthonia intermedia	Timber oat grass	Coll:1WWAB99PP	Wainwright	6.93
Danthonia intermedia	Timber oat grass	Coll:2WWAB00PP	Wainwright	3.53
Danthonia intermedia	Timber oat grass	Coll:3WWAB00PP	Wainwright	1.9
Danthonia intermedia	Timber oat grass	Coll:4WWAB00PP	Wainwright	0.65
Danthonia spicata	Poverty oat grass	Coll:1WWAB01PP	Tolland	0.52
Danthonia spicata	Poverty oat grass	Coll:2WWAB01PP	Wildmere	20.32
Danthonia sp.	Oat grass	Coll:1WNP300PKS	Waterton+E163	.
Deschampsia caespitosa	Tufted hair grass	Coll:1VEGAB98NP	Vegreville	25.85
Deschampsia caespitosa	Tufted hair grass	Coll:2WWAB00PP	Wainwright	3.24
Deschampsia caespitosa	Tufted hair grass	Coll:3WWAB00PP	Wainwright	0.74
Deschampsia caespitosa	Tufted hair grass	Coll:4WWAB00PP	Wainwright	10.56
Distichlis stricta	Sat grass	Coll:1WWAB00PP	Wainwright	5.34
Distichlis stricta	Sat grass	Coll:2WWAB00PP	Wainwright	1.17
Distichlis stricta	Sat grass	Coll:3S1salt00NP	Poplar Lake Ranch	0.39
Distichlis stricta	Sat grass	Coll:4S2salt00NP	Birch Lake	0.39
Distichlis stricta	Sat grass	Coll:5S3salt00NP	Hansman Lake	2.07
Elymus canadensis	Canada wild rye	Coll:1SK96DNern	Saskatchewan	.
Elymus canadensis	Canada wild rye	Coll:2WWAB97PP	Battle River ridge	4.9
Elymus canadensis	Canada wild rye	Coll:3WWAB00PP	Wainwright	2.35
Elymus canadensis	Canada wild rye	Coll:4WWAB00PP	Wainwright	3.55
Elymus canadensis	Canada wild rye	Coll:5WWAB00PP	Wainwright	0.8
Elymus canadensis	Canada wild rye	Coll:6WWAB01PP	Irma	37.83
Elymus innovatus	Hairy wild rye	Coll:1WWAB00PP	Wainwright	.
Elymus innovatus	Hairy wild rye	Coll:2WWAB00PP	Wainwright	2.92
Elymus innovatus	Hairy wild rye	Coll:3WWAB00PP	Wainwright	.
Elymus innovatus	Hairy wild rye	Coll:4JNP100PKS	Jasper/Parks	0.4
Elymus innovatus	Hairy wild rye	Coll:5WWAB01PP	Whitlaw nr Fairview	29.78
Elymus innovatus	Hairy wild rye	Coll:6FtMc302NP	Ft. McMurray	9.67
Eriophorum polystachion	Tall cotton grass	Coll:1WWAB00PP	Wainwright	0.63
Eriophorum spp.	Cotton grass	Coll:1WWAB02PP	WW Camp	0.34
Eriophorum spp.	Cotton grass	Coll:2WWAB00PP		0.75
Festuca altaica	Northern rough fescue	Coll:1Yukon93Decora	Whitehorse YK	9.77
Festuca campestris	Foothills rough fescue	Coll:1LethAB97JW-PL	Lethbridge	117.17
Festuca campestris	Foothills rough fescue	Coll:2LethAB94Enviro	Luscar	175.01
Festuca hallii	Plains rough fescue	Coll:1:94-96VEGAB	Vegreville AB	189.26
Festuca hallii	Plains rough fescue	Coll:2HHAB96Enviro	Hand Hills	.
Festuca hallii	Plains rough fescue	Coll:3WWAB97PP	Wainwright	24.06
Festuca hallii	Plains rough fescue	Coll:4WWAB98PP	Wainwright	.
Festuca hallii	Plains rough fescue	Coll:5WWAB00PP	Wainwright	363
Festuca hallii	Plains rough fescue	Coll:6WWAB00PP	Wainwright	225.32
Festuca hallii	Plains rough fescue	Coll:7WWAB00PP	Wainwright	23.81
Festuca hallii	Plains rough fescue	Coll:8WWAB00PP	Wainwright	5.23
Festuca hallii	Plains rough fescue	Coll:9WWAB00PP	Wainwright	14.84
Festuca hallii	Plains rough fescue	Coll:10WWAB00PP	Wainwright	15.67

Festuca hallii	Plains rough fescue	Coll:11WWAB00PP	Wainwright	39.84
Festuca hallii	Plains rough fescue	Coll:12WWAB00PP	Wainwright	62.54
Festuca hallii	Plains rough fescue	Coll:13WWAB01PP	Wainwright	88.24
Festuca hallii	Plains rough fescue	Coll:14WWAB01PP	Wainwright	11
Festuca hallii	Plains rough fescue	Coll:15WWAB01PP	N. Bruce	23.02
Festuca hallii	Plains rough fescue	Coll:16WWAB00NP	Hand Hills	10.46
Festuca hallii	Plains rough fescue	Coll:17WWAB00NP	WWB, Betty Lake	9.13
Festuca idahoensis	Idaho fescue	Coll:1line658	Rocky Mountains AB	99.22
Festuca idahoensis	Idaho fescue	Coll:2line73	Rocky Mountains AB	95.44
Festuca idahoensis	Idaho fescue	Coll:3line75	Rocky Mountains AB	128.62
Festuca octoflora	Six week fescue	Coll:1WWAB00PP	Wainwright	2.85
Festuca octoflora	Six week fescue	Coll:2WWAB00PP	Wainwright	1.77
Festuca octoflora	Six week fescue	Coll:3WWAB00PP	Wainwright	2.08
Festuca octoflora	Six week fescue	Coll:4WWAB00PP	Wainwright	0.65
Festuca octoflora	Six week fescue	Coll:5WWAB01PP	Irma	2.82
Festuca ovina	Sheep fescue	Coll:1WWAB01PP	Hardisty	15.34
Festuca ovina	Sheep fescue	Coll:2WWAB02PP	WW Dunes Eco	1.2
Festuca saximontana	Rocky Mt. fescue	Coll:1WWAB99PP	Wainwright	11.28
Festuca saximontana	Rocky Mt. fescue	Coll:2WWAB00PP	Wainwright	14.09
Festuca saximontana	Rocky Mt. fescue	Coll:3WWAB00PP	Wainwright	44.2
Festuca saximontana	Rocky Mt. fescue	Coll:4WWAB00PP	Wainwright	40.07
Festuca saximontana	Rocky Mt. fescue	Coll:5WWAB00PP	Wainwright	38.53
Festuca saximontana	Rocky Mt. fescue	Coll:6WWAB00PP	Wainwright	93.11
Festuca saximontana	Rocky Mt. fescue	Coll:7WWAB00PP	Wainwright	10.44
Glyceria grandis	Tall manna grass	Coll:1WWAB00PP	Czar	95.45
Glyceria grandis	Tall manna grass	Coll:2WWAB00PP	Torlea/Viking	105.41
Glyceria grandis	Tall manna grass	Coll:3WWAB01PP	Irma	214
Glyceria grandis	Tall manna grass	Coll:4WWAB02PP	Rosedale	5
Helictotrichon hookeri	Hookers' oat grass	Coll:1WWAB97PP	Wainwright	2.5
Helictotrichon hookeri	Hookers' oat grass	Coll:2WWAB99PP	Wainwright	1.78
Helictotrichon hookeri	Hookers' oat grass	Coll:3WWAB00PP	Wainwright	20.54
Helictotrichon hookeri	Hookers' oat grass	Coll:4WWAB00PP	Wainwright	3.7
Helictotrichon hookeri	Hookers' oat grass	Coll:5WWAB01PP	Tolland	3.7
Helictotrichon hookeri	Hookers' oat grass	Coll:6WWAB01PP	Riverdale	0.32
Helictotrichon hookeri	Hookers' oat grass	Coll:7WWAB00NP	Hand Hills	1.96
Helictotrichon hookeri	Hookers' oat grass	Coll:8WWAB00NP	WWB, Betty Lake	0.24
Hierochloe odorata	Sweetgrass	Coll:1VEGAB98NP	Veg (DU)	8.32
Hierochloe odorata	Sweetgrass	Coll:2WWAB97PP	Wainwright	2.29
Hierochloe odorata	Sweetgrass	Coll:3WWAB99PP	Wainwright	14.39
Hierochloe odorata	Sweetgrass	Coll:4WWAB00PP	Wainwright	13.56
Hierochloe odorata	Sweetgrass	Coll:5WWAB00PP	Wainwright	37.45
Hierochloe odorata	Sweetgrass	Coll:6WWAB00PP	Wainwright	13.25
Hierochloe odorata	Sweetgrass	Coll:7WWAB00PP	Wainwright	5.98
Hierochloe odorata	Sweetgrass	Coll:8WWAB00PP	Wainwright	2.55

Hierochloe odorata	Sweetgrass	Coll:9WWAB00PP	Wainwright	14.22
Hierochloe odorata	Sweetgrass	Coll:10WWAB00PP	Wainwright	11.24
Hierochloe odorata	Sweetgrass	Coll:11WWAB00PP	Wainwright	13.16
Hierochloe odorata	Sweetgrass	Coll:12WWAB00PP	Wainwright	10.8
Hierochloe odorata	Sweetgrass	Coll:13WWAB01PP	Edgerton	4.66
Hierochloe odorata	Sweetgrass	Coll:14WWAB01PP	Wainwright	1.83
Hierochloe odorata	Sweetgrass	Coll:15WWAB01PP	David Lake	1.46
Hierochloe odorata	Sweetgrass	Coll:16WWAB01PP	Metiskow	0.33
Hierochloe odorata	Sweetgrass	Coll:17WWAB01PP	CFBWainwright	.
