A WORKSHOP ON THE USES AND IMPORTANCE OF NATIVE PLANTS OF SASKATCHEWAN

PROCEEDINGS

September 21 and 22, 1994
Travel Lodge Inn
Saskatoon, Saskatchewan

Saskatchewan Agriculture and Food
Prairie Farm Rehabilitation Administration
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Compiled and Edited
by
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NATIVE PLANT MATERIALS - PRESENT AND FUTURE

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In the not too distant past, land disturbances due to extraction of resources were relatively small. As global economies grew and with the advent of multinational corporations, there has been a tremendous increase in the size of extraction operations (mining, forestry, agriculture, etc.) and the disturbances caused by the infrastructure to support these activities (e.g. roads, railways, and pipelines).

Although, the use of our natural resources has accelerated rapidly in the last five decades, there has not been a comparable increase in the knowledge base and the technology to repair the disturbances caused by this increased use of resources.

When disturbances were relatively small they were often left and the natural processes of succession took over. As larger and larger disturbances occurred the slow process of succession did not keep up and more and more of the land base was disturbed at any one time. The aesthetics of these disturbances, along with the increased public awareness regarding the need to preserve and conserve our natural areas lead to a move toward 'fixing' the disturbances. When reclamation began and one of the components was revegetation, the first step was to use plants that were available and that had a reasonable potential for success; success being defined as green cover (the thicker the better). Only recently, has there been an greater interest in using native plants - particularly in Alberta.

This interest grew out of concerns about revegetating areas for which no agronomic species was adapted. In Alberta, this interest began primarily at high elevations because few of the introduced agronomic species were adapted to the short growing season, or the dry, soilless conditions. The move to use native plants in other regions is not as advanced because the agronomic species are adapted and do provide a green cover. Since the move to use native plants has grown, we have also found that the introduction and/or large scale use of aggressive, persistent non-native agronomic species can (and has in some cases) lead to weed problems, and monocultures.

It would be ideal if, when planning reclamation or revegetation for a particular site, native plant species were the standard, however this is not the case. Therefore with almost every project there is still a large component of convincing a client or land user that native plants are the most appropriate option. In most cases of revegetation and reclamation in Alberta at this time the standard is to use a mixture of agronomic species; primarily grasses, with some legumes. Native species are not the plants of choice for three reasons:

1. lack of knowledge,
2. availability, and
3. cost

The lack of information concerning the benefits of native plants versus introduced species is enormous. We need a greater understanding of biological diversity and its role in natural systems and the possible problems associated with loss of plant species and or genetic diversity. We also need an understanding of ecological principles such as the role of competition and ecological succession.

We, as plant ecologists and environmentalists, have long been aware that diversity is one of the keys to success of any plant community and that this applies directly to revegetation and reclamation projects. Although diversity is often interpreted solely as the number of different species in a given community, we must also concern ourselves about diversity within species; the genetic variation within a species that allows a species to adapt to a range of edaphic and biotic conditions.

The need for diversity is one of the first considerations when we choose species for reclamation. As important as diversity is, there are other non-biological considerations; availability of plant material and cost of the material.

There are an increasing number of commercial seed producers interested in producing native plants for use in reclamation and revegetation. However, the lack of knowledge and understanding of the basic biology and agronomy of most species has limited their ability to produce material in large quantities.

We know that it takes more than just assumptions that native plants are a better choice to convince even the most environmentally sensitive decision-makers, to loosen the purse strings. Until commercial producers can streamline the production of native plants the cost of these materials will be prohibitive.

Those of us involved in trying to have native plants recognized as a feasible and preferable alternative to agronomic plants are making the assumption that eventually the end result of reclamation and revegetation should be a diverse community that will protect and conserve the indigenous plants and be self-sustaining; able to withstand the constant selection pressures that exist naturally. The vegetation cover should allow natural invasion from adjacent native communities. Most of us are realistic enough to know that we will never achieve the exact community that existed in the past but because the native communities are the best guideline we have, it should be our model for revegetation and reclamation.

There are, at present, only four sources for native plant material for revegetation projects:

1. harvesting and replacing plant materials that exist on site prior to disturbance,
2. harvesting plant materials that exist on site prior to the disturbance and multiplying these in a semi-controlled environment,
3. using native plants provenances brought in from great distances (generally from nursery grown stock), and
4. using locally selected varieties and/or species that are produced commercially.

The first option in increasing our choice is to collect plants/propagules prior to disturbance on a given site or from an adjacent site, such that these can be used to revegetate the site when construction/or extraction is complete. This could include collecting seeds, storing topsoil (and all propagules associated with the soil such as seeds, rhizomes, root pieces, etc.), storing sods, and/or individual plants or plant parts (cuttings, etc).

The benefit of this method is that we can potentially incorporate the diverse assemblage of species and maintain the existing genetic diversity of a site.

There are also several problems with this method:

1. we lack the knowledge to store and maintain the viability of many of the propagules for most native species especially those with limited or short viability,
2. there is often not enough material to completely revegetate the entire area that has been disturbed,
3. our knowledge of methods and technologies to apply (or reapply) plant materials to a disturbance are limited, and
4. with the physical changes on a disturbed site (aspect, soils, light, etc) there is no guarantee that the same species that existed prior to disturbance will be suited for the changed environment.

There is often a low expectation of success. Therefore, this method is difficult to sell to decision makers who are responsible for covering large areas. A single failure will also jeopardize future trials with this method.

There is little data available regarding the success of this method but it is recommended for small disturbances, particularly in areas where the plant species are those we understand (shrubs by seed and cuttings, grasses and some forbs). This is being recommended for small grassland sites, but generally not for complex alpine sites.

The downstream face of the Oldman River Dam (southwestern Alberta) was revegetated using (in part) this method. Topsoil from an adjacent native grassland that was to be flooded, was placed on the dam. Three native grasses were seeded into the topsoil. In the first year 11 species were present (including the three seeded grasses). After three years, there were approximately 65 species growing on the disturbed site (approximately 10 native grass species, 50 native forbs, and five native shrubs). After three years, this site was compared to a similar undisturbed site nearby. There were a number of the same species that had established, but the cover figures were different because the earlier succession species tended to dominate on the disturbance.

The second option is to collect or harvest seed and other propagules from the site to be disturbed (or an adjacent site), and increase the stock in a controlled or somewhat controlled setting such as a nursery. The resulting seed and progeny can then be used to revegetate the site. This method ensures a wide variety of species and maintains some of the existing diversity. It allows us to obtain larger quantities of plant materials especially if started several years in advance of the project.

There will be some loss of genetic diversity because there is little possibility of all species being harvested and increased and, in a nursery, there is automatically some selection occurring within a species. There are other problems associated with this method:

1. we do not know how to grow <u>most</u> of our native plants - we require information regarding seed storage, viability and germination, sowing or planting (how, when, and where), harvesting, etc.,
2. we do not have the methods and technologies to replace these plants back on the disturbed sites, and
3. there are still the problems associated with physical changes in the environment, and the adaptability of climax or semi-climax plant species to the new environment.

This method is gaining in popularity since it has several benefits. This is giving us a chance to learn a little bit about some native plants.

These first two methods have some merit, however, a warning must be given at this point. If seeds or other propagules are taken from adjacent undisturbed sites there is a possibility of causing harm to a second site. Guidelines for harvesting wild seeds and propagules are required, especially if and when the sale of native plants becomes lucrative.

A third option is to determine what species grow on the site prior to disturbance and use seeds of the same species from distant sites. This then brings up the whole problem of 'imports'. Some environmentalists believe that it is better to use the same species even from distant sites than to upset the balance by introducing non-natives whereas others believe that carefully selected non-natives are better than introducing distant provenances so as not to dilute and/or contaminate the local gene pool. To the best of my knowledge there have been no studies concerning this problem especially in Alberta or Saskatchewan.

The advantages of this method include:

1. the availability and cost (they are often cheaper than the second option),
2. there is less likelihood that these plants will become extremely persistent and competitive (therefore weedy) as is the case with many agronomic species, and
3. there is still the opportunity that there can be some natural re-invasion by natives from

surrounding or adjacent communities.

Disadvantages include possible problems associated with the adaptability of distant sources; these don't always establish and grow well in harsh environments such as at high elevations, extremely arid conditions, or on saline sites. Consequently there can be a high risk of failure. Imported seeds are often much more expensive than tame species and tracking distant sources can be extremely time consuming and costly.

This is a method that is widely used at present since many companies and government agencies are scrambling to find native plants to live up to public expectations. Many reclamation projects rely heavily on 'natives' brought in from the U.S. from as for away as Utah, Colorado, California, and Wisconsin.

The final source of native material is seeds of selected species, varieties, cultivars, or ecological varieties of native plants.

These generally have some guarantee of quality due to rigorous testing; they have predictable germination, emergence, growth, and yield, and there is information regarding the agronomy (how to seed, harvest, clean seed etc.). These are certainly easier to produce and are, therefore, available in sufficient supplies. Although there may be limited diversity there is no extreme contamination of the local gene pool as is possible with imports. Varieties are now being developed that provide a rapid cover, but that are not highly competitive and do not persist for a long period of time, these can be used to provide an early cover so that native plants can invade from adjacent native areas. Varieties can be selected for use on some of the most harsh sites such as high elevations and highly saline sites.

One disadvantage of this method is the extremely limited genetic diversity. This problem, to some extent, can be solved by using mixture of selected species and varieties. Selection can be long and time consuming process and requires some initial input of funds. Selected species and varieties must be used in very specific sites particularly from near their point of origin and should not be promoted as a single solution for all sites over a wide area.

I am not sure that there is one single source of plant material that can be considered the best. I believe that each of the sources has merit, and that used in combination we may be most successful. There are some actions that can be taken that will allow us to have greater choices and increase the potential for native plants as an attractive alternative.

1. We must develop technologies to use salvaged plant materials taken from the construction site prior to disturbances or from adjacent land to be disturbed.

2. We must develop technologies for growing native plants from all regions. This means both growing plant species to produce seed and propagule supplies, and also knowing how to use these (sow, fertilize, irrigate, etc) at site that require reclamation. At this time we have a good understanding of a few, primarily shrub, tree, and grass species, and a few legumes. Little or no work has been undertaken with many potentially useful plants even such large groups of plants such as the Composites - a large and significant group in grasslands and parklands, and the Ericaceae - particularly for alpine and northern locations.

3. We must develop a nursery trade such that plants species can be produced in appropriate regions.

4. We must document successes and failures. Our successes will allow us to convince industry and government that native plants can be used in reclamation (and ultimately restoration) and their use is a viable alternative to agronomic species. Documenting our failures will allow us to move forward and not repeat the same mistakes.

On a more general note we need basic research on all aspects of the biology and ecology of our

native plants, and our native plant communities. We need to publish and exchange ideas on all aspects of reclamation, not tuck information into shelved reports. There must be a concerted effort made to promote all aspects of reclamation, revegetation, and restoration with native plants to all interested groups including: users,
producers, researchers, regulatory agencies, governments and the general public.

There has been and continues to be an evolution in our thinking regarding reclamation and revegetation. The use of agronomic species was an early stage in the evolution. This evolution continues as more and more land requires reclaiming and revegetating.

Many of us are now convinced that native plants are the best solution to the revegetation problems we face today and there are a range of opinions as to whether reclamation or revegetation is enough or whether we must actually restore the ecosystems that we have disturbed or destroyed. At present we are using only a small number of our native plants due to a lack of knowledge regarding most of our indigenous species and our native plant communities. This in turn leads to the problems of availability and high cost, and high risk of failure.

There are many different aspects that we need to pursue so my advice to anyone that is interested in native plants is to pick an area and start to chip away at the problem.

I have only worked with native plants in revegetation for going on 15 years, but I have some concerns that I would like to voice. I have seen the interest in native plants rise and fall significantly over period. In the late seventies there was a relatively strong push for using native plants in revegetation. It was almost trendy or faddish. I have seen the excitement rise among industry and government agencies when great claims were made regarding native plants and their absolute infallibility - and I have been around trying to explain when these claims proved to be exaggerated.

We can't afford to have uninitiated decision makers at any level see this interest in native plants as a fad - it must be a continuing upward trend. It would be better to progress slowly, and base each step on solid facts, on solid principles, and on knowledge and understanding.

I have a passionate belief that native plants **are** the best and maybe only solution to some of our revegetation problems, and for that matter and on a smaller scale for many urban landscape and garden problems. However, let's proceed forward with enthusiasm, but let's not forget that no one solution is absolute and that a variety of approaches is the key to success.

THE NATURAL VEGETATION OF SASKATCHEWAN

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The purpose of this paper is to present Saskatchewan's major zones of native vegetation, the dominant plant species, and the environmental factors controlling their distribution. The following paper by Dr. Harms will discuss the flora in greater detail.

Understanding of natural vegetation patterns is important for those interested in using native plant material. First, natural vegetation is the source of such material. Second, natural vegetation reflects many centuries of adjustment to the constraints imposed by climatic and other environmental factors. Selection of species which are a natural part of the vegetation in the region of interest will ensure that plant material is well adapted to the local environment.

Saskatchewan shows a clear zonation of climate, with attendant zonation of vegetation and soil, from southwest to northeast. The main climatic factors that affect vegetation are temperature and moisture.

The critical temperature variables are the length and warmth of the growing season, the period warm enough for plant growth. A widely used measure is the number of "growing degree-days", calculated by summing over the growing season the amount by which each daily mean temperature exceeds a threshold of 5° C. In Saskatchewan, the average number of growing degree-days varies from almost 2000 in the south, to about 750 in the far northeast.

The other important factor controlling vegetation is the availability of moisture. Trends in annual precipitation in the Prairie Provinces are a result of the rainshadow effect of the mountain ranges to the west. In Saskatchewan, low precipitation totals are found in the southwest corner, closest to the mountains, with normal values below 300 mm at some stations. Annual precipitation increases northward and eastward, as the rainshadow effect weakens, and some stations in the eastern part of northern Saskatchewan average over 500 mm.

The moisture available to plants depends on both precipitation and temperature. Precipitation is the input into soil moisture, while the main output is evaporation, which increases with temperature. Both decreasing precipitation and increasing temperature from north to south are important in producing climates in which plant growth is limited by lack of moisture.

Zones of vegetation are also related to topography and geology. Variations in elevation are generally modest, with most of the province lying between 300 and 800 m, and only subtle effects on vegetation are observed. However, the Cypress Hills in southwestern Saskatchewan rise abruptly to over 1200 m, causing more obvious ecological changes.

Geologically, most of Saskatchewan lies on soft sandstones and shales of Cretaceous age (or Tertiary age in the far south), which have yielded thick mantles of glacial drift. However, the northern third of the province is dramatically different, lying on the older rocks of the Precambrian Shield. These are largely hard igneous and metamorphic rocks, but the Athabasca region consists of Precambrian sandstone.

Within this setting, distinctive zones of the vegetation have developed. In the broadest terms, the vegetation of Saskatchewan falls into two zones. The southern part of the province is part of the Great Plains grassland which extends through the western United States. The northern part of the province is part of the belt of boreal forest reaching across the northern parts of North America and Eurasia.

At a more detailed level, these zones have been divided into eleven ecoregions, according to the new map (Figure 1) which has been adopted by a number of provincial and federal departments. These ecoregions are based on a combination of climatic, physiographic, and ecological criteria. The actual region boundaries are drawn by aggregation of smaller landscape areas, to facilitate the hierarchical summarization of information. The regions are correlated with similar maps in the adjacent provinces and territories.

The climatic trends among the regions have been summarized in a diagram (Figure 2) showing annual precipitation on the X-axis and growing degree-days on the Y-axis. The ecoregions have been plotted on the basis of climatic records for stations within each region. The upper and lower quartiles of climatic data have been removed, to reduce the overlap between regions and show the trends more clearly.

The coldest part of the province, in the northeast corner, is included in the **Selwyn Lake Upland** ecoregion. There are few climatic stations in this region, but they show 600 to 950 growing degree-days, and precipitation of 310 to 410 mm[1]. Permafrost is discontinuous, but is more widespread than in the regions to the south. This area lies on the Precambrian Shield, and there are exposures of hard bedrock, as well as sandy glacial drift and peatlands.

This region with its short growing season is part of the Subarctic Zone, the transition between the Boreal Forest and the Arctic Tundra. The typical vegetation consists of open woodlands of low-growing black spruce (*Picea mariana*), with reindeer lichens (*Cladina* spp.) and dwarf shrubs occupying the spaces between the trees. The soils on the sandy deposits are Dystric Brunisols--forest soils with rather weak development of A and B horizons.

The following three regions (**Tazin Lake Upland, Athabasca Plain,** and **Churchill River Upland**) share warmer growing seasons, with 910 to 1140 growing degree-days over most of the area, although the southern part of the Churchill River Upland extends to 1290 growing degree-days. Precipitation shows an increasing trend from the Tazin Lake Upland (260-380 mm) to the Athabasca Plain (360-480 mm) to the Churchill River Upland (420-520 mm). Previous maps maps have included these in "high boreal" or "northern boreal" ecoregions.

All three regions are on the Precambrian Shield. However, the Tazin Lake Upland in the northwest and the Churchill River Upland in the southeast are on hard igneous and metamorphic rocks, resulting in rugged rock hills with lakes and streams between them. The Athabasca Plain, by contrast, is on Precambrian sandstone, resulting in lower relief and deep surficial sands.

The climate in these regions is warm enough to support closed boreal forests, with black spruce and jack pine (*Pinus banksiana*) the most common tree species. White spruce (*Picea glauca*) and the hardwoods are restricted to unusually favourable sites, but become more widespread in the southeastern part of the Churchill River Upland, where the climate is warmer and fine-textured lacustrine deposits occur. The deep sands of the Athabasca region support mainly open stands of jack pine with a lichen understory. Typical soils are Dystric Brunisols on sandy material and Gray Luvisols on finer material, while Organic soils with discontinuous permafrost occur in depressions.

Mid Boreal Vegetation is found in warmer climates than the regions considered so far. On the map, this broad zone is divided into two ecoregions. The eastern part is low-lying, part of the basin of Glacial Lake Agassiz, and is referred to as the **Mid Boreal Lowland** ecoregion, while the higher western part, as well as several isolated uplands to the south, make up the **Mid Boreal Upland** ecoregion. Climates in the Mid Boreal Upland have 1230 to 1330 growing degree-days and 420 to 520 mm of precipitation. Temperatures appear to be a little higher in the Mid Boreal Lowland, with 1310 to 1400 growing degree-days, but this may reflect the particular locations of the climatic stations in that region. Precipitation ranges from 430 to 470 mm in the Mid Boreal Lowland.

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[1]Climatic values discussed in the text include a broader range of the data, with only the first and tenth deciles removed, compared to the boxes in Figure 2

Permafrost is rare in the Mid Boreal region.

Geologically, the Mid Boreal ecoregions lie south of the Shield, on Cretaceous bedrock. As in the rest of southern Saskatchewan, the glacial till tends to be loamy in texture, but there are also glaciofluvial deposits of sand and gravel, and clayey lacustrine sediments. Typical soils are Gray Luvisols, which have a leached A-horizon and a clay-enriched B-horizon. The less-developed Brunisols still occur on sand.

The Mid Boreal zone has more variety of vegetation types than the regions further north. Jack pine dominates the dry sandy sites. The typical vegetation on well drained sites is a mixture of trembling aspen (*Populus tremuloides*) and white spruce, with the proportion of spruce increasing as the stands get older, and late-successional balsam fir (Abies balsamea) also appearing. Stands high in aspen tend to have a dense understory of shrubs and herbs, whereas stands higher in spruce have a sparser understory and a ground cover of feather mosses. Balsam poplar (*Populus balsamifera*) is added to the mixture on moister sites, while wet areas tend to be dominated by black spruce. Trees grow faster and taller here than further north, and this is the main region in which commercial forestry is practised.

Peatland is an important part of the landscape throughout the boreal forest. Peatlands vary in vegetation depending on their water chemistry. The more acidic peatlands are called bogs. The surface is *Sphagnum* moss, and heath shrubs such as Labrador-tea (*Ledum groenlandicum*), leatherleaf (*Chamaedaphne calyculata*), and cranberry (*Vaccinium vitis-idaea*) are common. Some bogs are treed, with very slow-growing black spruce. Less acidic, more nutrient-rich peatlands are called fens. Sedges (*Carex* spp.) tend to replace *Sphagnum* as the main ground cover. Tamarack (*Larix laricina*) appears with black spruce in treed fens, and swamp birch (*Betula glandulifera*) and speckled alder (*Alnus rugosa*) are common shrubs.

The Mid Boreal Lowland ecoregion has extensive areas of low-lying peatland. In the Cumberland Delta there are also islands and levees of alluvial soil which are highly productive for tree growth. Along with white spruce and balsam poplar, there are stands of American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), and Manitoba maple (*Acer negundo*), species which come into Saskatchewan from the east along river valleys.

The southern edge of the boreal forest is the **Boreal Transition** ecoregion. Temperatures tend to be warmer (1240 to 1470 GDD) and precipitation lower (390 to 490 mm), but there is considerable overlap with the Mid Boreal ecoregions. This area is often included with the Mid Boreal as "southern boreal" or "boreal mixedwood", but some other maps separate it as "low boreal" or "mixedwood-parkland transition". Many Saskatchewan people think of this area as the "forest fringe".

Conifers are on the retreat in this somewhat drier climate, and much of the native vegetation on uplands is pure aspen forest. However, white spruce appears in moist sites, spruce and jack pine on sand plains, and black spruce and tamarack on peatlands. The first patches of upland grassland appear in this region, for example on steep south-facing slopes. Much of the land is cultivated, with straight edges on the remaining blocks of trees showing that the fields have been created by clearing. Gray Luvisols are still found here, but there are also areas of Dark Gray Chernozemic soils, transitional to the grassland soils found further south.

The next zone, the **Aspen Parkland**, is still warmer (1440-1660 GDD) and drier (370-470 mm). This is the true zone of transition between forest and grassland. The conifers have dropped out of the vegetation altogether. Grassland occurs on ridges and south-facing slopes, and aspen stands on the cooler north-facing slopes and depressions. The balance between forest and grassland depends on fire. With the fire suppression that has accompanied agricultural settlement, aspen stands have tended to expand, and shrubs have also spread into much of the grassland. Regular burning, which is probably what happened before settlement, leads to contraction of the woody cover and expansion of the grassland.

The typical grassland here is fescue prairie, dominated by a single species, rough fescue (*Festuca hallii*). However, other grasses and forbs tend to replace fescue when the grassland is heavily grazed. Kentucky blue grass (*Poa pratensis*), which is considered by some scientists to be mainly of exotic origin, has encroached on much of the fescue grassland. Because of the widespread cultivation in the Aspen Parkland region, fescue prairie is a threatened ecosystem type.

The soils in the Aspen Parkland are Black Chernozems. These are grassland soils, in which a dark A-horizon has been formed by decomposition of the fibrous grass roots. The climate is dry enough that there is only limited leaching of humus and nutrients away from this A-horizon.

With increasingly warm and dry climates, upland aspen stands disappear, and grassland covers most of the natural landscape. The grassland zone of Saskatchewan has been divided here into two regions. The **Moist Mixed Grassland** is the somewhat moister portion, with 1560 to 1750 growing degree-days and 330 to 410 mm of precipitation. The **Mixed Grassland** ecoregion is the somewhat drier portion, with 1590 to 1750 growing degree-days and 320 to 400 mm of precipitation.

The term "mixed grassland" refers to the mixture of mid-sized grasses with shorter grasses and sedges. Mid-grasses include the spear grasses (*Stipa comata, S. curtiseta, S. viridula*) and wheat grasses (*Agropyron dasystachyum, A. smithii*), while the short species include blue grama (*Bouteloua gracilis*), June grass (*Koeleria cristata*), and a number of dryland sedges (*Carex* spp.). The balance between mid-grasses and short grasses varies with climate, soil, and grazing pressure. Short grasses are more prominent in the drier parts of the region, and on drier soil types. Extended drought leads to shifts in relative abundance in favour of the shorter species. Grazing also tends to discriminate against the more accessible mid-grasses, leaving a higher proportion of short grasses, as well as of unpalatable forbs. However, our grasslands are generally dominated by mid-grasses except on extreme soil types or on heavily overgrazed pastures.

Trees are absent from most of the upland landscape. However, especially in the Moist Mixed Grassland, aspen stands may still appear as rings around wetlands. Riparian woodlands, with plains cottonwood (*Populus deltoides* var. *occidentalis*), green ash, and Manitoba maple, are characteristic features of streams throughout the grassland region. In addition, a wide variety of shrub communities occupy depressions and gullies where moisture is enhanced. Major species include western snowberry (*Symphoricarpos occidentalis*), Wood's rose (*Rosa woodsii*), wolf-willow (*Elaeagnus commutata*), chokecherry (*Prunus virginiana*), saskatoon (*Amelanchier alnifolia*), and hawthorn (*Crataegus* spp.).

Unusual soil types produce different kinds of vegetation. Sand dunes have grasses such as sand reed grass (*Calamovilfa longifolia*), Indian rice grass (*Oryzopsis hymenoides*), and sand dropseed (*Sporobolus cryptandrus*), along with much more woody cover than found on finer soils. Shrubs such as chokecherry, wolf-willow, and creeping juniper (*Juniperus horizontalis*) are part of the grassland mosaic, and aspen stands occur in hollows or flats.

Saline soils are common in the grassland ecoregions, and support halophytic species such as salt grass (*Distichlis stricta*), alkali grass (*Puccinellia nuttalliana*), and a variety of forbs. Freshwater wetlands are also widespread, supporting submergent plants such as pondweed (*Potamogeton* spp.), floating plants such as pond-lily (*Nuphar variegatum*), and emergent plants such as cat-tail (*Typha latifolia*), bulrushes (*Scirpus* spp.), and sedges.

The typical soils in the grassland ecoregions are Chernozems, similar to the soils found in the Aspen Parkland, but with less accumulation of organic matter because of the drier climate and lower plant production. The Moist Mixed Grassland corresponds roughly with the Dark Brown soil zone, and the Mixed Grassland with the Brown soil zone, reflecting the gradual decrease in humus content and resulting darkness of the A-horizon.

Over most of Saskatchewan, changes in elevation are modest enough to cause only subtle changes in the vegetation. However, the **Cypress Hills** form a plateau with elevations over 1200 m, roughly 400 m higher than the plains to the north. This elevation change produces both cooler temperatures and higher precipitation. There are only a few climatic stations, but growing degree-days range from 1520 down to 1260, roughly spanning the range from Aspen Parkland to Mid Boreal ecoclimates. Precipitation totals vary from 430 to 520 mm, similar to those found in the Mid Boreal.

The natural vegetation shows a dramatic response to this climatic gradient. The Mixed Grassland of the surrounding plains gives way with rising elevations to fescue grassland, often with abundant shrubby cinquefoil (*Potentilla fruticosa*). Aspen Groves appear on moist sites. On the highest areas, aspen is joined by white spruce and lodgepole pine (*Pinus contorta*). This is the only location in Saskatchewan where lodgepole pine and a number of other montane plant species are found, and in fact the Cypress Hills forests appear to be outliers of the Rocky Mountain forests about 250 km to the west.

Saskatchewan has a wonderful diversity of natural vegetation. However, significant proportions of some kinds of vegetation have been lost or damaged. The productive soils within the Mixed Grassland, Aspen Parkland, and Boreal Transition regions have largely been cultivated, restricting native vegetation to areas which are too steep, sandy, saline, or wet for cropland. Other land has been claimed by towns, roads, railways, transmission corridors, and oil and gas development. Some of the remaining native areas are threatened by heavy grazing and invasion of exotic plant species, including both accidentally introduced weeds such as leafy spurge (*Euphorbia esula*) and intentionally introduced forage species such as smooth brome grass (*Bromus inermis*). Native plant material may be a useful tool for rehabilitation of some of the land that has been disturbed, but complete restoration of native ecosystems in all of their complexity may be difficult to achieve, especially over large areas. The most important point on which people interested in native plants should agree is the need to conserve our remaining areas of native vegetation, through a combination of protection and good resource management.

AN OVERVIEW OF THE FLORA OF SASKATCHEWAN

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I. Introduction

The topic of my talk today is "An Overview of the Natural Flora of Saskatchewan". Following upon the preceding talk that presented an overview of the native vegetation in Saskatchewan, we need first to clarify the distinction between "flora" and "vegetation".

VEGETATION refers to the plant community types present in a region as usually defined by the dominant species and their structural characteristics of life form, coverage, longevity and stratification (i.e. a community concept based on quantitative and qualitative relationships of the various plant species present). The term "vegetation" reflects an ecological approach directed toward determinations of plant "community" associations or types.

FLORA refers to all of the plant species present in a region (i.e. the total spectrum of the plant life of a region in a taxonomic sense). "Floristics" represents a taxonomic approach to the study of plants,directed towards determining plant species composition, individual and concurrent species ranges, and interpretations of these. Floristics tends to recognize and emphasize the presence and importance of rare species, which the vegetational or ecological approach may overlook.

II. Plant Numbers in the Flora:

There are about 1600 species of vascular plants naturally occurring in Saskatchewan. Of these, about 1300 are native (i.e. indigenous to the province), while about 300 are introduced (i.e. exotic), having arrived either as invasive weeds or escaping cultigens that have become naturalized. These are only approximations rather than precise numbers, since species concepts differ, and especially now, numbers are in some flux because of a multitude of new taxonomic revisions of families and genera for the major Flora of North America Project that is in progress. About 200 species have been added to the province's natural flora since Breitung's 1957 **Annotated List,** roughly half or somewhat more of these being newly recognized native species overlooked and unrecorded before, and the rest exotic species that may, or may not, have been here before. Cultigens that do not escape to establish themselves naturally in the wild are not considered part of the natural flora and are omitted from floral manuals and lists of natural regional floras. Introduced plants that occasionally are found growing in nature outside of cultivation but which are not really naturalized (i.e. established and propagating in the wild) are considered only adventive species and also are not accepted as part of the natural flora.