Hierochloe odorata	Sweetgrass	Coll:18WWAB02PP	WW Dunes Eco	0.33
Hierochloe odorata	Sweetgrass	Coll:19WWAB02PP	Neilburg, SK	0.34
Hierochloe odorata	Sweetgrass	Coll:20WWAB02PP	Wainwright	0.12
Hierochloe odorata	Sweetgrass	Coll:21WWAB02PP	Wainwright	1.03
Juncus balticus	Baltic rush	Coll:1WWAB99PP	Wainwright	2.66
Juncus balticus	Baltic rush	Coll:2WWAB00PP	Wainwright	0.09
Juncus balticus	Baltic rush	Coll:3WWAB00PP	Wainwright	0.1
Juncus balticus	Baltic rush	Coll:4WWAB01PP	Innisfree	0.02
Juncus longistylis	Long styled rush	Coll:1WWAB00PP	Wainwright	.
Juncus spp.	Rush	Coll:2WWAB00PP	Wainwright	4.77
Juncus spp.	Rush	Coll:3WWAB01PP	Innisfree	0.53
Juncus spp.	Rush	Coll:4WWAB02PP	Chauvin	29.43
Juncus spp.	Rush	Coll:5WWAB02PP	Metiskow	32.74
Juncus spp.	Rush	Coll:6WWAB01PP	Wainwright	1.18
Koeleria macrantha	June grass	Coll:1:SAAB99DW)	D.Waker	50.12
Koeleria macrantha	June grass	Coll:2WWAB00PP	Wainwright	24.13
Koeleria macrantha	June grass	Coll:3WWAB00PP	Wainwright	14.31
Koleria macrantha	June grass	Coll:4WWAB02PP	Cadogan	0.85
Luzula spp.	Wood rush	Coll:1WWAB00PP	Lindburgh	0.07
Muhlenbergia cuspidata	Prairie muhly	Coll:1WWAB00PP	Wainwright	5.56
Muhlenbergia cuspidata	Mat muhly	Coll:2WWAB02PP	Paradise Valley	12.22
Muhlenbergia richardsonis	Mat muhly	Coll:1WWAB98PP	Wainwright	0.62
Muhlenbergia richardsonis	Mat muhly	Coll:2WWAB99PP	Wainwright	18.48
Muhlengergia richardsonis	Mat muhly	Coll:3WWAB00PP	Wainwright	6.93
Muhlenbergia richardsonis	Mat muhly	Coll:4WWAB01PP	Irma	1.1
Oryzopsis asperfolia	White grained mt. rice grass	Coll:1WWAB99PP	Wainwright	2.37
Oryzopsis asperifolia	White grained mt. rice grass	Coll:2WWAB00PP	Wainwright	1.95
Oryzopsis asperfolia	White grained mt. rice grass	Coll:3WWAB01PP	Edgerton	16.4
Oryzopsis asperfolia	White grained mt. rice grass	Coll:4WWAB01PP	David Lake	36.8
Oryzopsis asperfolia	White grained mt. rice grass	Coll:5WWAB01PP	Metiskow	42.26
Oryzopsis asperifolia	White grained mt. rice grass	Coll:6WWAB02PP	Paradise Hill, SK	2.12
Oryzopsis asperifolia	White grained mt. rice grass	Coll:7WWAB02PP	Edgerton (Chauvin)	56.62
Oryzopsis asperifolia	White grained mt. rice grass	Coll:8WWAB02PP	Metiskow	25.83
Oryzopsis asperifolia	White grained mt. rice grass	Coll:9WWAB02PP	David Lake (Dunes.)	3.18
Oryzopsis asperifolia	White grained mt. rice grass	Coll:10WWAB00NP	Cadogan	0.37

Oryzopsis canadensis	Canadian rice grass	Coll:1WWAB00PP	Wainwright	10.47
Oryzopsis hymenoides	Indian rice grass	Coll:1WWAB97PP	Wainwright	2
Oryzopsis hymenoides	Indian rice grass	Coll:2WWAB98PP	Wainwright	0.03
Oryzopsis hymenoides	Indian rice grass	Coll:3WWAB99PP	Wainwright	7.69
Oryzopsis hymenoides	Indian rice grass	Coll:4WWAB99PP	Wainwright	8.07
Oryzopsis hymenoides	Indian rice grass	Coll:5WWAB99PP	Wainwright	1.56
Oryzopsis hymenoides	Indian rice grass	Coll:6WWAB99PP	Wainwright	1.82
Oryzopsis hymenoides	Indian rice grass	Coll:7WWAB99PP	Wainwright	2.59
Oryzopsis hymenoides	Indian rice grass	Coll:8WWAB00PP	Wainwright	5.77
Oryzopsis hymenoides	Indian rice grass	Coll:9WWAB00PP	Wainwright	17.03
Oryzopsis hymenoides	Indian rice grass	Coll:10WWAB00PP	Wainwright	3.75
Oryzopsis hymenoides	Indian rice grass	Coll:11WWAB00PP	Wainwright	5.09
Oryzopsis hymenoides	Indian rice grass	Coll:12WWAB01PP	Heath	0.94
Oryzopsis hymenoides	Indian rice grass	Coll:13WWAB01PP	Wainwright	0.77
Oryzopsis hymenoides	Indian rice grass	Coll:14WWAB01PP	Ribstone	0.38
Oryzopsis hymenoides	Indian rice grass	Coll:15WWAB01PP	David Lake	2.5
Oryzopsis hymenoides	Indian rice grass	Coll:16WWAB01PP	Irma	3.76
Oryzopsis hymenoides	Indian rice grass	Coll:17WWAB02PP	Wainwright	5.65
Oryzopsis hymenoides	Indian rice grass	Coll:18WWAB02PP	Chauvin	4.81
Oryzopsis hymenoides	Indian rice grass	Coll:19WWAB02PP	WW Camp	8.97
Oryzopsis hymenoides	Indian rice grass	Coll:20WWAB02PP	Cadogan	4.06
Oryzopsis hymenoides	Indian rice grass	Coll:21WWAB02PP	Edgerton	7.82
Oryzopsis hymenoides	Indian rice grass	Coll:22WWAB02PP	Wainwright	2.63
Oryzopsis hymenoides	Indian rice grass	Coll:23WWAB01PP	Irma	0.6
Oryzopsis micrantha	Little seed rice grass	Coll:1WWAB01PP	David Lake	13.53
Oryzopsis micrantha	Little seed rice grass	Coll:2WWAB01PP	WWDunes Eco Reserve	4.89
Oryzopsis micrantha	Little seed rice grass	Coll:3WWAB01PP	Metiskow	11.29
Oryzopsis pungens	Northern rice grass	Coll:1WWAB99PP	Wainwright	3.96
Oryzopsis pungens	Northern rice grass	Coll:2WWAB01PP	Heinsburg	9.12
Oryzopsis pungens	Northern rice grass	Coll:3WWAB02PP	WW Dunes Eco	0.89
Oryzopsis pungens	Northern rice grass	Coll:4WWAB02PP	Metiskow	3.37
Panicum wilcoxianum	Sand millet	Coll:1WWAB01PP	Cadogan	0.03
Phleum alpinum	Alpine timothy	Coll:1:98VEGAB	Vegreville AB	3.56
Phragmites communis	Giant reed grass	Coll:1WWAB00PP	Viking	0.46
Phragmites communis	Giant reed grass	Coll:2WWAB01PP	Wainwright	0.14
Phragmites communis	Giant reed grass	Coll:3WWAB01PP	Cadogan	2.31
Poa arida	Plains blue grass	Coll:1WWAB02PP	Edgerton	4.44
Poa cambyii	Canbyii blue grass	Coll:1WWAB99PP	Wainwright	106.75
Poa palustris	Fowl blue grass	Coll:1WWAB00PP	Wainwright	3.7
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:1WWAB00PP	Wainwright	22.89
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:2WWAB00PP	Wainwright	8.92
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:3WWAB00PP	Wainwright	3.04
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:4WWAB01PP	Ribstone	24.21

Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:5WWAB01PP	Paradise Valley	18.57
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:6WWAB01PP	Chauvin	7.44
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:7N1salt00NP	Akasu Lake	0.78
Puccinellia nuttalliana	Nuttall's salt-meadow grass	Coll:8N2salt00NP	Two Hills	0.43
Puccinellia nuttalliana	Salt meadow grass	Coll:9WWAB02PP	Czar	44.99
Puccinellia nuttalliana	Salt meadow grass	Coll:10WWAB02PP	WW Camp	38.44
Schizachne purpurascens	Purple oat grass	Coll:1WWAB97PP	Wainwright	6.16
Schizachne purpurescens	Purple oat grass	Coll:2WWAB99PP	Wainwright	4.78
Schizachne purpurescens	Purple oat grass	Coll:3WWAB99PP	Wainwright	5.71
Schizachne purpurescens	Purple oat grass	Coll:4WWAB99PP	Wainwright	2.24
Schizachne purpurescens	Purple oat grass	Coll:5WWAB00PP	Wainwright	7.07
Schizachne purpurescens	Purple oat grass	Coll:6WWAB00PP	Wainwright	3.28
Schizachne purpurescens	Purple oat grass	Coll:7WWAB00PP	Wainwright	2.62
Schizachne purpurescens	Purple oat grass	Coll:8WWAB01PP	Heath	15.34
Schizachne purpurascens	Purple oat grass	Coll:9WWAB02PP	Edgerton	9.33
Schizachne purpurascens	Purple oat grass	Coll:10WWAB02PP	Metiskow	5.31
Schizachne purpurascens	Purple oat grass	Coll:11WWAB02PP	Onoway	1.04
Schizachne purpurascens	Purple oat grass	Coll:12WWAB00NP	Cadogan	17.28
Schizachyrium scoparium	Little bluestem	Coll:1WWAB97PP	Wainwright	14.46
Schizachyrium scoparium	Little bluestem	Coll:2WWAB97PP	Wainwright	3.87
Scirpus paludosus	Prairie bullrush	Coll:1WWAB01PP	Paradise Vallley	2.79
Scirpus validus	Bulrush	Coll:1WWAB00PP	Torlea	11.14
Spartina gracilis	Alkali cord grass	Coll:1WWAB97PP	Wainwright	14.32
Spartina gracilis	Alkali cord grass	Coll:2WWAB98PP	Wainwright	33.29
Spartina gracilis	Alkali cord grass	Coll:3WWAB99PP	Wainwright	14.9
Spartina gracilis	Alkali cord grass	Coll:4WWAB99PP	Wainwright	22.74
Spartina gracilis	Alkali cord grass	Coll:5WWAB01PP	Chauvin -Salt Lk.	37.4
Spartina gracilis	Alkali cord grass	Coll:6WWAB02PP	Cadogan	6.27
Spartina gracilis	Alkali cord grass	Coll:7WWAB02PP	Bodo	26.31
Sporobolus cryptandras	Sand dropseed	Coll:1WWAB97PP	Wainwright	5.04
Sporobolus cryptandras	Sand dropseed	Coll:2WWAB98PP	Wainwright	1.66
Sporobolus cryptandras	Sand dropseed	Coll:3WWAB99PP	Wainwright	2.95
Sporobolus cryptandras	Sand dropseed	Coll:4WWAB99PP	Wainwright	546.69
Sporobolus cryptandrus	Sand dropseed	Coll:5WWAB99PP	Wainwright	0.84
Sporobolus cryptandrus	Sand dropseed	Coll:6WWAB99PP	Wainwright	20.31
Sporobolus cryptandrus	Sand dropseed	Coll:7WWAB00PP	Wainwright	55.02
Sporobolus cryptandrus	Sand dropseed	Coll:8WWAB00PP	Wainwright	15.53
Sporobolus cryptandrus	Sand dropseed	Coll:9WWAB01PP	N. Chauvin	22.52
Sporobolus cryptandrus	Sand dropseed	Coll:10WWAB01PP	Wainwright	48.59
Sporobolus cryptandrus	Sand dropseed	Coll:11WWAB01PP	S Irma	10.66
Sporobolus cryptandrus	Sand dropseed	Coll:12WWAB02PP	Cadogan	19.4
Sporobolus cryptandrus	Sand dropseed	Coll:13WWAB02PP	Bodo	25
Sporobolus cryptandrus	Sand dropseed	Coll:14WWAB02PP	Edgerton	17.2
Sporobolus cryptandrus	Sand dropseed	Coll:15WWAB02PP	Edgerton	22.83

Sporobolus cryptandrus	Sand dropseed	Coll:16WWAB02PP	Gilt Edge	173.86
Stipa comata	Needle and thread grass	Coll:1WWAB97PP	Wainwright	2.88
Stipa comata	Needle and thread grass	Coll:2WWAB02PP	Capt. Ayre Lake	0.78
Stipa comata	Needle and thread grass	Coll:3WWAB02PP	WW Dunes Eco	0.2
Stipa spartea	Porcupine grass	Coll:1WWAB97PP	Wainwright	23.48
Stipa spartea	Porcupine grass	Coll:2WWAB99PP	Wainwright	12.6
Stipa virdula	Green needle grass	Coll:1WWAB97PP	Wainwright	3
Stipa virdula	Green needle grass	Coll:2WWAB99PP	Wainwright	13.08
Stipa virdula	Green needle grass	Coll:3WWAB02PP	Pipeliine ro	19.41
Stipa virdula	Green needle grass	Coll:4WWAB02PP	Wildmere	17.87
Stipa virdula	Green needle grass	Coll:5WWAB02PP	Rosedale	11.72
Stipa virdula	Green needle grass	Coll:6WWAB02PP	Paridise valley	3.76
Stipa viridula	Green needle grass	Coll:7WWAB01PP	Wainwright	11.12
Forbs				
Achillea millefolium	Yarrow	Coll:1WNP300PKS	Waterton	0.17
Achillea millefolium	Yarrow	Coll:2KAN100PKS	Kananaskis	0.17
Achillea millefolium	Yarrow	Coll:3LPL100PKS	Peter Lougheed	0.28
Achillea millefolium	Yarrow	Coll:4WNP100PKS	Waterton	0.65
Achillea millefolium	Yarrow	Coll:5JNP4100PKS	Jasper	0.66
Achillea millefolium	Yarrow	Coll:6LUS1100PKS	Luscar	1.1
Achillea millefolium	Yarrow	Coll:7WNP100PKS	Waterton Lake	0.05
Achillea millefolium	Yarrow	Coll:8JNP500PKS	Jasper	0.89