III. Distribution of the Native Flora:

The native plant species in Saskatchewan may be less numerous than in some similar-sized regions such as more eastern or Pacific North America. Yet the Saskatchewan native flora is much more diverse than is often realized. From south to north, Saskatchewan stretches across 11° of latitude, and the equivalent climatic zones. Six general vegetational zones occur in the province, from dry short mixed-grasslands in the extreme south and southwest, to more mesic mixed-grasslands, aspen-parkland, southern and northern boreal forest, and subarctic transitional lichen/woodland in the northeasternmost corner. Within these zones, a variety of vegetation types exist, each with successional and mature stages (eg. forests, shrublands, grasslands, wetlands, etc.). The nature and species composition of general plant community types differ greatly between the zones and subzones. Even within general vegetational zones, the plant community compositions vary considerably from east to west across the province. For example, in the general southern boreal forest zone, the same general forest stand types (eg. aspen, white spruce, or aspen/white spruce mixedwoods) vary significantly in terms of actual floristic composition between the Meadow Lake area in the west, Prince Albert National Park in the centre and the Pasquia Hills in the east.

The same is true within the general mixed-grassland zone, with the actual floristic composition of natural grassland communities differing considerably, for example, between the Souris River Valley, the Grasslands National Park, the Regina-Moose Jaw plains, the Last Mountain Lake-Allan Hills area, and the Beechy to Battleford Missouri Coteau Hills.

As implied already by saying that floristic compositions differ with the vegetational zones and types, ecological factors obviously play a major role in plant distributions.The floristic composition of different plant communities varies with the different ecological habitats, as a result of adaptations developed over long evolutionary histories. The native plant species and their component ecological races (=ecotypes) have all developed their peculiar tolerances to all factors of the environments in which they evolved. But the nature of plant distributions goes beyond just reflecting ecological factors of the environment . History and chance have also played major roles. Past major paleomigrations of floras with major climatic changes, especially in post-glacial times, have left their imprint on the mix of species now found in Saskatchewan, in the persistence here of particular floristic elements. (Floristic elements are groups of species with a common origin and migrational history which now may be intermixed with species having had different origins.) The superposition of plant distributions based on ecological factors and paleomigrations allows the definition of phytogeographical or floristic regions. But such floristic regions and subregions have never been well defined for Saskatchewan, although needed because it is apparent that the ecologically defined vegetational zones and types only partially reflect the distribution of floristic compositional types. Our present map shows some rough centres of concentration of different floristic elements in Saskatchewan, based on the concurrence of multiple species' ranges. Lacking peripheral boundaries, these do not represent floristic regions.

Some Saskatchewan centres of floristic elements are the following:

1. The Cypress Hills show a concentration of a Cordilleran (i.e. Rocky Mountain) floristic element. Several hundred plant species could be used as examples, including Lodge-pole Pine, Pine-drops, Giant Rattlesnake-plantain, Lance-leaved Spring-beauty, White Wild Geranium, Sticky Purple Geranium, White-flowered Hawkweed, Western Saxifrage, Linear-leaved Spring-beauty, Dagger-rush, Woodland Star, Meadow Wild Barley, Wolf's Trisetum, Large Yellow Monkey-flower.

2. A foothills-intermontane grassland element can be seen in southwestern Saskatchewan (eg. White-stemmed Evening-star, Rocky Mountain Juniper, Idaho or Bluebunch Fescue, Smooth Boisduvallia, Squirrel-tail Grass).

3. A Great Plains grassland element in southern Saskatchewan includes a multitude of species.

4. A tall-grass prairie element centres on the Souris River valley in SE Saskatchewan but with outlying influences along the eastern edge of the province (eg. Tall Bluestem, Sideoats Grama, Indian-Grass, Prairie Cord-grass, Switch-grass, Whorled Milkwort).

5. An eastern deciduous forest element centres in the Pasquia and Porcupine Hills, and to a somewhat lesser degree in the Cub Hills, Duck Mountain, upper Assiniboine watershed, and lower Qu'Appelle and Souris River Valleys (eg. Bur Oak, American Elm, Green Ash, Sand Cherry, Inland Wood Anemone, Ram's-head Lady's-slipper, Fringed Milkwort, Bog Twayblade, Nanny-berry, Closed Blue Gentian).

6. An arctic-subarctic centre is found in northeastern and northernmost Saskatchewan, but with some species extending further southward to Clearwater River, Cree Lake and Wollaston Lake. A secondary centre of subarctic plants is disjunctly located much farther south in the Pasquia

and Porcupine Hills (eg. Alpine Grass-of-Parnassus, Spear-leaved Arnica, Mountain Bistort, Crowberry, Red Alpine Bearberry, Ashy Whitlow-grass, Hairy Butterwort, Narrow-leaved Labrador-tea, Trailing Azalea, Small False Asphodel).

7. The south shore of Lake Athabasca constitutes an important centre of endemism in Canada, with 10 endemic taxa found only here, mostly on active sand dunes or wind-swept gravel-barrens. These endemics include Inland Sea-thrift, Large-headed Woolly Yarrow, Mackenzie's Hairgrass, Impoverished Pinweed, Floccose Indian Tansy, Sand Chickweed, and four willows.

8. The Saskatchewan boreal forest zone includes some plants of a western boreal forest element (eg. Tall Larkspur, Awlwort, Mountain Alder, Clinton's Rush, Western Water-hemlock, Western Mountain-ash, Northern Goldenrod).

9. An eastern boreal element is also included (eg. Showy Mountain-ash, Selkirk's Violet, Speckled Alder, Eastern Water-hemlock, Bristly Sarsaparilla, Red-berried Elder).

IV. Rare Plant Species in Saskatchewan:

Rare plant species are a small but important part of the flora of Saskatchewan, telling us much about the flora, and also representing an early warning system because of their susceptibility to environmental change.

Based on the latest listing (Harms, Ryan and Haraldson, 1992. Nature Saskatchewan Report), a total of 367 taxa of vascular plants are provincially rare in Saskatchewan. Of these, 43 are categorized as endangered, 101 as threatened, and 217 as vulnerable; 5 are likely extirpated; 10 others were excluded because of too uncertain a status or uncertain taxonomy. A total of 81 vascular plant taxa in the Saskatchewan flora represent nationally rare plants. Perhaps they should instead be called candidates for national rarity, but in fact, as far as plants in Saskatchewan and western Canada are concerned, the official COSEWIC list is too incomplete to be very meaningful.

For an April, 1993, workshop conference on the protection of "Saskatchewan Special Places", we compiled maps showing some "hot-spots" (i.e. centres of concentration) of both provincially and nationally rare native vascular plants in Saskatchewan. These maps seem quite revealing in regard to our flora with the rarity "hot-spots" often correlating with the recognized centres of floristic regions and elements in the province. The ultra hot-spots (concentrations of 40+ rarities) are the Cypress Hills region, the Lake Athabasca South Shore and the North Shore, the lower Souris River Valley, the Pasquia Hills, and the subarctic northeasternmost corner of the province. Some major hot-spots (30-39 rarities) include the Porcupine Hills, Cluff Lake, and the Greenwater Lake-Barrier Lake-Nut Lake region. Other important hot-spots (20-29 rarities) include the lower Frenchman River-Wood Mountain (i.e. the Grasslands National Park) area, the Candle Lake-Cub Hills area, Amisk Lake, lower Qu'Appelle River valley, Duck Mountain, Nut Hills (or western Porcupine Hills), Stony Rapids-Black Lake, lower Red Deer River Valley (or Porcupine Plains), Southend-Waddy Lake, and the Missouri Coteau west of Moose Jaw. The major and more important hot-spots (i.e. concentrations) of nationally rare plants in Saskatchewan, with the exception of the Lake Athabasca south shore with its unique endemics, are largely concentrated relatively near the U.S.A. border, perhaps indicative of their usual peripheral nature here. The major Saskatchewan centres of nationally rare plants are the Grasslands National Park and Cypress Hills areas.

V. Maintenance of Natural Floristic Diversity:

The maintenance of natural biodiversity is seen as one of the most critical environmental concerns for today and the future. Central to this concern, is the need to preserve floral and faunal species diversity in natural ecosystems.

An environmentalist's creed to preserve our natural biodiversity:

1. "Keep all parts...for all time" -Aldo Leopold.
2. There are no dispensable parts of ecosystems.
3. A goal should be no loss of species.

We should remember that forests are more than timber-trees, native prairies are more than forage-grasses, and wetlands are more than game-bird habitats. Rather they are natural ecosystems composed of hundreds (perhaps thousands) of plants, animals, and microorganisms. All have their importance in nature.

I think that too often plants are underrated in ecosystem-thinking. Native plant species are all true inhabitants of our natural forests, grasslands, shrublands, wetlands, etc. They are not just products or resources for human exploitation, and neither should they be considered only in the context of representing "habitat" for faunal wildlife. They have a natural heritage value equal to all other wildlife.

If natural resources (either plants or animals) are to be exploited from the wild, there is a critical need to carefully manage and regulate their harvesting (or prevent it) in ways that best protect the natural diversity of native species and the ecosystems they comprise.

Personally, I think there are serious ethical questions existing with regard to harvesting native plants from the wild. Such once relatively numerous plants as Seneca-root, Northern Valerian, Alum-root, Colt's-foot, Yellow Pond-lily, and Yellow Evening-primrose can hardly tolerate massive annual harvesting from nature. Even species populations that now would appear quite abundant, such as Labrador-tea, American Licorice, Common Bearberry, Common Horsetail, Wild Sarsaparilla, Ground-pine, Red-osier dogwood and Woolly Yarrow, can hardly not be affected adversely by long continued massive harvesting from nature. The 1993 Mater Report on "Special Forest Products Market Analysis" produced by Weyerhauser Canada indicates an annual harvesting from nature of about 2500 tons of the native fern-ally, *Lycopodium dendroideum* (Ground-pine), - a quite appalling figure to my mind, despite the fact that this is now a fairly common species. Some of the apparently targeted native species for use in Saskatchewan would seem much too rare or borderline-rare provincially to tolerate harvesting from the wild, including the Purple Coneflower, Sweet Flag, Stemless Lady's-slipper, and Pitcher-plants. *Sphagnum* (Peat-moss) and other mosses may be very abundant in boreal Saskatchewan, and their supply may seem almost unlimited. But let us not forget that these mosses do not exist just to themselves, - they form the habitats for other species. When I hear figures bandied about concerning the possible commercial extraction of thousands of tons of peat-moss annually, what I personally envision is the gradual but relentless destruction of the natural bog and muskeg habitats of rare native orchids, sundews, beak-rushes, etc. The above comments are all prompted by my primary concern for the maintenance of natural biodiversity (specifically floristic diversity) in Saskatchewan's still remaining natural ecosystems. I think that there needs to be careful management and regulation of any native plant harvesting, and for many species, field or garden culturing would seem much preferable to collection from the wild, if an already existing agricultural the land-base is used for such.

But, a potential "ethical" concern also seems to exist with regard to the cultivation of native species, especially if genetically altered cultivars of native species are developed and used, because of the risk that they may spread into adjacent native areas, altering species' original gene pools. The problem is compounded if genetically altered or genetically narrowed cultivars of native plants are used in restoration ecology, in that they may compromise genetic diversity as well.

USES OF NATIVE PLANT MATERIALS IN SASKATCHEWAN - AN OVERVIEW

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Introduction

There are three general ways in which we make use of native plant materials in Saskatchewan. These are:

1. use of native plants in their natural setting (ie. uncultivated rangelands),

2. use of native plant materials that have been harvested from the wild,

3. use of native plants as cultivars and for cultivar/ecovar development.

I. Uses of Native Plant Materials in Natural Settings

Most of Saskatchewan's native plants are used for livestock grazing and this is a key industry for the province. It is estimated that there is approximately 24 million acres of pasture and native rangeland and of this, 2.6 million acres are publicly owned in the form of provincial and PFRA community pastures (provincial grazing leases are not included in these figures). Sixteen million of the 24 million acres are believed to be native range. The provincial livestock population is estimated at 2 million head of cattle and about 100,000 sheep (Dill, 1994).

In addition to livestock grazing these non cultivated lands are key areas for wildlife habitat and use is both consumptive (ie. hunting) and non consumptive. Both types of uses of wildlife are economically important activities. Non consumptive values may include wildlife viewing, photography, berry picking, etc. Ecotourism is emerging as a possibility for economic diversification and we already have vacation ranches who will take guests on cattle drives and wildlife viewings.

Historically, Saskatchewan's native plants were important commodities for aboriginal people and settlers for both food and medicine, and some of this use undoubtedly still occurs. Many possible future uses (both medicinal and for food) remain untapped, so the potential value of these intact ecosystems is unknown. Other non-market values such as spiritual values and biological diversity/ecosystem integrity are difficult (if not impossible) to place a value on.

National, provincial and regional parks consisting of native plants are important for biodiversity, wildlife habitat, education, and recreation. These types of publicly owned lands are managed under different objectives than are private and public lands used for agriculture (such as grazing) and represent opportunities to observe how different management strategies affect native plants. Some of the 33 provincial parks in Saskatchewan allow livestock grazing.

Public lands (and private lands, to some extent) act as a source of native plant materials. It will be these lands in which other uses of native plant materials will ultimately depend. Materials can be used directly (for revegetation using native harvests) or they can also be used to develop other types of native plant materials such as cultivar and ecovars.

Generally, some type of permit is presently required to collect native seed from publicly owned lands. However, there is a need to develop collection guidelines so that native plant use will not compromise the ecological integrity of the collection sites.

II. Uses of Native Harvests

Wildlife Habitat Canada staff at Last Mountain Lake (a National Wildlife Area) have been collecting and propagating native plants for wildlife habitat restoration. A wide array of machines and technical devices have been used to try and unlock the secrets for use of native plant materials. Native plants are enjoying renewed interest by the public and we now have a few small greenhouse operations who supply field grown and greenhouse grown native perennials for urban dweller's horticultural use. A volunteer group has started a small native planting at the Provincial Museum in Regina. Seeds were collected from the wild, grown in greenhouses and then planted at the site. Use will be aesthetic and educational.

Various groups including the University of Saskatchewan, Ducks Unlimited and the SaskPower Shand Greenhouse are interested in propagating winterfat for use in wildlife habitat plantings. Ducks Unlimited has identified a listing of native forbs that they would like to utilize in their dense nest cover sites.

One interesting use of native harvests is the harvest aquatic plants from lakes for end use as fertilizers and land amendments. This activity may be undertaken to remove unwanted plants so that fish habitat can be improved or to provide greater ease of recreational boating.

Native plants such as saskatoon, pincherry, chokecherry and wild mushrooms may be harvested directly for domestic food use.