Acteae rubra	Red baneberry	Coll:1WWAB00PP	Wildmere	0.48
Agastache foeniculum	Giant hyssop	Coll:1WWAB00PP	Riverdale	5.76
Agastache foeniculum	Giant hyssop	Coll:2WWAB01PP	Wildmere	3.85
Agoseris glauca	False dandelion	Coll:1WWAB99PP	Wainwright	4.15
Agoseris glauca	False dandelion	Coll:2WWAB00PP	Wainwright	0.09
Agoseris glauca	False dandelion	Coll:3PC100PKS	Pincher Creek AB	0.29
Agoseris glauca	False dandelion	Coll:4:KAN100PKS	Kananaskis	0.29
Agoseris glauca	False dandelion	Coll:5:WNP200PKS	Waterton	0.46
Agoseris glauca	False dandelion	Coll:6:MtPk100PKS	MT.PARK	0.35
Agoseris glauca	False dandelion	Coll:7WWAB01PP	Heath	0.06
Agrimonia striata	Agrimony	Coll:1WWAB00PP	St. Paul	0.51
Agrimonia striata	Agrimony	Coll:2WWAB00PP	Wildmere	3.04
Anemone canadensis	Canada anemone	Coll:1WWAB01PP	Ribstone	8.43
Anemone multifida	Cut-leaved anemone	Coll:1WWAB99PP	Wainwright	25.3
Anemone multifida	Cut-leaved anemone	Coll:2WWAB00PP	Edgerton	0.78
Anemone multifida	Cut-leaved anemone	Coll:3WWAB00PP	Irma	NIL
Anemone multifida	Cut-leaved anemone	Coll:4WWAB00PP	Wildmere	0.22
Anemone multifida	Cut-leaved anemone	Coll:5PLP100PKS	Peter Lougheed	1.34
Anemone multifida	Cut-leaved anemone	Coll:6AN100PKS	Kananaskis	NIL
Anemone multifida	Cut-leaved anemone	Coll:7PC100PKS	Pincher Creek AB	5
Anemone multifida	Cut-leaved anemone	Coll:8PLP100PKS	Peter Lougheed	NIL

Anemone multifida	Cut-leaved anemone	Coll:9WNP100PKS	Waterton Lake	NIL
Anemone multifida	Cut-leaved anemone	Coll:10WNP200PKS	Waterton Lake	1.16
Anemone multifida	Cut-leaved anemone	Coll:11WNP300PKS	Waterton Lake	NIL
Anemone multifida	Cut-leaved anemone	Coll:12MtPk100PKS	MT.PARK	NIL
Anemone multifida	Cut-leaved anemone	Coll:13WWAB00NP	WATC-Coyote Hill	0.37
Anemone parviflora	Small wood anemone	Coll:1GC100PKS	Grande Cache	1.05
Anemone parviflora	Small wood anemone	Coll:2NP100PKS	Jasper	0.58
Anemone sp.	Anemone	Coll:1CRD100PKS	Cardinal River Divide	0.26
Anemone sp.	Anemone	Coll:2CRD100PKS	Cardinal River Divide	.
Anenome patens	Prairie crocus	Coll:1WWAB01PP	Wainwright	0.65
Antennaria nitida	Pussy toes	Coll:1PLP100PPKS	Peter Lougheed	NIL
Antennaria nitida	Pussy toes	Coll:2PLP200PKS	Peter Lougheed	NIL
Antennaria nitida	Pussy toes	Coll:3GC300PKS	Grande Cache	4.14
Antennaria nitida	Pussy toes	Coll:4MtPk200PKS	MT.PARK	0.08
Antennaria nitida	Pussy toes	Coll:5JNP100PKS	Jasper	0.05
Antennaria nitida	Pussy toes	Coll:6JNP200PKS	Jasper	NIL
Antennaria sp.	Everlasting	Coll:1WWAB99PP	Cardinal River Divide	0.81
Antennaria sp.	Everlasting	Coll:2WWAB01PP	Heinsburg	NIL
Arabis hirsuta	Rock cress	Coll:1WWAB00NP	WWB Betty Lake	1.08
Arabis sp.	Rock cress	Coll:1WWAB99PP	Wainwright	4.11
Arnica fulgens	Shining arnica	Coll:1WWAB98PP	Wainwright	NIL
Artemesia campestris	Plains wormwood	Coll:1WWAB02PP	Sounding Lake	13.31
Artemisia cana	Hoary sagebrush	Coll:1WWAB00PP	Czar	.
Artemisia frigida	Pasture sagewort	Coll:1WNP100PKS	Waterton Lake	0.09
Artemisia frigida	Pasture sagewort	Coll:2PC200PKS	Pincher Creek	3.17
Artemisia frigida	Pasture sagewort	Coll:3WNP100PKS	WNP1	0.09
Asclepias ovalifolia	Dwarf milkweed	Coll:1WWAB00PP	Edgerton	NIL
Asclepias ovalifolia	Dwarf milkweed	Coll:2WWAB00PP	Wainwirght	0.62
Asclepias ovalifolia	Dwarf milkweed	Coll:3WWAB00PP	Edgerton	1.35
Aster conspicuus	Showy aster	Coll:1WWAB00PP	Ranfurly	0.7
Aster ericoides	Many-flowered aster	Coll:1S3salt00NP	Hansman Lake	0.67
Aster ericoides	Many-flowered aster	Coll:2N2salt00NP	Two Hills	0.75
Aster ericoides	Many-flowered aster	Coll:3N1salt00NP		0.75
Aster laevis	Smooth aster	Coll:1WWAB00PP	Wildmere	0.1
Aster paniceus	Purple stemmed	Coll:1WWAB00PP	Czar	.
Aster sp.	Aster	Coll:1WWAB00PP	Wainwright	.
Aster sp.	Aster	Coll:1CRD100PKS	Cardinal River Divide	0.73
Astragalus aboriginum	Indian Milkvetch	Coll:1WWAB01PP	Wainwright	0.05
Astragalus aboriginum	Indian Milkvetch	Coll:2WWAB01PP	Irma	1.2
Astragalus aboriginum	Indian Milkvetch	Coll:3WWAB01PP	Irma	2.47
Astragalus bisulcatus	Two grooved milkvetch	Coll:1WWAB99PP	Wainwright	10.67
Astragalus canadensis	Canada milkvetch	Coll:1VegAB98NP	Vegreville	111.77
Astragalus canadensis	Canada milkvetch	Coll:2VegAB99NP	Vegreville	124.13
Astragalus canadensis	Canada milkvetch	Coll:3WWAB01PP	Wainwright	6.68

Astragalus drummondii	Drummond's milkvetch	Coll:1WWAB99PP	Wainwright	1.2
Astragalus drummondii	Drummond's milkvetch	Coll:2WWAB99PP	Wainwright	19.37
Astragalus drummondii	Drummond's milkvetch	Coll:3WWAB01PP	Auburndale	7.08
Astragalus goniatus	Purple milkvetch	Coll:1WWAB00PP	Czar	0.19
Astragalus missouriensis	Missouri milkvetch	Coll:1WWAB00PP	Lee Park	1.8
Astragalus striatus	Ascending purple milkvetch	Coll:1WWAB99PP	Wainwright	0.79
Astragalus striatus	Ascending purple milkvetch	Coll:2WWAB01PP	Riverdale	1.6
Astragalus striatus	Ascending purple milkvetch	Coll:3WWAB01PP	Riverdale	8.47
Atriplex hortensis	Garden ochre	Coll:1S600NP	Drumheller	4.99
Atriplex hortensis	Garden ochre	Coll:2N401NP	Lamont	.