III. Use of Native Seed - Cultivars and Ecovars

The primary present uses of native grass cultivars are for wildlife habitat restoration and reclamation of disturbed native rangelands. Seed mixes typically include western wheatgrass, northern wheatgrass, slender wheatgrass and an American variety of green needlegrass. At this time there are 10 Canadian cultivars of 5 native grass species. This is in contrast to the USA where 54 cultivars of 17 different species have been developed to date (Joyce, 1993).

Ducks Unlimited Canada is a key purchaser of native grass cultivars in Saskatchewan and since 1989, approximately 12,000 acres have been reseeded (about 2-3000 acres per year). It is estimated that annual demand by Ducks Unlimited across the prairies is around 100,000 pounds (Joyce, 1993). To date, all native cultivars have been purchased from outside sources, but Ducks Unlimited staff in Saskatchewan are starting to assemble some wild harvests and propagate seed from these seeded stands for their own use. Other examples where native grass cultivars, trees and shrubs were used to create wildlife habitat include the Rafferty/Alameda Mitigation Lands in southern Saskatchewan.

Native cultivars have been used by various utility companies to reclaim disturbed native prairie. Different projects include reclamation of pipelines, transmission lines and oil/gas well sites. Native cultivars are a more dependable and economically feasible alternative to using wild harvested seed but there is a need to learn how to economically reseed some of these areas with native harvests that will be more locally adapted, especially where ecological integrity is an objective.

Introduced species typically do not have the same grazing characteristics as native range and do not work well in reclamation where the primary use is livestock grazing. Seedings of crested wheatgrass in native range are left ungrazed which represents a loss of forage in the long term. Thus, the use of native species in reclamation of native range is of interest to stockgrowers who own native range. Livestock operators are also interested in solid seedings of native grasses that will retain their palatability and forage value into late fall and early winter (a time when forage quality is most likely to be low on most operations). Duane McCartney's research (Melfort Agriculture Research Station) has demonstrated that "Lodorm" green needlegrass holds up well under mob grazing.

Five different Agriculture and Agri-Food Research Stations across the prairies are presently evaluating 12 different American cultivars for suitability and adaptability to the Canadian prairies. Scott Wright (Melfort Agriculture Research Station) is presently working with Ducks Unlimited Canada to develop ecovars (porcupine grass, needle-and-thread, etc.) that could be used for wildlife habitat. Needle-and-thread is also one of the most important grasses on native ranges for livestock grazing (Looman, 1983). Paul Jefferson (Swift Current Agriculture Research Station) is working on prairie sandreed, a grass that grows on sandy rangelands. Sandy areas are one of the most difficult sites to reclaim after disturbance, so this species will have great value in reclamation.

Most of the work undertaken with trees and shrubs at the PFRA Shelterbelt Centre in Indian Head could be placed in the group of "ecovars" (Schroeder, 1994). The Shelterbelt Centre is currently involved in collecting between 150-200 accessions of native trees and shrubs, including buffalo berry, chokecherry, western snowberry, rose, hawthorn, wild plum and dogwood. These will be tested for adaptability to the prairie environment and staff will be propagating them from seed. End uses will be for conservation plantings (shelterbelts) and wildlife habitat.

Numerous cultivars of saskatoon are used in commercial operations in Saskatchewan. Uses include U-pick operations, commercial jams, jellies and saskatoon chocolates as well as garden plantings by the general public for home use. Other native plants continue to be assessed for these types of markets.

Summary

Native plants are important to the economy and ecological well being of Saskatchewan and numerous market and non-market values still remain unidentified to date. Diverse use of native rangelands, plant materials from native harvests, and native cultivars is presently occurring in the province. Niches exist for ecovar development. Overall activity using native plants is much wider than most people realize and the level of interest in native plants is high. Multiple partnerships presently exist and will be required in future to ensure that even greater use and appreciation of native plants is achieved.

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BEAUTIFYING A LANDSCAPE WITH NATIVE PLANTS

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My topic today deals with the use of native plants for beautification. I am going to focus on describing various local sandhill prairie plant communities and the abiotic processes and features that support them. My intent is not to deal with the actual establishment process but to cover a variety of plants, some which are already used in our landscaping, such as native junipers.

Before I get into any specifics I am going to define the word "beautification" as the enrichment of a landscape for the betterment of our mental and spiritual well being. A rich landscape appeals not only to our sense of sight but also to our sense of taste, touch smell and hearing, in short to our entire being. There is another quality to a landscape that is crucial to its success in my opinion. That is its ability to raise interest and excitement through the element of discovery. I believe it is important not to judge a landscape solely on the basis of how it looks. Quite often these landscapes end up over-manicured and sterile, a green desert if you like. "IF IT LOOKS GOOD IT IS GOOD" is an attitude that should be challenged. A landscape doesn't have to necessarily look good to enrich us. I remember a few years ago we lost two poplars in the back yard. My neighbours and I both agreed that the skeletons should be removed as they were quite unsightly. Well, not so to the local bird population. Before I knew it we had flickers visiting on a regular basis. These poplars became a focus of activity. I soon realized that in death the poplars were providing life. We had become a bird watchers paradise. We took the trees down anyway to beautify our yards. But I wonder if the yard wasn't better with them. For anyone who enjoys watching woodpeckers, eastern kingbirds and many other birds, I'd recommend planting a few dead trees. And if you need help just phone me, as I'm an expert at planting them.

This story is just a small example of the element of surprise and discovery that happens when we care to tune into our natural world. Each surprise encounter whets the appetite to learn more about this world we often take for granted. But when we do take time to explore it a certain rhyme and reason becomes apparent. An organized pattern of colour and texture, a harmony emerges that is reminiscent of a fine oil painting or a good tune on the radio, only better. And the selection of masterpieces is infinite as we move through time and space through the landscape. Everything is a continuum that evolves and transforms. So it is with our natural vegetation.

So why aren't people using this system of infinite rhyme and reason more often as a blueprint for planting up a landscape? Perhaps it is simply a matter of ignorance. We just haven't taken time to stop and smell the prairie roses. Or maybe it is a case of arrogance. We have improved on nature and glory so much in our past technological achievements that we simply and honestly believe we can further improve on nature. Or maybe it is simply a case of survival mentality. Some scientists believe we favour those landscapes that provided our ancestors with the best chance for survival. Or could it be we simply won't put up with the annoyances, even the occasional one, that come from a diverse environment. You know, those crickets getting into the house and keeping us up all night, or those gophers that "threaten our health" as a Saskatoon T.V. reporter coaxed and coerced out of an unsuspecting resident this past summer and, of course, the ever annoying "hay fever" syndrome that makes us feel like we have a permanent code in the node. Or maybe it is simply our deep-seated need to be active and creative. WE have to create something from nothing to really feel good about ourselves. Whatever the reason I believe we are at a turning point in our relationship with Mother Nature and it is fast coming the time when many of us will look to her for guidance when we plant up our yards and cities.

With that lengthy introduction out of the way I will give some examples of Mother Nature's blueprint found in the sandhills environment of the Meewasin Valley here in Saskatoon. This is my favourite landscape. The sand dunes at Beaver Creek and Cranberry Flats have some of the best displays of wildflowers in the valley. For example here is an unusual plant that has very showy sepals. It is an early pioneering plant found on open sand. Sand dock is not very common and is always a nice surprise. Another showy flower found in active sand dunes is the annual sunflower which often graces our roadsides. One of my favourite grasses is Canada wild rye. The graceful nodding heads add visual interest well into the winter season. Open sand dunes and blowouts slowly fill in with plants. A solid plant cover results when colonizers such as sandgrass, bearberry and juniper take hold. The resulting stabilized landscape is characterized by a profusion of wildflowers and prostrate shrubs including junipers which are the only two species of evergreens in the Saskatoon area. It makes a great place to picnic or just to lay back on the thick green carpet and enjoy the fragrance of the juniper. Bearberry is the other common groundhugging shrub. Site conditions such as groundwater and slope steepness and aspect creates a wide variety of vegetation communities in this newly colonized sere.

One of the more unusual communities I will call the enchanted forest. Here we find an unusual mix of aspen, a very open understorey and a thick green groundcover of bearberry and juniper. The aspen can take on a gnarled stunted appearance on sites with marginal growing conditions. On other sites we can find youthful vigorous aspen and on still others over-mature stands. The understorey is also variable and more vigorous shrub growth does occur.

On more xeric sites we lost the aspen and find shrubs as the dominant. Two shrubs that are particularly useful for landscaping are the common juniper and the wolf willow. Robust specimens of common juniper can reach 2 m in height and add a pleasing accent to the landscape. Wolf willow has a wide ecological tolerance and its silvery colour blends and contrasts well with other shrubs. In this slide it is particularly effective in highlighting the juniper. The dominant shrub on sandhills is chokecherry. It is a good source of food and provides exceptional colour in the fall. Its growth and berry production in sandhills is prolific. Rose is another common shrub that has similar qualities and even the maligned poison ivy provides good fall colour as you can see in the foreground of this slide. Moving to the driest sites we lost the tree and shrub layers as well as the bearberry. We are left with a ground layer dominated by creeping juniper and a wide variety of wildflowers. Purple prairie clover, early and late yellow locoweed, hairy golden aster, blue and yellow flax, dotted blazingstar and low goldenrod are but a few. At Cranberry Flats the unusual is the order. We know that violets are blue but here we also have a yellow variety. And in addition to the blue flax we have a yellow one. In contrast to the dry hilltops we move to the most mesic community type. We call this the birch flats as it is characterized by river birch on a level site. Groundwater is a dominant influence supporting the river birch but the community still retains the characteristic prostrate shrub ground cover. These small patches attract flocks of cedar waxwings and increase the structural diversity of the vegetation in areas that support few trees or shrubs. When dead trees occur they provide excellent perches for insect gatherers such as flycatchers.

Over time the landscape evolves yet again. The nitrogen fixers such as lichens, various legumes and wolf willow together with the gradual accumulation of organic material slowly gives dominance to the cool season grasses that characterize the mixed grass prairie. This prairie type has its own charm and grace with depressions with centres of golden solidago or mauve bergamot ringed by snowberry which is in turn ringed by wolf willow which is in turn ringed by the cool season grasses and so on and so forth. Here we also find silver coloured plants like Psoralea agrophylla or prairie sage amidst the cool season dominant grasses.

The dominance of cool season grasses is in direct contrast to the lack of them in the sandhills habitat. It is perhaps a lack of cool season grasses that so marks the sandhills as a unique and appealing environment. That is not to say that there are no cool season grasses. There are but in small quantities and they tend to be dwarf, compact and bunched. Two classic examples and among the most common cool season grasses on the sandhills are June grass and sheeps fescue. A horticultural variety of sheeps fescue which has a strong blue tint is often specified for use in wildflower beds by wildflower seed companies. June grass is another excellent choice for mixing with wildflowers. But put a mix of these grasses and wildflowers in a rich soil with plenty of water and I'll bet dollars to donuts that the cool season grasses will not only dominate but will eventually kick out every one of those wildflowers. How many times have I walked over a natural landscape that has a spot of topsoil scraped out to the mineral soil with a resulting thick patch of wildflowers and a sprinkling of sheeps fescue or June grass. These spots are so rich in colour they make you stop and look for a while. And how many times do we plant our wildflowers in a bed of rich topsoil. Soil defertilization is a technique well accepted for establishing wildflowers. The other group of plants I haven't mentioned yet which also tend to favour a mineral soil are the warm season grasses. These tend to have richer colours than the cool season grasses. I am thinking specifically of Little Bluestem and to a lesser extent Blue Grama. Also Muhlenbergia can take on a richer colour. Now I admit that these colours are generally subtle as compared to the wildflowers but they can add interest late in the season adding some balance and depth to our community of plants.

Reducing soil fertility, at least the total available nitrogen also enhances biodiversity. This is a well documented concept in aquatic environments and it appears to hold true for terrestrial ones as well.

One of the main advantages of this sandhills ecosystem is its ecological stability. Due to its relative infertility and droughtiness there aren't many exotic plants that can naturalize in this environment. This translates to reduced weed control and together with no watering or fertilizing we have a low maintenance landscape. A disadvantage is the fragile nature of this landscape to mechanical wear and tear. Well designed trails are critical to the success of this landscape.

Another low maintenance aspect of this and most local natural landscapes is their ability to regenerate after a disturbance. Take for example the idea of replacing trees and shrubs. This is a labour intensive proposition and is one of the reasons administrations resist planting more trees. I suggest we follow Mother Nature's example and recycle them instead. The recycling method used here cost about $10 for the area you see in this slide. Now at about 5 chokecherry saplings per square foot on approximately 6000 square feet we are producing 30,000 saplings for $10, or about three for a penny (including G.S.T.). And we don't have to plant or water them. And we can recycle them over and over again at the same cost. How do we accomplish this? Just mow, burn or otherwise disturb them. Most native shrubs and trees are adapted to disturbance.

I hope the above observations give you some ideas about incorporating sandhill plants into your landscaping plans.

HISTORICAL USE OF NATIVE PLANTS AS FOOD

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Grassland Plants as Traditional Foods of Plains Indians

This paper concerns native Saskatchewan prairie plants used for food by some of the Plains tribes of our area: the Blackfoot, Assiniboine, Cree, Hidatsa and Gros Ventre.

A typical prairie hillside near Saskatoon in early summer has a large number of native species growing on it, which are adapted to this particular environment. This habitat is typical of the ones where the Plains Indians found edible native plants. Useful food plants are not confined to the sheltered or moist habitats in river valleys and coulees, but also occur on the open prairie.

The Plains Indians had a long and intricate dependence on prairie ecosystems and had to know which plants were useful. Fortunately, much of this knowledge had been preserved in writings about traditional native life. These writings are the source of information for this paper. Without these, we would need to collect and analyse our prairie plant species for nutrient content and the presence of toxins before knowing what is edible and what is not. This kind of research is both expensive and time consuming. In addition, it does not address the questions of what are the best season for collection and the best methods of preparation of the foodstuff.

One of the most important staples in the Plains Indian diet is a native plant that grows on prairie hillsides. It has a large starchy root that grows about 15 cm. under the ground. It is called Indian Breadroot or Prairie Turnip (Psoralea esculenta). Native people gathered these roots with a long, pointed stick called a digging stick. They peeled the roots and hung them to dry in long strings for use in winter. The roots are starchy and were eaten like potatoes, cut into chunks and added to soups and stews or like flour, powdered and added to soups to thicken the broth.

The Indian Breadroot is one of our native prairie plants that has been analyzed for its nutritive value. Kaldy et al (1980) found that 69% of the dry weight is starch, and the roots contains a small amount of fairly high quality protein, including the amino acid lysine, which is lacking in cereals.

Breadroot is very palatable and in the 1840's, M. Lamare-Picquot, a French botanist, introduced it to France as a cultivated plant. At that time, the French potato crop was failing due to disease. The Breadroot was grown successfully for several years in France, but did not become established because the potato crop soon recovered and the need for a substitute vanished (Nute 1957).

Indian Breadroot is undoubtedly the most well known Plains Indian plant food, but there are many others. They are mostly berries and roots, eaten fresh or preserved dry for later use, but also include tree sap and bark, and green vegetables eaten fresh.

The most important berries were Saskatoon-berries (Amelanchier alnifolia) and Chokecherries (Prunus virginiana). Saskatoon-berries were gathered in large quantities, sun dried whole on hides on the ground and stored in hide sacks for winter use.

Chokecherries were also gathered in large quantities. They were crushed whole and formed into patties for drying. Why did the native people prepare Chokecherries in this apparently unpalatable way? In matters such as this, the Plains Indians acted from experience, not ignorance, although they were limited in the technologies available to them. If they lacked a technology to remove the pits on a large scale, they would have to eat the entire fruit, pits and all. But what about the cyanide that these pits contain? It is conceivable that crushing the berries and then drying them, either allowed the cyanide to escape or altered it so that it was safe to eat in considerable quantities.

Chokecherry preparation provides a good example of the need to learn details of food preparation when using anecdotal material as a source of information on what people eat.

The following list presents information on 19 other plants used for food by Plains tribes. In general, these uses are less well documented than those of the plants already mentioned; they are listed in a variety of sources as part of the diet but details on quantities used and the methods of preparation are lacking.

1 - Wild Onion, Allium species: the raw bulbs were added to soups and stews for flavouring.
2 - Western Wood Lily, Lilium philadelphicum var. andinum: bulbs were eaten raw or added to soups.
3 - Aspen poplar, Populus tremuloides: inner bark was eaten raw by children in the spring as a snack.
4 - Bur-oak, Quercus macrocarpa: acorns were roasted and dried for food.
5 - Yellow umbrella plant, Eriogonum flavum: roots were eaten by children as a sweet snack.
6 - Currants and Gooseberries, Ribes species: fruits were eaten fresh and dried.
7 - Strawberries (Fragaria species) and Raspberries (Rubus idaeus): fruit were eaten fresh.
8 - Rose hips, Rosa species: were cooked in various ways to feed very small children.
9 - Milk vetch, Indian Milk vetch, Astragalus aboriginum, and Canada Milkvetch, Astragalus canadensis: roots were eaten raw or were dried and added to soups in winter.
10 - Sweetvetch, Hedysarum americanum: roots were eaten raw.
11 - Manitoba Maple, Acer negundo: sap was made into syrup.
12 - Pin cushion cactus, Coryapantha vivipara: young fruit was eaten fresh as a snack.
13 - Silverberry or Wolf-willow, Elaeagnus commutata: fruit were eaten in times of famine and also used as an addition to soups.
14 - Thorny buffalo-berry, Shepherdia argentea: the dried fruits were added to soup and the fresh fruits were mashed to make juice.
15 - Cow-parsnip, Heracleum lanatum: leaf and flower stalks were peeled and eaten fresh or roasted.
16 - Yampah or Squawroot, Perideridia gairdneri: roots were eaten raw, especially as a childrens' snack, or dried to add to soups. This is another plant that has been analyzed nutritionally. It is a good source of starch (69% of the dry weight), and protein (only 6% of dry weight but very high quality, higher than beans, because of its mixture of amino acids). It also contains useful quantities of vitamins A and C. (Kaldy et al, 1980)
17 - Red-osier dogwood, Cornus stolonifera: fruit were an important food item for some tribes and a famine food for others.
18 - Bearberry, Arctostaphylos uva-ursi: fruit were dried and boiled or fried in grease.
19 - Green Milkweed, Asclepias viridiflora: the root, dried or fresh, was added to soups.

In summary, there are a fair number of edible plants on our prairies. A few of these grow in sufficient quantity to be reliable staple foods for Plains Indians who lived in small groups and moved about a great deal. Others were used casually as a seasonal treat, or a lunch when away from home, and as such undoubtedly provided a low but continuous intake of fresh fruits and vegetables during the growing season.

Not far from here the Plains Indians were also farmers. The Mandan and Hidatsa tribes of the Missouri Valley in North Dakota raised a variety of beans, corn and squash. For several years now, some of these varieties have been grown in a demonstration garden at the Royal Museum of Natural History in Regina.

I think it is worth pointing out that the people who grew and gathered plants on the plains were the same as the "real" Plains Indians, the ones who chased buffalo on horseback. It should be remembered that the Indian on horseback is an image greatly enhanced by Hollywood and few people know about the role of plants in the lives of these people.

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USE OF NATIVE WOODY PLANTS IN A XERISCAPE HORTICULTURAL CONTEXT

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Acer negundo (Manitoba maple)

Description: Manitoba maples are native to the Prairies and have been used extensively as shelterbelt, shade and boulevard trees. They may grow 10 to 13 m (30 or 40 ft.). They have compound leaves and winged samaras; a moderately weak structure (prone to breakage in storms); and are very sensitive to 2.4-D damage (are in fact considered an "indicator plant to its presence).

Culture: They are adapted to full sun, a wide range of soils, and are fully hardy. Unfortunately, they are prone to infestations of aphids which excrete "honeydew" that drips from the tree and can be annoying on decks, picnic tables and vehicles. They are also attacked by cankerworms. If wounded, they tend to produce an abundance of watersprouts from the base of the trunk.

Use: Excellent in shelterbelts, farmsteads or acreages, they cannot be recommended for smaller urban lots due to their size and undesirable characteristics. They remain excellent as a climbing tree.

Propagation: Seed

Amelanchier alnifolia (Saskatoon berry)

Description: A native shrub well known for its fruit, the saskatoon has ornamental value as well. Heights range from 2.6 to 5 m (8 to 15 ft.) with a spread of 1.3 to 2.0 m (4 to 6 ft.). The flowers are white, blooming in May, with dark blue berries in mid-summer. Among the fruiting cultivars are 'Honeywood', 'Northline', 'Pembina', 'Smoky' and 'Thiessen'. "Altaglow' is a white fruited saskatoon, columnar in form, with outstanding gold fall color.

Culture: Saskatoons grow in a wide range of soils in sun or partial shade. They are drought tolerant once established. If grown in close proximity to junipers (2-4 km) they may become infected with saskatoon-juniper rust during warm rainy springs. This fungal disease is characterized by orange lesions on the leaves and fruit of the saskatoon plants. Control with a registered fungicide.

Use: Saskatoons are excellent as part of an informal shrub border, or as a small tree in a small yard. The berries are a bonus.

Propagation: Recommended methods of propagation include etiolated cuttings, seed, and tissue culture. Plants grown from seed will show some variation in form height, and fruiting characteristics (size of berry and overall yield of plant).

Arctostaphylos uva-ursi (kinnikinnick)

Description: A low, trailing evergreen groundcover of the northern forests, kinnikinnick has glossy leaves, with light pink flowers followed by bright red berries.

Culture: Plant in full sun in sandy, well drained soils with a neutral or acid pH.

Use: Useful as a ground cover

Propagation: Softwood cuttings or seed.

***Crataegus spp*. (hawthorn)**

Description: Small trees, somewhat resembling a crabapple in fruit and form, hawthorn are attractive in spring when in flower and in late summer and fall when in fruit. The name "hawthorn" is a combination of the word "haw", meaning a hedge or enclosure, and "thorn" referring to the nature of their armament - not a tree recommended for climbing although some species are thornless.

C. chrysocarpa **(round-leaved hawthorn)** is a native selection with dark, glossy leaves and red-orange berries

*C**.crus-galli*** **(cockspur thorn)** is a native hawthorn with bright red fruit retained over much of the winter. The foliage has good fall color ranging from orange to scarlet. It has a distinct horizontal branching habit.

Culture: Hawthorns do well in full sun on a variety of soils as long as drainage is good. They are susceptible to pear slug as well as cedar-apple rust, the severity of which varies from year to year.

Use: Because of its small size, the hawthorn is an excellent but under-used tree in the smaller urban yard. Not recommended for climbing, its value lies in its size, flowers, and fruit.

Propagation: Seed.

Eleagnus commutata **(wolf willow)**

Description: Wolf willow is a shrub of 1 to 4 m (3 to 12 ft.) with silver colored leaves. The small fragrant inconspicuous flowers in late May or early June which have a yellow interior and a silver exterior. The flowers are followed by a small silver-colored berry.

Culture: Plant in full sun on well drained soils. They seem to tolerate moderate salinity.

Use: Wolf willows are useful in a shelterbelt or on farms or shelterbelts where other shrubs may be difficult to establish. Under irrigated conditions on smaller lots, it may sucker too profusely.

Propagation: Seed, root cuttings, and hardwood stem cuttings.

Fraxinus pensylvanica subintererrima 'Patmore' **('Patmore' green ash)**

Description: A hardy, native tree of 8 to 12 m (24 to 36 ft.), green ash has compound leaves with attractive gold fall color. 'Patmore' was selected in Manitoba because it leafs out earlier in the spring than most other green ash and retains its foliage longer into the fall. It is a male clone without the winged seed pod or samara. Its root system is primarily that of a tap root so it is able to "tap" subsoil moisture and is not competitive with lawns or flower beds.

Culture: Green ash do well in full sun or partial shade in a variety of soils.

Use: Because of their form and the nature of their root system they are excellent as shade or boulevard trees.

Propagation: Budding.

Humulus lupulus (hops)

Description: Native to the Prairies, hops is a fast growing, vigorous perennial vine in spite of the fact that its top growth dies back to the snow line each winter. It is capable of quickly climbing 7 m (20 ft.) or more in a single growing season. It climbs by twining shoots and will form a dense cover.

The small greenish-white flowers are followed by a bract covered fruit used in the manufacture of beer. Male and female flowers are borne on separate plants. A plant of each sex is required to ensure fruit production.

Culture: This is a plant which will thrive on neglect. Plant in a sunny location on well drained soil. Once established, it is heat and drought-tolerant. It will need some support (wire, trellis, or netting).

Use: An excellent plant for screening, hops has the added bonus of being a raw ingredient for beer. The perfect plant for the brewer turned home gardener!

Propagation: Seedlings or division.

Juniperus spp.(junipers)

Description: Junipers are one of the most drought tolerant of the evergreens. They have scale-like or awl-like leaves and small blue-grey fruit.

Juniperus communis **(common juniper)** is native to North America, Europe and Asia. It is usually about 0.6 m (2 ft.) in height and tends to turn purple in cooler fall weather. The fruit is used in the manufacture of gin. Like chicory, it was also used as a coffee substitute by early settlers. 'Depressa aurea' is a selection with golden yellow foliage equal or superior in hardiness and drought-tolerance to the better known 'Golden Pfitzer' (*Juniperus x media* 'Pfitzerana Aurea').***Juniperus horizontalis*** **(creeping juniper)** is native to the Canadian Prairie and is generally only 15 to 30 cm (6 to 12 inches) high. Color varies from blue to green, often turning purple with the onset of colder weather in late fall. Some of the more common selections are 'Bar Harbor', 'Blue Chip', 'Dunvegan Blue', 'Prince of Wales', and "Wapiti'.

Culture: Junipers prefer well drained soil and full sun and will usually perform well on southern and western exposures where cedars will not. They also do surprisingly well in semi-shaded locations. Some are hosts to saskatoon-juniper rust.

Use: Junipers are useful as foundation plantings, ground covers, holding difficult slopes or banks, or in a rock garden.

Propagation: Cuttings.

Pinus banksiana **(jack pine)**

Description: With a rather twisted "Group-of-Seven" form, jack pines are about 12 m (30 to 40 ft.) in height with short dull needles in bundles of two and cones which curve toward the tips of the branches.

Culture: It does well on poorer sandy soils in full sun and was in fact believed by early settlers to be an indication of land poorly suited for agriculture.

Use: While other pines are considered preferable in urban settings, jack pine would be a useful tree to include around a northern cabin.

Propagation: Seed.

***Pinus contorta var. latifolia* (lodgepole pine)**

Description: Native to the Cypress Hills where it was missed by the Wisconsin Glacier 10,000 years ago, lodgepole pine was, as the name suggests, used for construction of lodges by native peoples. A straight tree to 20 m (60 ft), the yellowish-green needles are in bundles of two. In contrast to jack pine, the cones point toward the trunk of the tree. The two species will hybridize if grown in close enough proximity.

Culture: Plant in full sun on moderately to well drained soils.

Use: Lodgepole pine is used occasionally as an ornamental planting but is more frequently found in farm shelterbelts.

Propagation: Seed.

***Potentilla fruticosa* (cinquefoil)**

Description: Native to the Prairies, potentillas form a group of small (up to 1 m or 3 ft.) flowering shrubs with mainly white or yellow flowers. They produce a flush of flowers in June followed by less profuse flowering the remainder of the summer. The bark is loose and shredding. Among the more dependable cultivars are 'Coronation Triumph' (with a looser form but very floriferous with large yellow flowers); 'Katherine Dykes' (arching growth habit with pale, yellow flowers); 'Snowflake' (taller, upright plant with white flowers), and 'Goldfinger' (a more compact plant with large, yellow flowers.)

Culture: These are extremely hardy and drought tolerant plants with few insect or disease problems. Plant in full sun on well drained soils.

Use: Because of their size and long blooming period, potentillas are useful as foundation plantings and in shrub borders. The more compact types would not be out of place in a perennial border or rock garden.

Propagation: Seed, division, and cuttings.

***Prunus pensylvanica* (pincherry)**

Description: A tall, open shrub of up to 5 m (15 ft), pincherries produce small white flowers in the spring followed by bright red berries which are good for jelly. The foliage turns a bright yellow-orange in fall. They tend to sucker. 'Jumping Pound' is a smaller, weeping selection which does not tend to sucker.

Culture: Plant in full sun or partial shade on well drained soils.

Use: Because of its suckering habit, the species is desirable only in shelterbelts where it can spread freely and do double duty as bird food. In contrast, 'Jumping Pound' is an excellent choice for the smaller urban lot. It needs to be made more commercially available.

Propagation: Seed and ???

***Prunus virginiana* var. *melanocarpa* (chokecherry)**

Description: The chokecherry is native to much of temperate North America. Usually found in shrub form, it is 5 m (15 ft.) in height and quite broad due to its tendency to sucker. The attractive white flowers are produced in long racemes, followed by clusters of black berries.

The 'Schubert' chokecherry can be grown in either tree or shrub form. The leaves emerge green in the spring but turn a purple-red by mid-summer. 'Boughen's yellow' has large yellow fruit as does 'Spearfish'. 'Copper Schubert' has coppery green leaves and less astringent red fruit. 'Boughen's Chokeless' has almost non-astringent fruit.

Culture: A hardy, drought-tolerant plant, chokecherries are adapted to a wide variety of soils and will do well in full sun or partial shade. On a smaller lot their tendency to sucker may need control. They are susceptible to a fungal disease, black know, which may be controlled through pruning.

Use: If pruned to a single trunk, they make an attractive small tree. AS a large shrub, they are useful in an informal shrub border (where space permits) or for wildlife or shelterbelt plantings. The fruit makes an excellent jam or syrup.

Propagation: Seed, suckers, or cuttings.