Atriplex nuttallii	Nuttall's atriplex	Coll:1WWAB02PP	Hart Lake	97.76
Atriplex nuttallii	Nuttall's atriplex	Coll:2S7salt02NP	Jenner Bridge	493.66
Atriplex patula		Coll:1N1salt00NP	Akasu Lake	5.66
Atriplex patula		Coll:2S5salt00NP	Big Valley	8.82
Atriplex patula		Coll:3S4salt00NP	Campsite 41/13	6.19
Atriplex patula		Coll:4N3salt00NP	Vegreviile	5.93
Atriplex patula		Coll:5S2salt00NP-	Birch Lake	1.33
Atriplex patula		Coll:6:S8salt02NP	New Dayton	72.89
Atriplex patula		Coll:7N2salt02NP	Two Hills	70.2
Atriplex patula		Coll:8:N1salt02NP	Akasu Lake	19.23
Campanula rotundifolia	Harebell	Coll:1WWAB00PP	Czar	5.55
Campanula rotundifolia	Harebell	Coll:2WNP100PKS	Waterton Lake	0.23
Campanula rotundifolia	Harebell	Coll:3WNP200PKS	Waterton Lake	0.12
Campanula rotundifolia	Harebell	Coll:4WNP300PKS	Waterton Lake	0.03
Campanula rotundifolia	Harebell	Coll:5WWAB01PP	Irma	1.38
Campanula rotundfolia	Harebell	Coll:6WWAB02PP	Irma	1.71
Campanula rotundifolia	Harebell	Coll:7WWAB00NP	WWB, Betty Lake	0.74
Cerastium vulgatum	Mouse-eared chickweed	Coll:1WWAB01PP	Irma	0.33
Chamaerhodos erecta	bunge	Coll:1WWAB98PP	Wainwright	.
Chamaerhodos erecta	bunge	Coll:2WWAB01PP	Riverdale	4.07
Chenopodium album		Coll:1S5salt00NP	Big Valley	9.62
Chenopodium pratericola		Coll:1S2salt00NP	Birch Lake	10.39
Chenopodium salinum		Coll:1S3salt00NP	Hansman Lake	1.76
Chenopodium salinum		Coll:2S4salt00NP	Campsite 41/13	2.42
Chenopodium salinum		Coll:3N1salt02NP	Akasu Lake	69.26
Clematis occidentalis	Purple Clematis	Coll:1JNP100PKS	Jasper	3.86
Clematis verticellaris	Purple Virgin's-Bower	Coll:1WWAB00PP	Edgerton	0.07
Cleome serrulata	Bee Plant	Coll:1WWAB97PP	Wainwright	2.1
Cleome serrulata	Bee Plant	Coll:2WWAB01PP	Wainwright	30.49
Corydalis aurea	Golden corydalis	Coll:1WWAB02PP	Edgerton	19.04
Corydalis aurea	Golden corydalis	Coll:2WWAB02PP	Dina	72.58
Crataegus rotundifolia	Round leaved hawthorne	Coll:1WWAB97PP	Wainwright	58.42
Crataegus rotundifolia	Round-Leaved Hawthorn	Coll:2WWAB97PP	Paradise Valley	185.05
Dodecatheon pulchellium	Saline shooting star	Coll:1WWAB01PP	Heath	2.92

Dodecatheon pulchellum	Saline shooting star	Coll:2WWAB97PP	Wainwright	0.08
Dodecatheon pulchellum	Saline shooting star	Coll:3WWAB02PP	Czar	2.39
Dryas drummondii	Yellow mountain avens	Coll:1WWAB00PP	Mercoal	3.08
Dryas sp.	Mountain avens	Coll:1KAN100PKS	Kananaskis	7.65
Dryas sp.	Mountain avens	Coll:2JNP300PKS	Jasper	6.86
Dryas sp.	Mountain avens	Coll:3JNP40PKS	Jasper	7.89
Dryas sp.	Mountain avens	Coll:4JNP500PKS	Jasper	3.42
Dryas sp.	Mountain avens	Coll:5CRD100PKS	Cardinal River Divide	0.05
Epilobium angustifolium	Fireweed	Coll:1WWAB00PP	Wainwright	0.41
Erigeron caespitosus	Tufted fleabane	Coll:1WWAB00PP	Marwayne	0.24
Erigeron glabellus	smooth fleabane	Coll:1WWAB00PP	Czar	0.11
Erigeron glabellus	smooth fleabane	Coll:2WWAB00PP	Bodo	0.39
Eriogonum flavum	Yellow umbrella plant	Coll:1WWAB00PP	Irma	0.86
Erysimum asperum	Western wallflower	Coll:1WWAB97PP	Wainwright	0.5
Erysimum asperum	Western wallflower	Coll:2WWAB00PP	Czar	1.75
Erysimum asperum	Western wallflower	Coll:3WWAB00PP	Wainwright	66.52
Erysimum asperum	Western wallflower	Coll:4WWAB02PP	Capt. Ayre Lake	0.13
Eupatorium maculatum	Spotted Joe-Pye weed	Coll:1WWAB01PP	Wainwright	0.05
Eurotia lanata	Winterfat	Coll:1WWAB00PP	Tolland	69.72
Eurotia lanta	Winter fat	Coll:2WWAB01PP	Wildmere	26.32
Fragaria virginiana	Strawberry	Coll:1MtPk100PKS	MT.PARK	0.23
Gaillardia aristata	Blanket flower	Coll:1WWAB99PP	Wainwright	1.02
Gaillardia aristata	Blanket flower	Coll:2WWAB99PP	Wainwright	2.12
Gaillardia aristata	Blanket flower	Coll:3WWAB00PP	Edgerton	0.04
Gaillardia aristata	Blanket flower	Coll:4WWAB00PP	Dina	0.04
Gaillardia aristata	Blanket flower	Coll:5PC100PKS	Pincher Creek AB	2.46
Gaillardia aristata	Blanket flower	Coll:6WNP100PKS	Waterton	0.48
Gaillardia aristata	Blanket flower	Coll:7WNP200PKS	Waterton	NIL
Gaillardia aristata	Blanket flower	Coll:8WNP300PKS	Waterton	NIL
Gaillardia aristata	Blanket flower	Coll:9WWAB01PP	Irma	1.66
Galium boreale	Northern bedstraw	Coll:1PC100PKS	Pincher Creek AB	0.09
Galium boreale	Northern bedstraw	Coll:2WNP100PKS	Waterton	0.13
Galium boreale	Northern bedstraw	Coll:3WNP200PKS	Waterton	0.22
Galium boreale	Northern bedstraw	Coll:4GC100PKS	Grande Cache	1.36
Galium boreale	Northern bedstraw	Coll:5WNP400PKS	Waterton	0.56
Galium boreale	Northern bedstraw	Coll:6WWAB01PP	Riverdale	2.29
Galium boreale	Northern bedstraw	Coll:7WWAB00NP	WWB, Betty Lake	0.84
Gaura coccinea	Scarlet butterfly weed	Coll:1WWAB99PP	Wainwright	NIL
Gentiana amarella	Northern gentian	Coll:1WWAB00PP	Viking	0.78
Gentiana amarella	Northern gentian	Coll:2WWAB00PP	Tolland	59.5
Gentiana amarella	Northern gentian	Coll:3WWAB00PP	Bodo	6.22
Gentiana amarella	Northern gentian	Coll:4WWAB00NP	WWB, Betty Lake	6.15
Geum aleppicum	Yellow avens	Coll:1WWAB00PP	Wildmere	3.34
Geum triflorum	Three flowered avens	Coll:1WWAB00PP	Wainwright	1.14

Geum triflorum	Three flowered avens	Coll:2WWAB00PP	Wainwright	.
Geum triflorum	Three flowered avens	Coll:3WWAB00PP	Lee Park	.
Geum triflorum	Three flowered avens	Coll:4WWAB00PP	Irma	0.05
Geum triflorum	Three flowered avens	Coll:5PLP200PKS	Peter Lougheed	2.31
Geum triflorum	Three flowered avens	Coll:6WNP100PKS	Waterton	0.06
Geum triflorum	Three flowered avens	Coll:7WNP200PKS	Waterton	NIL
Glycyrrhiza lepidota	Wild licorice	Coll:1WWAB97PP	Wainwright	2.63
Glycyrrhiza lepidota	Wild licorice	Coll:2WWAB99PP	Wainwright	1.55
Glycyrrhiza lepidota	Wild licorice	Coll:3S200NP	Birch Lake	1.55
Glycyrrhiza lepidota	Wild Licorice	Coll:4WWAB02PP	Tolland	6.15
Glycyrrhiza lepidota	Wild licorice	Coll:5WWAB00NP	Lee Park	0.69
Gutierrezia sarothrae	Common broomweed	Coll:1WWAB00PP	Wildmere	.
Haplopappus spinulosus	Spiny iron plant	Coll:1WWAB98PP	Wainwright	0.23
Haplopappus spinulosus	Spiny iron plant	Coll:2WWAB99PP	Wainwright	0.73
Haplopappus spinulosus	Spiny iron plant	Coll:3WWAB00PP	Fayban	.
Haplopappus spindulosa	Spiny Iron Plant	Coll:4WWAB02PP	Riverdale	14.72
Hedysarum boreale	Northern sweetbroom	Coll:4WWAB97PP	Wainwright	4.14
Hedysarum boreale	Northern sweetbroom	Coll:5WWAB99PP	Wainwright	35.6
Hedysarum boreale	Northern sweetbroom	Coll:6WWAB01PP	Auburndale	8.3
Hedysarum sulphurescens	Yellow sweetbroom	Coll:1PLP100PKS	Peter Lougheed	3.28
Hedysarum sulphurescens	Yellow sweetbroom	Coll:2KAN200PKS	Kananaskis	0.69
Hedysarum sulphurescens	Yellow sweetbroom	Coll:3WNP200PKS	Waterton	0.04
Hedysarum sulphurescens	Yellow sweetbroom	Coll:4KAN100PKS	Kananaskis	0.73
Helianthus couplandii	Annual prairie sunflower	Coll:1WWAB99PP	Wainwright	NIL
Helianthus couplandii	Annual prairie sunflower	Coll:2WWAB00PP	Minburn	3.25
Helianthus couplandii	Annual prairie sunflower	Coll:3WWAB00PP	Metiskow	5.36
Helianthus couplandii	Annual prairie sunflower	Coll:4WWAB00PP	Edgerton	11.38
Helianthus couplandii	Annual prairie sunflower	Coll:5WWAB00PP	Wallaby Lake	0.45
Helianthus couplandii	Annual prairie sunflower	Coll:6WWAB01PP	Irma	1.51
Helianthus couplandii	Annual prairie sunflower	Coll:7WWAB02PP	Edgerton	4.24
Helianthus petiolaris	Prairie sunflower	Coll:1WWAB97PP	Wainwright	12.88
Helianthus petiolaris	Prairie sunflower	Coll:2WWAB97PP	Bodo	20.9
Helianthus subrhomboideus	Beautiful sunflower	Coll:1WWAB00PP	Minburn	0.63
Helianthus subrhomboideus	Beautiful sunflower	Coll:2WWAB00PP	Wildmere	7.76
Helianthus subrhomboideus	Beautiful sunflower	Coll:3WWAB00PP	Edgerton	3.77
Heliopsis helianthoides var, scabra+A280	Rough false sunflower	Coll:1WWAB01PP	Irma	1.9
Heterotheca villosa	Hairy golden aster	Coll:1WWAB97PP	Wainwright	1.41
Heterotheca villosa	Hairy golden aster	Coll:2WWAB00PP	Wainwright	0.45
Heterotheca villosa	Hairy golden aster	Coll:3WWAB02PP	Wainwright	1.08
Heterotheca villosa	Hairy golden aster	Coll:4WWAB02PP	Bodo	11.5
Heterotheca villosa	Hairy golden aster	Coll:5:WWAB02PP	Chauvin	21.99
Heuchera richardsonii	Alumroot	Coll:1WWAB97PP	Wainwright	2.82
Heuchera richardsonii	Alumroot	Coll:2WWAB99PP	Wainwright	0.98

Heuchera richardsonii	Alumroot	Coll:3WWAB99PP	Wainwright	1.79
Heuchera richardsonii	Alumroot	Coll:4WWAB99PP	Wainwright	1
Heuchera richardsonii	Alumroot	Coll:5WWAB99PP	Wainwright	0.59
Hudsonia tomentosa	Sand heather	Coll:1WWAB00PP	Wainwright	0.3
Hypericum majus	Large Canada St. Johnswort ®	Coll:1WWAB01PP	Amisk	0.45
Kochia scoparia		Coll:1S7salt02NP	Jenner Bridge	94.1
Lactuca pulchella	Wild blue lettuce	Coll:1WWAB98PP	Wainwright	.
Lathyrus orchroleucus	Cream colored peavine	Coll:1WWAB01PP	WWGolf	0.48
Lathyrus venosus	Purple peavine	Coll:1KAN100NP	Barrier Lake Trail	0.83
Lesquerella arenosa	Sand bladderwort	Coll:2WWAB97PP	Wainwright	.
Lesquerella ludoviciana	Sand bladderwort	Coll:1WWAB01PP	Wallaby Lake	1.8
Lesquerella ludoviciana	Sand bladderwort	Coll:2WWAB02PP	Randi Lake Dunes	0.79
Liatris punctata	Blazing Star	Coll:1PCAB00NP	Lee Lake	2.82
Lilium philadelphicum	Western Lily	Coll:1WWAB00PP	Riverdale	3.47
Lilium philadelphicum	Western Lily	Coll:2WWAB01PP	Ribstone	4.2
Linum lewsii	Wild blue flax	Coll:1SK96DNern	Saskatchewan	.
Linum lewisii	Wild blue flax	Coll:2WWAB00PP	Irma	0.03
Linum lewisii	Wild blue flax	Coll:3WWAB00PP	Islay	1.41
Linum lewisii	Wild blue flax	Coll:4PC100PKS	PC1	0.2
Linum lewisii	Wild blue flax	Coll:5WNP100PKS	WNP1	0.11
Linum lewisii	Wild blue flax	Coll:6:WNP200PKS	WNP2	0.21
Linum lewisii	Wild blue flax	Coll:7JNP100PKS)	JNP1	0.64
Linum lewisii	Wild blue flax	Coll:5WNP100PKS	WNP1	0.1
Linum lewisii	Wild blue flax	Coll:8WNP100PKS	WNP1	0.08
Linum lewisii	Wild blue flax	Coll:10:WWAB01PP	Irma	1.11
Linum lewisii	Wild blue flax	Coll:11WWAB01PP	Islay	0.18
Linum sulcatum	Grooved Yellow flax	Coll:1WWAB01PP	Tolland	1.38
Linum sulcatum	Grooved Yellow flax	Coll:2WWAB01PP	Clear Lake	7.67
Linum sulcatum	Grooved Yellow flax	Coll:3WWAB00NP	WWB	0.41
Lithospermum incisum	Narrow-leaved puccoon	Coll:1WWAB97PP	Wainwright	5.86
Lithospermum incisum	Narrow-leaved puccoon	Coll:2:WWAB98PP	Wainwright	0.27
Lithospermum incisium	Narrow-leaved puccoon	Coll:3WWAB00PP	Amisk	1.39
Lithospermum incisum	Narrow-leaved puccoon	Coll:4WWAB01PP	Wainwright	4.3
Lithospermum incisum	Narrow-leaved puccoon	Coll:5WWAB01PP	CFB Wainwright	54.82
Lonicera dioica	Twining Honeysuckle	Coll:1WWAB01PP	WW Golf	16.99
Lonicera dioica	Twining honeysuckle	Coll:2WWAB02PP	Dewberry	0.44
Lupinus nookatensis	Nootka lupine	Coll:1GC200PKS	Grande Cache	6.02
Lupinus sericeus	Flexile lupine	Coll:1PC100PKS	Pincher Creek AB	0.24
Lupinus sericeus	Flexile lupine	Coll:2WNP200PKS)	Waterton	0.07
Lygodesmia juncea	Skeleton weed	Coll:1WWAB98NP	Triex site	0.04
Lygodesmia juncea	Skeleton weed	Coll:2WWAB00PP	Wainwright	0.05
Lygodesmia juncea	Skeleton weed	Coll:3WWAB00PP	Marwayne	NIL
Lygodesmia juncea	Skeleton weed	Coll:4WWAB02PP	Claysmore	0.05
Lysimachia ciliata	Fringed Loosestrife	Coll:1WWAB01PP	Wainwright	0.09

Maianyhemum canadense	Lily of the valley	Coll:1FtMc302NP	3	5.73
Maianyhemum canadense	Lily of the valley	Coll:2FtMc102NP	1	3.22
Mamillaria vivipara	Pincushion cactus	Coll:1WWAB01PP	Wainwright	3.04
Mirabilis nyctaginea	Heart-leaved umbrellawort	Coll:1WWAB99PP	Wainwright	3.78
Mirabilis hirsuta	Hairy umbrellawort	Coll:1WWAB98PP	Wainwright	0.07
Mirablilis hirsuta	Hairy umbrellawort	Coll:2WWAB00PP	Wainwright	0.27
Mirablilis hirsuta	Hairy umbrellawort	Coll:3WWAB00PP	Wainwright	0.85
Mirablilis hirsuta	Hairy umbrellawort	Coll:4WWAB00PP	Amisk	0.46
Mirablilis hirsuta	Hairy umbrellawort	Coll:5WWAB00PP	Marwayne	2.07
Mirablilis hirsuta	Hairy umbrellawort	Coll:6WWAB00PP	Amisk	27.44
Monarda fistulosa	Wild Bergamont	Coll:1WWAB97PP	Wainwright	3.12
Monarda fistulosa	Wild Bergamont	Coll:2WWAB99PP	Wainwright	4.59
Monarda fistulosa	Wild Bergamont	Coll:3WWAB00PP	Wildmere	3.69
Monarda fistulosa	Wild Bergamont	Coll:4WNP100PKS	Waterton	0.05
Monarda fistulosa	Wild Bergamont	Coll:5WNP200PKS	Waterton	0.62
Monarda fistulosa	Wild Bergamont	Coll:6WNP300PKS	Waterton	0.12
Musineon divaricatum	Leafy musineon	Coll:1WWAB01PP	Wildmere (Battle River)	6.26
Oenothera biennis	Yellow evening primrose	Coll:1WWAB00PP	Amisk	24.07
Oenothera biennis	Yellow evening primrose	Coll:2WWAB00PP	Lindburg	4.28
Oenothera biennis	Yellow evening primrose	Coll:3WWAB02PP	Dewberry	8.49
Oenothera nuttallii	White evening primrose	Coll:1WWAB01PP	Delusion Lake	.