***Quercus macrocarpa* (bur oak)**

Description: This is an ideal tree for the gardener who wants something unique. A moderately fast growing tree, bur oaks will put on about 10 inches of growth annually. Native to Manitoba and eastern Saskatchewan, it is a large attractive and long-lived tree of 10 m (30 ft.) or more. Its leaves are typically "oak"-like with yellow to red fall coloration. The acorns are "mossy cup" or fringed.

Culture: Adapted to most of the Prairies, the bur oak is drought-tolerant once established due to the nature of its taproot. The taproot also makes it difficult to transplant once it is over .6 m (a few feet high).

Use: It is excellent as a shade or specimen tree in a modest to large lot. Because of its taproot it is not competitive with nearby lawns or flower beds.

Propagation: Seed.

***Ribes aureum* (golden currant)**

Description: A hardy native plant of 1.3 to 2 m (4 to 6 ft.) with loose, arching branches, it has fragrant yellow flowers followed by edible black berries useful for jelly. The foliage has an attractive orange-scarlet fall color.

Culture: Golden currant is drought-tolerant and adapted to a variety of soils in sun or partial shade.

Use: Part of the "edible landscape", plant it where you can take advantage of its fragrance. It suckers readily and is more adapted to informal plantings and may be more useful on larger lots. It is also used as a shelterbelt planting to attract birds.

Propagation: Cuttings, layering or seed.

***Rosa acicularis* (prickly rose)**

Description: One metre (3 ft.) in height, the prickly rose has an upright-spreading form, numerous spines, and single pink flowers through most of the summer which are followed by pear-shaped orange to red "hips". The hips provide fall and winter landscape value, are high in vitamin C, are sometimes used in jelly and are a food source for birds.

Culture: Roses do best in full sun. They will benefit from mulching.

Use: These roses are useful in shelterbelts and wildlife enhancement, and in informal shrub borders on farms and acreages.

Propagation: Cuttings.

***Shepherdia argentea* (silver buffaloberry)**

Description: A large 3 to 4 m (9 to 12 ft.) native shrub, buffaloberry is characterized by silver foliage, thorns, clusters of bright red berries, and branchlets which grow almost perpendicular to the branches. Because it is dioecious (male and female flowers are borne on separate plants), plants of both sexes must be grown to ensure fruit.

Culture: Buffaloberries grow on any well drained soil in full sun and are very drought tolerant. They are also moderately tolerant of saline soils.

Use: Because of its size and tendency to sucker, it is most suited to an informal planting on a larger lot. Alternatively, it can be pruned to a single stem and used as a small specimen tree in the smaller urban yard. It is also used extensively for wildlife and shelterbelt plantings. The fruit is considered edible but may not be liked by everyone. It may also be used as a hedge.

Propagation: Cuttings and seed.

***Symphoricarpos occidentalis* (western snowberry or buck brush)**

Description: Usually about 1 m (3 ft.) in height, western snowberry has clusters of small tubular pink and white flowers in July followed by a small whitish-brown berry with a waxy-like coating. The leaves are opposite, grey-green, and somewhat oval. The overall appearance is of a dense, suckering clump.

Culture: Snowberry can be grown in full sun or partial shade on a variety of soils.

Use: It has been used extensively as an underplanting on the University of Saskatchewan campus. It can also be massed as a groundcover.

Propagation: Seed and suckers.

***Vitis riparia* (riverbank grape or Manitoba grape)**

Description: Riverbank grape is a vigorous woody climber (up to 6 m or 18 ft.). It is grown primarily for its foliage (typical "grape-like" leaves) although it does produce small blue fruit which are suitable for jams and jellies. It climbs using tendrils which will need support.

Culture: Plant in sun or partial shade in a loamy soil. Incorporation of organic matter and mulching are beneficial. Once established, they are drought tolerant. Leaf hoppers and powdery mildew are sometimes a problem.

Use: Fairly vigorous, the Manitoba grape is excellent for covering a large expanse of wall, as a "garden ceiling" for a large arbor, or as a ground cover or to hold a slope or bank.

Propagation: Softwood cuttings or suckers.

WILDLIFE HABITAT: THE CONCEPT OF BIODIVERSITY

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Native plant communities support all wildlife species which occur in Saskatchewan. For over ten thousand years wildlife and their habitats have co-evolved in this part of North America. The patterns of local plant communities across the landscape have resulted in ecosystem diversity and influenced wildlife species diversity, distribution, life cycles and the very genetic uniqueness of each of these animal species. The interrelationship between wildlife and their habitats is complex and often exhibits interdependence.

The functional integrity and diversity of native plant communities is essential to maintaining healthy wildlife populations. The reduction of diversity at any level will have effects at the other levels. Wildlife species are often the first indicators of environmental change in this hierarchical arrangement.

How should we define wildlife? The Canada Wildlife Act (1973) includes both all native plants and animals within its definition of wildlife. This is considerably broader in scope than the traditional view that wildlife meant only birds and mammals usually with a strong emphasis on game species.

How should we define wildlife habitat? In the best sense habitat includes the living plant and animal components plus the non-living soil, air and water components. Traditional research on wildlife habitat has started with plant studies but sooner or later expands to include other wildlife species and investigations into the differences in and relationships between other environmental components such as soil types, moisture and climate variables. This is the true ecological approach.

The capacity of Saskatchewan's habitats to support wildlife species is impressive. Although our north temperate environment may have a fewer number of species than the tropics, the number of individuals per species is very high. We have all heard of the hugh flights of Passenger Pigeons which roared through the sky some flocks being 75 miles long, and the great swarms of migratory grasshoppers which darkened the skies over the great plains before the turn of the century. In 1869 Isaac Cowie of the Hudson's Bay Company passed through one of the last great herds of bison at the north end of Last Mountain Lake. He wrote ... *"they blackened the whole country, the compact moving mass covering it so that not a glimpse of green grass could be seen. Our route took us into the midst of the herd, which opened in front and closed behind the train of carts like water round a ship ... So we travelled among the multitudes for several days."* Today, some 70% of the continents millions of ducks are produced in the prairie potholes and several million arctic nesting geese and cranes migrate through the prairies each spring and fall. Even under foot, a gram of prairie soil contains, as a rule of thumb, some one billion separate micro organisms.

Habitat loss and change through physical alteration (agriculture, urbanization), fragmentation, introduction of exotic species, over harvesting, pollution, disruption of natural processes and global climate change have favoured a few species, but more often than not caused declines in many species. Unable to adapt these animals are given modifiers like vulnerable (Plains Pocket Gopher), threatened (Burrowing Owl), endangered (Whooping Crane), extirpated (Black-footed Ferret) and extinct (Passenger Pigeon).

How many species of wildlife (plants and animals) are there? Table 1 compares the number of species in selected groups of organisms found in Saskatchewan with the numbers found in Canada and throughout the world. The term biodiversity is a new and more explicit expression of some of the most fundamental concepts of ecology. It embraces two ideas: the variety or diversity of life plus the interrelationships between and among the ecological elements. Saskatchewan clearly has significant natural biodiversity. Ironically, ecologists must now include exotic species occurring in an area as part of the biodiversity of a site.

Another twist to the biodiversity issue is that evolution is still in progress for wildlife species in Saskatchewan. Be it at the subspecies level of the Thirteen-lined Ground-squirrel which has different forms adapted to the arid grasslands, the moist grasslands and the northern aspen woodlands or the physiological level inside plants, wildlife species are changing in an effort to survive the environmental changes and habitat loss.

How do animals make use of the 1250 or so native plants in Saskatchewan? They eat them (tent caterpillars, beaver), use them for shelter (woodpeckers, gall wasps), mimic them in an effort to avoid predators (grouse, female ducks, moths), help them reproduce (pollination, seed dispersal - burrs) and recycle them as nutrients through the ecosystem. Use of plants by animals may show a two way adaptation in which the plant adjusts its physiology and growth to the timing of animal movements and reproduction and vice versa. The relationship between plains bison's seasonal grazing patterns and evolution of northern prairie grasses, the C3, C4 story, is a classic example of this type of mutual adaptation.

The most important habitats for wildlife species are thought to be used at critical times in their annual or life cycle: breeding, feeding, resting and migration stop over sites. Both classification and conservation efforts have frequently concentrated on the spectacular sites: fish spawning, ungulate calving, bird nesting and migrating areas. But wildlife needs enough habitat to successfully complete their full life cycles. This often means protecting many sites, some very large, others very small to ensure a prairie landscape containing significant native habitat is present to maintain the prairie's biodiversity. Unfortunately our knowledge of the needs and relationships of wildlife species is woefully inadequate. Intrinsically all native habitat remaining is worthy of protection as a consequence.

The conservation of existing natural plant communities is the most cost effective way to preserve wildlife habitat and biodiversity. Collectively we know the tremendous effort needed to restore and rehabilitate native plant communities.

Table 1. Biodiversity: Number of wildlife species (flowering plants and animals) found in Saskatchewan compared to Canada and the world.

Organisms	Saskatchewan	Canada	World
Flowering plants*	1,244	3,160 (+881 exotic)	300,000 est.
Invertebrate animals	22,800 est.	100,000 est.	2 million + (X10?)
Vertebrate animals	504	1,048	44,242
Fish	60	937 (177 freshwater)	22,000
Reptiles/ Amphibians	19	82	9,214
Birds	349 (261 breed)	590 (426 breed)	9,035
Mammals	76	199	3,993

*Includes all Angiosperms and Gymnosperms but not some 300,000 species of bacterial, algae, fungi, mosses and ferns found in the world.

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AGRICULTURE--GRAZING OF NATIVE RANGE

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Agriculture is the main user of native rangelands the world over. With most of the Agricultural use being grazing of domestic livestock. So when I came to Saskatchewan just over three years ago, I asked 'How many acres of native rangeland is there?' To my surprise, there were only estimates and these ranged from nine million up to 34 million acres. These estimates came from SAMA, Wildlife Branch, SSGA, Lands Branch, Ag Canada, PFRA and private landowners. We are just now learning about one of the most important resources we have in the Province. It is now possible to make an estimate that is fairly close due to the efforts of many people. In Saskatchewan there is approximately 16 million acres of native rangeland.

Estimates of the current condition of these acres are based on observations and determinations of the few trained Rangeland Agrologists in the Province. While it is true that not all the acres have been condition classed, and much more work needs to be completed, the native rangeland is in mid-fair to low good range condition. This is an average and some are in excellent condition as well as some in poor condition. With the majority of these acres in fair condition, there is still tremendous potential for improvement.

The 16 million acres currently support about 1.9 million head of cattle at least some time during the grazing season. In addition there are 100,000 head of sheep that utilize areas of native rangeland. These areas are also home to wildlife species, both game and non-game.

Given the current condition of native rangeland, we may be very near the sustainable carrying capacity. An example of the potential is taken from the southwest portion of the Province, where there are approximately between 7 and 8.5 million acres of native range. If these acres were improved from fair to good condition the carrying capacity would increase by about 60,000 head of cattle or 400,000 Animal Unit Months. In addition to the grazing potential many producers are currently examining the use of native plants for reseeding areas.
With this background information it is now time to turn to the issues and concerns expressed by producers. The most pressing concern is the availability of seed for many of the native species. Several seed companies have small amounts of seed available. However, the question that arises is from where did that seed originate? If the seed was harvested in Canada, North Dakota or possibly Montana, there is a good chance of a successful seeding. If the seed was harvested from other ares the likelihood of success is much lower. Research has determined that a plant can be transplanted about 100 miles south or 150 miles north of it's origin with success. The same observations have been noted for the seed of the plant. This means that seed produced and harvested from Kansas has little chance of establishing in Saskatchewan. Since there is plentiful seed for only a few native species, there is a need for development of a sustainable seed inventory for Saskatchewan.

This leads to another concern. Do we have the expertise to select and grow native species for seed? Currently there is very little information available on seed production, handling, storage, planting and establishment for the majority of native species. The management is very different when a plant is utilized for seed production vs for grazing. There needs to be some information gathered to determine where these differences are. The collection of seed from a local native site may be a place to start, but we should not continually collect from the same plants. This may cause a decline in the health of the site due to the loss of the seed reserve. Once the seed is collected and planted in fields for seed production, what criterion should be selected for? Is the important characteristic seed production or is it vegetative production? There is a fundamental difference in the way these things are decided. To lower the cost of seed, the species needs to have high seed production. However, when the plant is in the field and is to be grazed, it should produce vegetation. Is the seed currently available for purchase correct for the intended use? Some of the native species seed available has been selected and grown for seed production. As one characteristic is selected for, other characteristics may be lost. Species such as northern wheatgrass, western wheatgrass, tall wheatgrass, slender wheatgrass and green needlegrass that are available now have been changed from the true native plants we see in native rangeland. So, are they native or are they 'semi-native'?

A third issue is the transfer of technology once it is gained. There seems to be a bottle-neck in the transfer mechanism. Canadian universities and Agri-Food Agriculture Canada have some of the expertise and knowledge that could help in this issue. However, because their mandate is conducting research, much of the information does not get out to the producers that would use it. This may be changing with the current atmosphere, but will it continue?

A large issue that must be addressed is the question of who pays the bill for development of native seed sources and the information needed to produce the seed? Currently the largest user of native species is the livestock producer. This is the same user that is bearing the cost for sustaining these areas. Should they also be asked to bear the costs of further development of seed sources?

The process that we have embarked on is interesting and very exciting. Progress may be slow and it probably should be, but the end result can have far reaching consequences. I would hate to see the same thing happen here as did in Nebraska when the Federal Government announced the Conservation Reserve Program. It was decided that all land in Nebraska that was accepted into the program had to be seeded to native species. The day after this was announced the price of seed tripled and this was not due to a short supply. With this in mind, I am excited about the new found interest in native rangelands and the plants that make up the diverse population. My hopes are that we can progress and develop a worthwhile program.

ETHICS AND CONSEQUENCES OF HARVEST FROM NATURAL AREAS

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Only when your mind is clean are you in a suitable state to read books and study the ancients. Otherwise when you hear a good saying, you will borrow it to cover your shortcomings.
- Huanchu Daoren, Reflections on the Tao

The objective in this paper is to review some of the principles of environmental philosophy, especially the ethics which might apply to the harvesting of native plants from natural ecosystems. The development of ecophilosophy as a discipline has occurred in parallel with concerns of society over impacts of human actions on the environment. The idea that human relationships with the biosphere and its components have a moral dimension has increasingly become accepted. The inclusion of the topic in the program of this workshop probably is an indication of its growing importance to people. I approach the task with, I hope, a clean mind, but also with a debt to the philosophers and others quoted so freely here.

The ecophilosopher Michael Zimmerman (1993) divides environmental philosophy into three major fields:

(1) Radical ecophilosophy

This field includes deep ecology, ecofeminism and social ecology. Deep ecologists are convinced that one of the roots of the environmental crisis is anthropocentrism, the view that humans are the measure and measurers of all things; that nature is only raw material for satisfying human desires. Ecofeminists feel the major root of our environmental problems is patriarchy: an oppressive social structure that justifies exploitation of women and nature, both of which are considered inferior to men. They argue that we need an ontological change in what it means to be human. Ecocentrism shifts the focus from human interests to the broader interests of the biosphere which supports all organisms, not just humans. Stan Rowe elaborates on anthropocentrism versus ecocentrism in his book Home Place (Rowe 1990).

(2) Environmental ethics

According to the proponents of environmental ethics, progress could be made in solving the environmental crisis if we altered our anthropocentric ethical attitudes so as to extend "moral considerability" to nonhuman beings and other entities such as communities of organisms and the biosphere itself. "Human beings are intrinsically more valuable than non-humans, but ... at least some non-human beings cannot be treated merely instrumentally for they have a worth of their own" (Zimmerman 1993).

(3) Anthropocentric reformism

From this viewpoint pollution, wasteful resource use and other environmental problems stem from ignorance, greed and shortsightedness. These can be corrected by legislation, public policy, increasing education, emphasis on moral obligations to future generations and promotion of wise stewardship of resources. Nature has value only as an instrument for human ends, ranging from food to aesthetic pleasures. Reformers consider radical ecophilosophers to be naive about the prospects of introducing drastic changes in social attitudes and institutions responsible for ecological problems.

The reformism approach is widely accepted in Canadian Society today. Some reformers are optimistic that progress is being made, whereas radicals are sceptical that changes are fundamental enough to ensure that preservation of nature and a quality environment in the broadest sense. This audience probably is already convinced that "wise stewardship" of nature is the bare minimum that is necessary for environmental protection. A significant number present may be hostile to aspects of radical ecophilosophy. I intend today to concentrate on the field of environmental ethics, particularly the attempts to develop a moral theory which strengthens our ability to protect the ecosphere that supports us. I will try to make the presentation as objective and balanced as my own biases permit.

Ethics is the branch of philosophy concerned with developing a theory of morality. Philip Hanson (1989) makes two claims about the utility of general ethics:

(1) Ethics can provide a framework of reasons for moral prescriptions other than mere sentiment.

(2) Ethics can provide a rational basis for commitments to ideals and principles. Morally-based principles are not easily overruled by desires of the moment or the contingencies of circumstance. Although morality is a part of our social fabric we do not have a clear understanding of basic moral principles or their application. What makes an issue a moral one? What moral principles apply in complex human interactions? Society in general, and ethicists in particular are struggling with all types of moral issues. To this confusion we must add considerations of the moral significance of the environmental impact of our actions.

I do not have the time, and definitely lack the qualifications to explain the major theories of morality that have been developed by philosophers over the ages. Moral theorists agree that moral principles must have four general features (Hanson 1989):

(1) Generality: having universal applicability and impartiality.
(2) Disinterestedness: invocation not conditioned on interests of one agent to the exclusion of others. This distinguishes moral principles from those based on particular interests.
(3) Priority: The only thing that can overrule a moral principle is a higher moral principle.
(4) Universalizability: Recommended for adoption by every other moral agent as a moral principle. We must be able to defend moral principles, particularly if they form the basis for public policy or law.

Environmental ethics attempts to define theory concerning the morality of human activity affecting the biosphere and its components. Some object to the application of the term morality in this sense because the entities being considered include more than the human species. Leiss (1986) argues that ethical systems require "a reciprocal mutual recognition by moral agents of the rights and obligations shared by them...such reciprocal acknowledgement of ethical standing is impossible for any group of beings wider than a human species". For this basic reason environmental ethics has had difficulty penetrating the traditional humanistic base of philosophy.

Callicott (1993a) points out that 1973 marked the debut of environmental ethics on the "staid and conservative stage" of professional philosophy. In that year three seminal papers were published: Animal Liberation by Peter Singer, The Shallow and the Deep, Long Range Ecology Movement by Arne Naess and Is There a Need for a New, an Environmental Ethic? by Richard Sylvan. The animal liberation movement made a major contribution by arguing that we need to extend moral consideration beyond the species barrier. Sylvan pointed out that as late as 1973 an adequate non-anthropocentric environmental ethic did not exist in western intellectual tradition, although one was envisioned by the American conservationist Aldo Leopold in the late 1940's.

Aldo Leopold envisioned land ethics to be the next stage of human moral evolution in which our concern with ethics in dealing with other humans is extended to the entire biotic community (the land). The ecophilosopher J. Baird Callicott (1993b) points out that Leopold's land ethic has been treated with neglect, confusion or even contempt by many contemporary academic philosophers. The Canadian philosopher L.W. Sumner called it "dangerous nonsense". Leopold's land ethic is judged by Callicott as posing a serious intellectual challenge to business-as-usual moral philosophy.

We will come back to the land ethic in a few moments but first I want to talk about the philosophic problems relating to extension of ethical concern to non-humans. One of the major topics in environmental philosophy is the shift in our moral relationship to non-human organisms, the biotic community and the biosphere. Diagram A, based on an anecdote in Rolston (1993) shows that non-humans, in this case flowers, have traditionally had only instrumental value. They are morally significant only in relation to our dealings with other humans ("Please leave the flowers for others to enjoy"). The question is: Do these flowers have non-anthropogenic value? The sign "Let the flowers live!" reflects the view that they have moral interest beyond those assigned by humans beings. Moral consideration has been extended to include them.

There has been a split in philosophy between those arguing for an extension of ethical concerns to individual non-humans, and philosophers who consider that ethical consideration should be given to larger entities such as species, biotic communities or even the ecosphere (Diagram B). The proponents of animal liberation and animal rights theory extend ethical consideration to individual sentient non-humans, particularly mammals and birds. They make little distinction between domestic and wild animals, in fact emphasis has been on rights of domesticated animals used in agriculture and animal experimentation. According to Peter Singer, our moral responsibility to animals is not just based on the principle that cruelty to animals is bad (nobody denies that) but that we are obliged to prevent the suffering and killing of animals, however it is caused (Sagoff 1993). It can be argued, reductio ad absurdum that we have a moral duty to protect prey from predators, mice from coyotes.

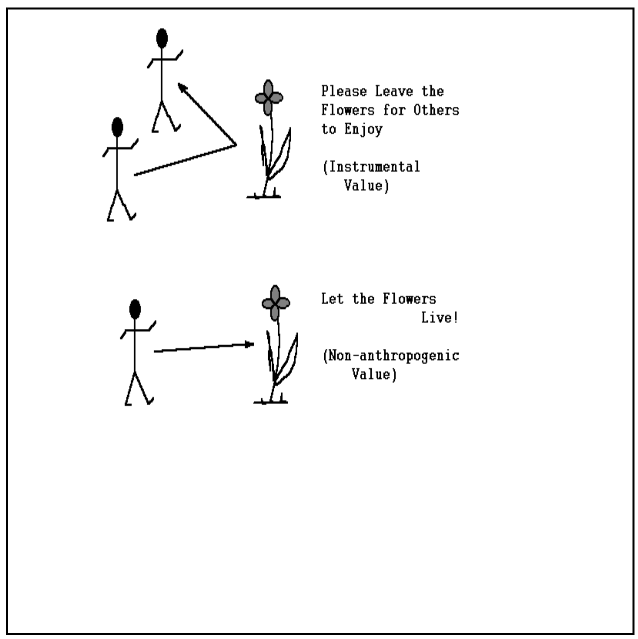

DIAGRAM A

Although we have no duty, or right to interfere in natural ecological interactions, such interactions do have a moral dimension when humans enter on the side of one species or another. Competition between blue grama and western wheatgrass, both native grasses, is not an ethical matter, but competition between blue grama and introduced exotic grass species is, because past genetic selection and relocation away from its native pests and predators by humans give the latter an "unfair" advantage.

A major problem for the concept of animal rights, pointed out by Mark Sagoff (1993) is that "only individuals may have rights, but environmentalists think in terms of protecting collections (species), systems and communities". The obligation to preserve a biotic community implies no duties to individual animals. Individual animals are expendable. Sagoff concludes that "a humanitarian ethic- an appreciation not of nature, but of the welfare of animals- will not help us understand or to justify an environmental ethic".

We are concerned with plants in this workshop. Holmes Rolston (1993) describes how on San Clemente Island the U.S. Fish and Wildlife Service planned to shoot 2000 feral goats to save three endangered plant species with surviving individuals numbering only a few dozen. Under protest some goats were trapped and relocated, but hundreds were shot. In this case a few plants counted more than individual goats. Thus it may, for the sake of the health of a biotic community be necessary to kill individual animals. In a recent example closer to home, feral horses were

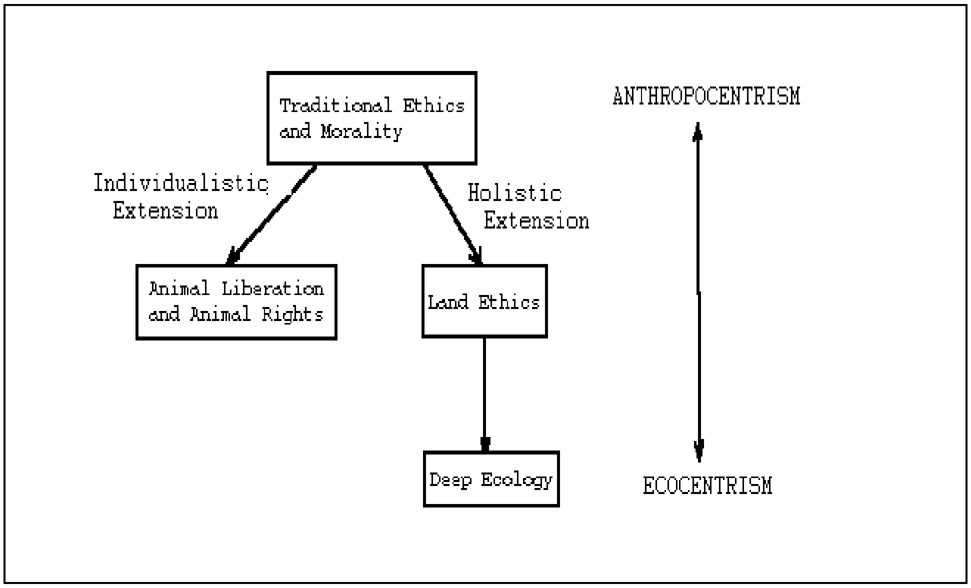

DIAGRAM B

removed from Suffield in part to improve rangeland condition there. Individual animals were sacrificed for the good of the community. Aldo Leopold would have approved, but this approach has led animal liberationists to label proponents of land ethics as environmental fascists! In their view the rights of individual animals take precedence over the survival of species, the latter being considered only an abstract concept.

Animal liberationists conclude that there can be ethics about sentient animals but respect for life ends somewhere in zoology. Singer wrote "if a being is not capable of suffering...there is nothing to be taken into account". Respect for life is not a part of botany. As Holmes Rolston points out, there are no humane societies for plants.

Do we need an ethic that is more objective about what categories count morally? Rolston (1993) gives the example of the Wawona giant sequoia with a carved out tunnel big enough to drive a car through. When this tree blew down people said "cut us another drive-through sequoia", but the new environmental ethic said "<u>No</u>! You ought not to mutilate majestic sequoias for amusement". Magnificent ancient trees inspire this feeling in many people, but what about small ugly plants? Do they have moral considerability?

L.E. Johnson (1991) concludes that all non-human entities have <u>interests</u> which must be weighed morally against competing human interests, and the interests of other entities. Human and non-human individuals, populations, species, ecosystems and the biosphere all have morally significant interests in what Johnson concludes is a "morally deep world". "<u>It is respect for interests that is, at least, the core if not the whole of morality</u>". This is a kind of unified moral theory that encompasses human as well as environmental morality. According to Johnson, "Even among humans, neither rationality or sentience is a necessary condition for the moral significance of an interest".

Johnson admits that there is no "magic formula" for determining the "morally best way to act toward those others with whom or which we share the world". There is not even an adequate formula to apply in the human sphere, and the web of competing interests is even more complex in the living world at large. The best approach is to "develop an awareness of other beings, and of their interests, together with an attitude of respect and consideration for their interests. Morally we ought, as best we can, to allow the living world, and the entities thereof, in their diversity, to thrive in richness, harmony, and balance."

Perhaps Johnson's general moral principle could be given even greater force by reference to moral codes included in many of the world's religions including native American spirituality (Callicott 1989), Taoism (Johnson 1991) and Christianity (Nash 1989). Although White (1967) accused the Judeo-Christian tradition of being the "root of our environmental crisis", he also offered St. Francis as a model for a balanced concern for all of God's creation. (St. Francis is the patron saint of ecologists).

The challenge is not only to establish a solid theoretical foundation for environmental ethics, but to develop practical ethics to help us deal with day-to-day environmental relations. An example of an attempt to clarify ethics dealing with harvesting native plants is included in Kahlee Keane's book "More useful wild plants of Saskatchewan":

- Rather than taking plants from the wild, try cultivation; it makes sense to utilize tilled soil instead of further destroying wild places. Discover how to grow native and medicinal herbs and share your knowledge.

- When wildcrafting to supplement your income, consider the plant community and the number of plants required to sustain it, not about how many plants you need to make so many dollars. Put the planet's needs ahead of your own.

- If you harvest from the wild, treat the native plant complexes like the fine perennial gardens they are. Propagate while you collect. Replant root crowns, scatter seed or prune trees to enhance growth. Monitor harvest areas every year to check your conservation successes.

- Whenever possible, only harvest part of the plant by pinching off individual leaves, flower heads, or rhizome segments, leaving the main part of the plant intact to flourish and reproduce.

- Pick no more than 5% of the native plants in any harvest area.

- Do not under any circumstances harvest endangered, threatened or sensitive plants. Become familiar with these plants by asking the head botanist at your local university for information.

- Always try to harvest native plants from areas that are to be developed or cultivated. Clear cut areas need the vegetation of the forest floor to flourish if reforestation is to be successful. The intrinsic value of this ecosystem must be preserved.

In this list of proscriptions we can recognize components of a land ethic like that developed by Aldo Leopold nearly 50 years ago, and which I quote here to summarize the foundation on which we can build ethical relations with the ecosphere:

"All ethics so far evolved rest upon a single premise: That the individual is a member of a community...his instincts prompt him to compete for his place in the community, but his ethics prompt him also to cooperate. The land ethic simply enlarges the boundaries of the communities to include soils, water, plants, and animals, or collectively: the land."

"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends to do otherwise."

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A DEFINITION OF NATIVE PLANT MATERIAL

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A definition of native plant material would seemingly be quite obvious. Native plant material is material collected from native plants. In its simplicity this definition may seem adequate, however specific stipulations such as source of material, planting location, and level of selection and breeding make this definition archaic and untenable.

Terminology of Native Plant Material:

Native Cultivar

- "have been selected to exhibit superior performance within a proven area of adaptation." (Jacobson et al.,1994)
- "a cultivated variety, breed and selected for forage production". (Ducks Unlimited, 1993)

The selection for native cultivars is narrow, thus genetic diversity is minimal.