Oenothera nuttallii	White evening primrose	Coll:2WWAB97PP	Claysmore	0.04
Oenothera serrulata	Shrubby evening primrose	Coll:1WWAB97PP	Wainwright	.
Oenothera serrulata	Shrubby evening primrose	Coll:2WWAB98PP	Wainwright	0.19
Opunitia fragilis	Brittle prickly pear cactus	Coll:1WWAB02PP	Cadogan	0.24
Orthocarpus luteus	Owl's clover	Coll:1WWAB99PP	Wainwright	20.04
Orthocarpus luteus	Owl's clover	Coll:2WWAB99PP	Wainwright	18.12
Orthocarpus luteus	Owl's clover	Coll:3WWAB99PP	Wainwright	19.99
Oxytopsis campestris	Late yellow loco-weed	Coll:1WWAB97PP	Wainwright	0.24
Oxytropis campestris	Late yellow loco-weed	Coll:2WWAB99PP	Wainwright	11.36
Oxytropis campestris	Late yellow loco-weed	Coll:3WWAB01PP	Riverdale	44.88
Oxytropis campestris	Late yellow loco-weed	Coll:4WWAB02PP	Irma	0.32
Oxytropis cusickii	Late yellow loco-weed	Coll:1CRD100PKS	Vermilion	0.41
Oxytropis cusickii	Late yellow loco-weed	Coll:2CRD200PKS	CRD1	8.73
Oxytropis monticola	Late yellow loco-weed	Coll:1WWAB98PP	Wainwright	16.65
Oxytropis podocarpa	Inflated Oxytrope	Coll:1CRD100PKS	Cardinal River Divide	5.06
Oxytropis sericea	Early yellow loco-weed	Coll:1WWAB98PP	HH - Fish Lake	81.21
Oxytropis sericea	Early yellow loco-weed	Project1-33PCAB	Pincher Creek AB	.
Oxytropis sericea	Early yellow loco-weed	Project1-34PCAB	Pincher Creek AB	.
Oxytropis splendens	Showy loco-weed	Coll:1WNP300PKS	Waterton Lake	0.51
Oxytropis splendens	Showy loco-weed	Coll:2WNP200PKS	Waterton Lake	2.96
Oxytropis splendens	Showy loco-weed	Coll:3WNP300PKS	Waterton Lake	1.2
Oxytropis splendens	Showy loco-weed	Coll:4WNP100PKS	Waterton Lake	0.54
Oxytropis splendens	Showy loco-weed	Coll:5WNP200PKS	Waterton Lake	2.9

Oxytropis splendens	Showy loco-weed	Coll:6AN100PKS	Kananaskis	2.6
Penstemon gracillis	Lilacflowered beardstongue	Coll:1WWAB01PP	Clear Lake	0.02
Penstemon gracillis	Lilacflowered beardstongue	Coll:2WWAB01PP	Wildmere (Battle River)	0.25
Penstemon gracillis	Lilacflowered beardstongue	Coll:3WWAB01PP	Irma	0.94
Penstemon gracillis	Lilacflowered beardstongue	Coll:4WWAB01PP	CFB Wainwright	2.63
Penstemon gracillis	Lilacflowered beardstongue	Coll:5WWAB01PP	Riverdale	0.71
Penstemon procerus	Slender beardstongue	Coll:1WWAB99PP	Wainwright	4.52
Petalostemon candidum	White prairie clover	Coll:1WWAB01PP	Riverdale	.
Petalostemon candidum	White prairie clover	Coll:2WWAB01PP	CFB Wainwright	.
Petalostemon candidum	White prairie clover	Coll:3WWAB01PP	CFB Wainwright	.
Petalostemon candidum	White prairie clover	Coll:4WWAB01PP	Riverdale	.
Petalostemon candidum	White prairie clover	Coll:5WWAB01PP	Riverdale	.
Petalostemon candidum	White prairie clover	Coll:6WWAB01PP	Riverdale	.
Petalostemon purpurescens	Purple prairie clover	Coll:1WWAB99PP	Wainwright	1.56
Petalostemon purpuresens	Purple prairie clover	Coll:2WWAB02PP	Capt. Ayre Lake	12.16
Petalostemon purpuresens	Purple prairie clover	Coll:3WWAB02PP	Sounding Lake	2.03
Petasites sagittatus	Arrowleaved coltsfoot	Coll:1WWAB01PP	Onoway	0.15
Polygala seneca	Seneca root/snake root/milkwort	Coll:1WWAB01PP	Riverdale	9.17
Polygala senega	Seneca-root	Coll:2WWAB02PP	Minburn	9.17
Potentilla argentea	Silvery cinquefoil	Coll:1WWAB99PP	Wainwright	1.22
Potentilla argentea	Silvery cinquefoil	Coll:2WWAB01PP	Riverdale	4.27
Potentilla argentea	Silvery cinquefoil	Coll:3WWAB01PP	Irma	3.09
Potentilla arguta	White cinquefoil	Coll:1WWAB99PP	Wainwright	22.43
Potentilla arguta	White cinquefoil	Coll:2WWAB99PP	Wainwright	6.95
Potentilla arguta	White cinquefoil	Coll:3WWAB99PP	Wainwright	23.02
Potentilla arguta	White cinquefoil	Coll:4WWAB00PP	Edgerton	6.76
Potentilla arguta	White cinquefoil	Coll:5:WWAB02PP	Claysmore	23.51
Potentilla hippiana	Wooly cinquefoil	Coll:1WWAB98PP	Wainwright	4.88
Potentilla hippiana	Wooly cinquefoil	Coll:2WWAB00NP	WWB, Betty Lake	5.42
Potentilla pennsylvanica	Prairie cinquefoil	Coll:1WWAB99PP	Wainwright	2.42
Potentilla pennsylvanica	Prairie cinquefoil	Coll:2WWAB00PP	Edgerton	6.95
Potentilla pennsylvanica	Prairie cinquefoil	Coll:3WWAB00PP	Marwayne	2.07
Potentilla pensylvanica	Prairie cinquefoil	Coll:4WWAB01PP	Irma	2.67
Potentilla sp.	Cinquefoil	Coll:1WWAB99PP	Wainwright	NIL
Psoralea argophylla	Silver-leaved	Coll:1WWAB98PP	Wainwright	NIL
Psoralea argophylla	Silver-leaved	Coll:2WWAB99PP	Wainwright	NIL
Psoralea argophylla	Silver-leaved	Coll:3WWAB00PP	Dina	NIL
Psoralea esculenta	Indian Breadroot	Coll:1WWAB98PP	Wainwright	.
Psoralea esculenta	Indian Breadroot	Coll:2WWAB01PP	Auburndale	0.45
Psoralea esculenta	Indian Breadroot	Coll:3WWAB01PP	Auburndale	6.4
Psoralea esculenta	Indian Breadroot	Coll:4WWAB01PP	Wainwright	5.06
Psoralea esculenta	Indian Breadroot	Coll:5WWAB01PP	Riverdale	14.63
Psoralea esculenta	Indian Breadroot	Coll:6WWAB01PP	Irma	.
Psoralea esculenta	Indian Breadroot	Coll:7WWAB01PP	CFB Wainwright	0.88

Psoralea esculenta	Indian Breadroot	Coll:8WWAB01PP)	Riverdale	2.82
Psoralea esculenta	Indian Breadroot	Coll:9WWAB01PP	Irma	18.8
Psoralea esculenta	Indian Breadroot	Coll:10WWAB01PP	Delusion Lake	1.18
Psoralea esculenta	Indian Breadroot	Coll:11WWAB00NP	WWB, Betty Lake	2.53
Ranunculus sp.	Buttercup	Coll:1LUS100PKS	Luscar	0.5
Ratibida colulmnifera	Yellow prairie coneflower	Coll:1WWAB97PP	Wainwright	15.88
Ratibida columnifera	Yellow prairie coneflower	Col:2WWAB98PP	Wainwright	1.2
Ratibida columnifera	Yellow prairie coneflower	Coll:3WWAB01PP	Wildmere	0.94
Rosa arkansana	Prairie rose	Coll:1WWAB02PP	Claysmore	59.34
Rosa arkansana	Prairie rose	Coll:2WWAB02PP	Czar	31.02
Rumex occidentalis	Western Dock	Coll:1WWAB02PP	Tolland	9.63
Rumex venosus	Sand begonia	Coll:1WWAB99PP	Wainwright	19.92
Rumex venosus	Sand begonia	Coll:2WWAB00PP	Bodo	1.57
Rumex venosus	Sand begonia	Coll:3WWAB00PP	Bodo	17.32
Rumex venosus	Sand begonia	Coll:4WWAB00PP	Bodo	32.6
Rumex venosus	Sand begonia	Coll:5WWAB02PP	North Sounding Lake	1.97
Salicornia rubra	Red samphire	Coll:1S1salt00NP	Popular Lodge	2.11
Salicornia rubra	Red samphire	Col:2N2salt00NP	Two Hills	10.41
Salicornia rubra	Red samphire	Coll:3S1salt00NP	Popular Lodge	8.65
Salicornia rubra	Red samphire	Coll:4N2salt02NP	Two Hills	12.08
Sanicula marilandica	Snakeroot	Coll:1WWAB00PP	Wildmere	4.94
Sanicula marilandica	Snakeroot	Coll:2WWAB00PP	Ranfurly	29.92
Sanicula marilandica	Snakeroot	Coll:3WWAB00PP	St.Paul	10.17
Sarcobatus vermiculatus	Greasewood	Coll:1S7salt00NP	Jenner Bridge	2.88
Senecio canus	Silvery groundsel	Coll:1WWAB00PP	Edgerton	1.24
Senecio integerrimus	Entire leaved groundsel	Coll:1CRD100PKS	Cardinal River Divide	0.02
Senecio sp.	Groundsel	Coll:1MtPk200PKS	Mt. Park	0.05
Sisyrinchium monantum	Blue-eyed grass	Coll:1HHAB99NP	Hand Hills AB	0.12
Sisyrinchium montanum	Blue-eyed grass	Coll:2WWAB01PP	Irma	0.35
Sisyrinchium montanum	Blue eyed grass	Coll:3WWAB02PP	Vermilion	7.91
Sisyrinchium montanum	Blue eyed grass	Coll:4WWAB00NP	Brownfield	0.33
Sisyrinchium montanum	Blue eyed grass	Coll:5WWAB00NP	WWB, Coyote Hill	0.19
Smilacina stellata	Star-flowered Solomon's-seal	Coll:1WWAB01PP	Wainwright	3.55
Solidago gigantea	Late goldenrod	Coll:1WWAB00PP	Riverdale	0.08
Solidago missouriensis	Low goldenrod	Coll:1WWAB98PP	Wainwright	0.42
Solidago missouriensis	Low goldenrod	Coll:2WWAB00PP	Edgerton	0.87
Solidago missouriensis	Low goldenrod	Coll:3WWAB02PP	Edgerton	4.59
Solidago mollis	Velvety goldenrod	Coll:1WWAB00PP	Wildmere	2.01
Solidago rigida	Stiff goldenrod	Coll:1WWAB99PP	Wainwright	25
Solidago rigida	Stiff goldenrod	Coll:2WWAB00PP	Paradise Valley	1.56
Solidago rigida	Stiff goldenrod	Coll:3WWAB00PP	Minburn	0.72
Stachys palustris	Hedge Nettle	Coll:1WWAB00PP	Wainwright	1.45
Suaeda calceoliformis		Coll:1S1salt00NP	Popular Lodge	0.76
Suaeda calceoliformis		Coll:2S3salt00NP	Hansman Lake	2.14

Suaeda calceoliformis		Coll:3S7salt00NP	Jenner Bridge	0.1
Suaeda calceoliformis		Coll:4S5salt00NP	Big Valley	2.01
Suaeda calceoliformis		Coll:5S3salt00NP	Hansman Lake	3.68
Suaeda calceoliformis		Coll:6Ssalt400NP)	Campsite 41/13	3.65
Suaeda calceoliformis		Coll:7N1salt00NP	Akasu Lake	1.13
Suaeda calceoliformis		Coll:8S2salt00NP	Birch Lake	2.12
Suaeda calceoliformis var. erecta		Coll:9S8salt00NP	New Dayton	87.41
Suaeda calecoliformis var. erecta		Coll:10S3salt00NP	Hansman Lake	47.2
Thermopsis rhombifolia	Golden bean	Coll:1:WWAB98PP	Wainwright	1.15
Thermopsis rhombifolia	Golden bean	Coll:2LAVOYAB98NP	Lavoy AB	.
Thermopsis rhombifolia	Golden bean	Coll:3WWAB99PP	Wainwright	25.79
Thermopsis rhombifolia	Golden bean	Coll:4WWAB02PP	Edgerton	14.36
Townsendia exscapa	Low townsendia	Coll:1WWAB00PP	Edgerton	3.07
Townsendia exscapa	Low townsendia	Coll:2WWAB01PP	Edgerton	0.03
Townsendia exscapa	Low townsendia	Coll:3WWAB01PP	Wildmere	0.4
Townsendia exscapa	Low townsendia	Coll:4WWAB02PP	Wainwright	1.23
Tragopogon dubius	Goats beard	Coll:1WWAB00PP	Czar	3.6
Vicia americana	American vetch	Coll:1:VegAb95DU	Vegreville	35.5
Vicia americana	American vetch	Coll:2:HHAB97NP	Hand Hills AB	15.29
Vicia americana	American vetch	Coll:300KAN100PKS	Kananaskis	1.68
Vicia americana	American vetch	Coll:4VEGAB00NP	Vegreville	59.34
Viola adunca	Early blue violet	Coll:1WWAB02PP	Dewberry	0.8
Zizia aptera	Heart-shaped golden alexanders	Coll:1WWAB00PP	Ribstone	1.23
Zizia aptera	Heart-shaped golden alexanders	Coll:2WWAB01PP	Riverdale	5.07
Zygadenus gramineus	Death camas	Coll:1WWAB97PP	Wainwright	0.9