Ecovar

- "an ecological variety derived from a wider selection of individuals encompassing a greater genetic diversity". (my interpretation from Ducks Unlimited, 1993. Native Prairie Plants, brochure)

Native Species

- "a species that is a part of an area's original fauna or flora" (Kerr et al., 1993)

My definitions of native species are:

1. Non-Ecoregional Native Species

A species that is native to this continent, but not native to the specific ecoregion being addressed.
(Example - California poppy in Saskatoon, SK)

2. Ecoregional Native Species

A species that is native to the ecoregion in consideration.
(Example - blue grama in Grasslands National Park)

This definition should be more specific when defining the terminology and source of material used for a native planting.

2A. Non-Local Ecoregional Native Plant Material

Material from a native species listed in the ecoregion of the planting, but collected from outside

the ecoregion.
(Example - blue grama collected in Ontario and planted in Grasslands National Park)

2B. Local Ecoregional Native Plant Material

Material from a native species listed in the ecoregion of the planting and collected from within that ecoregion.
(Example - blue grama collected in Val Marie PFRA Community Pasture and planted in Grasslands National Park)

Planting Distance from Source of Original Plant Material

There has been considerable controversy as to how far one can move plant material from its source and still (1) have a successful planting, and (2) establish vegetation that is compatible and comparable, both phenotypically and genetically, with the native vegetation that is found (or was found) locally. It is well known that material moved north or south a considerable distance from its source will produce vegetation quite different from the parent stock. This is an effect of differences in the length of seasons and photoperiod. It is logical that plant material should be used in close proximity to its origin.

How close is too far? Is 100 km too far? Is 25 km too far? What distance is good enough? I suspect that part of the answer will reflect the objectives of the project. The whole controversy of distance revolves around the assumption that plant material from two close populations of the same species will be more similar genetically than from two populations separated by a greater distance. This may be true but where do you draw the line. I'm speculating that two conspecific plants located 50 km apart may be more similar genetically than to a plant located 50 m from one of these specimens. Could distant habitat similarities not support species ecotypes with greater genetic affinity than between conspecific individuals in differing local communities?

Whatever the case, the best guideline always will be to collect native plant material from as close to the planting site as is practically possible. In doing so, Local Ecoregional material should always be collected and the distance of the collection site (original genetic material) from the planting site recorded.

Examples would be:

1) Local ecoregional blue grama planted in Grasslands National Park, West Block, 55 km (this would denote that the material was collected 55 km from the planting site).

2) Non-local ecoregional coneflower planted at Little Quill, SK, 320 km.

In the quest to expand the use of native species in vegetation plantings, consideration should always be given to whether the material being planted is comparable and compatible with the surrounding native vegetation. Cleaning up after undesirable genetic pollution has occurred may not be that easy!

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DEVELOPMENT AND MANAGEMENT OF NATIVE PLANT MATERIALS - HIGHLIGHTS

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Introduction

I've worked with native plants for the past seven years, as a consultant, and with both non-government and government agencies. My work has centred almost exclusively around the identification, conservation and management of tall-grass and mixed-grass prairies in Manitoba and Saskatchewan. In 1992, the Prairie Farm Rehabilitation Administration (PFRA), hired me on contract to research and produce a report on native grass seed production and markets in Western Canada. The text that follows is based on the report, called *Native Plants: Exploring Grass Seed Production and Markets*, which was published by PFRA and Ducks Unlimited Canada (DU) in 1993. It is based on literature review and on discussions I had with breeders, users, producers and suppliers of native plant materials in the prairie provinces, many of whom were present at this workshop. I will gratefully accept any comments, corrections or updates you may have regarding this material. These I will incorporate into any future versions of this document I might have the opportunity to prepare for PFRA/DU.

Abstract

This paper deals with how native grass varieties are developed and what factors should be considered in their management. It outlines how and when native species became of interest in reclamation, how native grass varieties are developed and released for public use, both in Canada and the United States, and on what's currently available for use in Western Canada. There is also a brief outline of current research and activities in Canada. The section on management of native plant materials covers some practical aspects of native plant use: choosing appropriate species, assessing the suitability of cultivars, ecovars or wild-type strains in a given situation (based on cool- or warm-season nature, availability and cost of seed, predictability, and ease of seeding and harvest). The paper also identifies some of the gaps in development and management of native plant materials.

Background

What are native plant materials?

Generally, the term has come to mean *seeds, rootstocks and other propagative materials from plants which are indigenous to a particular region*. In this paper, I refer mainly to the seed of native grass species which are indigenous to the grassland regions of Alberta, Saskatchewan and Manitoba.

Pros and cons of native plant material (NPM) use in western Canada

Respect for nature and its systems seems a sensible place from which to approach any study or management of the land and as a basis for any decisions made regarding it. I like Aldo Leopold's expression of this idea.

Quit thinking about decent land use as solely an economic problem. Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise.

Aldo Leopold

Here are some of the advantages and disadvantages of using native plant materials frequently discussed in the context of land reclamation:

Pros:

adaptations to prairie soils and extreme climatic conditions
longevity of perennials
intra- and inter-specific variability of native populations (= adaptability)
low maintenance
beauty
"ecological acceptability" (There is a prevalent belief that NPMs provide more natural sources of food and shelter to indigenous fauna, contribute to richer and more diverse ecosystems)
use of natives lends additional economic value to (and impetus for preservation of) relict communities
presence of natural pathogens and predators to maintain ecological balance

Cons:

few appropriate species and varieties available
high seed costs
may require specialized equipment for seed harvest, storage and planting
lesser known than domestic species/cultivars (harvest, storage and seeding techniques)
less "predictable" (differences in dormancy, germination rates, variable forage quality, seed set, etc.)
potential for "genetic swamping" of wild native stands by native cultivars
potential harbouring of agricultural pests
difficulty of capturing the genetic diversity in wild populations in the development of native cultivars

<u>Current uses and users</u>

<u>Uses</u>	*<u>Users</u>* (a few local examples)
restoration (community "re-creation")	Grasslands National Park
reclamation/revegetation	gas, oil, mining companies
permanent cover plantings (erosion reduction)	PFRA
rangeland plantings	PFRA
wildlife habitat plantings	Canadian Wildlife Service, Ducks Unlimited Canada
roadside management & beautification	Manitoba Highways
urban (public) landscaping	Meewasin Valley Authority (Saskatoon, SK), City of Winnipeg (MB)

urban (private) landscaping	Miller's Nursery (Saskatoon, SK), Prairie Habitats (Argyle, MB), Prairie Originals (Winnipeg, MB); list of Alberta nurseries available from the AB Native Plant Council.
education (schoolyard and public plantings)	Elmwood High School (Winnipeg, MB), Fort Whyte Centre for Environmental Education (Winnipeg, MB), Royal SK Museum (Regina, SK), Brightwater Science and Environmental Centre (Saskatoon, SK)

Potential Uses

Potential uses include: bank stabilization, waterway management, roadside and rest site beautification, wildflower routes, restoration of historic sites, heritage rivers and canoe routes, increased use by florist and nursery trades, cultural use by aboriginal peoples. Many of these examples are drawn from existing programs in the U.S. and some are being explored in Canada, though to my knowledge, these have been on a limited basis.

DEVELOPMENT OF NATIVE PLANT MATERIALS

One of the first large scale revegetation efforts took place in the United States and in Canada during the "Dirty Thirties". Millions of acres of cultivated land that were abandoned during the depression were seeded to reduce wind erosion. "Fairway" was a crested wheatgrass cultivar developed by what is now the Canada Department of Agriculture that was widely used in revegetating lands in Canada and in the U.S. at that time. Because the supply of "Fairway" was insufficient to meet demands, some harvested native grass seed was used in reclamation seeding as well. By the late 1930s and early 1940s, "Fairway" had undergone enough increase to replace native harvests. By the mid-1960s, several million acres of deteriorated crop- and rangeland had been planted to grasses, mostly with cultivars of Eurasian species.

Development of native plant materials began between 1944 and 1953, in the United States, where cultivars were developed from seven native American grass species. Most were selected for forage production. By the mid-1960s, large-scale plantings had seeded several million acres, mostly with cultivars of Eurasian grass species. An environmental movement spawned at this time began to discourage the use of introduced species, especially crested wheatgrass, on public lands.

Native grass seed was specified in greater quantities in the United States during the 1970s, in seeding burned rangelands and reclaiming mined lands. By this time, a number of new native and domestic releases allowed for greater species diversity in seeding projects. The Bureau of Land Management (BLM) and private mining companies were the primary consumers of seed in the U.S.. Crested wheatgrass was still most used, but other domestic and some native cultivars comprised a much larger share of the market than before.

In 1985, the U.S. government, under its Farm Security Act, made plans to retire 45 million acres of marginal land in an effort to reduce grain surpluses and to reduce erosion. Two years later, the Conservation Reserve Program was begun with the aim of revegetating these lands with perennial plants, primarily grasses. Many of those involved in native seed production and use (Vogel and Masters, 1988; Haas, 1988; B. Wark, pers. comm.) reported significantly increased demands and higher prices for native grass seed as a result, both in Canada and the United States.

Over the past 10 or 15 years, new grass varieties have continued to be released. In the midwestern

United States, cultivars of warm-season grasses such as big bluestem, switchgrass, and Indian grass are popular because of their wide use in summer pasture and wildlife habitat, and for their ease of management. Cool-season varieties may prove to be more appropriate for plantings in most of prairie Canada, with the exception of Manitoba's Red River Valley, where warm-season grasses historically predominated.

Development and Release of Native Grass Varieties

The following is a synopsis of development and release procedures in the United States and Canada. Where procedures do not differ, notes are in U.S. column only.

	UNITED STATES	CANADA
ASSEMBLY	Plan identifies species and locations for collection, processing, storage & evaluation Collection coordinated by: USDA Soil Conservation Service (Plant Materials Centers) in U.S. USDA Agricultural Research Service (National Germplasm System) in other countries, including Canada	No seed repository or large-scale assemblies to date Small seed collections held by: Agriculture Canada provincial agriculture departments private interests
INITIAL EVALUATION	New collections screened using standard criteria: seed & forage production size disease and pest resistance	No standard selection criteria; individual breeders establish their own criteria. In Western Canada, the Native Plant Materials Development Group is coordinating the development of selection criteria for native plants.
VARIETAL IMPROVEMENT	USDA Agriculture Research Stations Criteria: seedling establishment awn removal (ease of seeding & processing) regrowth after grazing seed yield forage yield	Agriculture Canada Research Branch
SELECTION & INCREASE	superior plants selected, plants (or seed from them) isolated, seed harvested, used to establish initial seed increase fields	
FIELD TESTING	Selected plants/seeds are established in replicated small plot plantings. These are located in as many locations as possible to test them under typical site and actual use conditions in the projected areas of adaptation.	

LARGE SCALE SEED INCREASE & RELEASE	Data summarized from 3 years' field testing and presented to federal and state review boards. If the selection is found to be superior, it is released for commercial production.	New forage cultivars are tested for about 12 station years for performance, and, in western Canada, persistence. Data are presented to provincial and federal officials for assessment. The next step is registration. Reclamation grasses are treated differently -- performance data are not required. The breeder provides to Ag. Canada a variety description, how it differs from existing varieties, and its intended use, plus 2 kg of breeder seed as a museum sample.

Prior to and during the registration process, the breeder multiplies seed on breeder plots to provide foundation seed for distribution. Once registered, the foundation seed is distributed for multiplication by growers of pedigreed seed.

Seed grading

Canadian Seeds Act and Regulations is the regulatory document for the grading of seed. This is a fairly complex process, but here's a quick run-down for the uninitiated:

Agriculture Canada inspectors inspect all fields and processing sites.

25 g samples of each seed lot are graded on their germinability (pure live seed or PLS) and freedom from weeds and disease.

Producers are responsible for ensuring that their product meets certain requirements, including proper packaging and labelling. In some cases, a user holds higher standards of purity and stricter labelling requirements than required by law. For example, DU requires its native seed to be completely free of smooth, downy and Japanese bromes and rat-tailed fescue.

Based on all of this information, forage grass seed is given a grade of foundation, registered, certified or common.

Breeder seed is not for commercial sale. It is grown to produce larger quantities of registered or foundation class seed.

Foundation seed is the highest commercial class of seed; it is more widely planted to produce larger quantities of registered or certified seed.

Certified seed is the class of seed recommended for commercial crop production.
That seed produced from certified seed plantings (or wild-harvested seed) is given a ***common*** grade.

Wild-harvested seed - The main criterion which prevents wild-harvested seed from attaining a grade higher than "common", regardless of its purity, is the requirement for pedigree information. Each class of pedigreed seed is grown only by authorized growers and is managed to maintain genetic identity and purity at established levels. Each batch of seed produced is inspected, graded and tagged to assure that it meets or exceeds acceptable standards for the appropriate class.

High seed dormancy - This is one characteristic of **native species** which is not adequately accounted for in the grading process. The standard laboratory process for testing germination determines what percentage of seed germinates after a certain number of days. The percentage of pure live seed (PLS) is determined using germinability and the amount of pure seed in a sample. Because most introduced forage grasses are cultivars which have been selected for low seed dormancy, most of the live seed in a sample germinates quickly and achieving a high germinability score. Most native species have much higher dormancy. For example, up to half of a sample of living seed may not germinate until a year or more later. Germinability values, and therefore, PLS, will be much higher for most introduced varieties, even if the proportion of living seed is exactly the same, because there is less dormant seed in introduced than in native grass seed samples.

This can cause problems for producers and users of native grasses, who calculate seeding rates and use the information to buy the correct amount of native seed for their needs. (This is especially important given its cost.) Because seed growers usually go by the PLS and (short-term) germinability information in calculating seeding rates, they may buy more seed than they need, not taking into account the amount of "bonus" (live but dormant) seed that is hidden in the non-viable component of the seed lot they buy.

TZ test - One way to establish how much of a sample is dormant, living seed is to ask the seed testing laboratory to use the "TZ", or tetrazolium test in its analysis. (This is the same test that is used for winter wheat). The tetrazolium test accounts for the live dormant seed component that quick germination testing misses. This gives a measure of pure *viable* seed ("PVS") rather than just pure *living* seed. With germinability *and dormancy* information, a grower can get an idea of how much seed will germinate over the longer term, and calculate seeding rates accordingly. This information is especially valuable in planning restoration, reclamation, or permanent cover plantings, because it can reduce costs and aid in long-term management planning. In these types of plantings, where long-term site stability and low cost maintenance are desired, seed dormancy can actually be an asset. It is one of many native plant characteristics which help a planting "adapt" to a site, conserving energy until conditions are right for germination.

Seed labelling requirements

1) name & # of **noxious weed seeds**/unit wt. AND the total # of weed seeds/unit wt.

2) total # of seeds of **other crops**/unit wt.

3) **% germination** of a representative sample & the **date** on which the test was completed.

Some heavy users of native seed, such as Ducks Unlimited, demand more detailed information on the seed they buy. The supplier must provide a full seed analysis report, which includes not only the names and seed numbers of noxious weeds, but also tetrazolium test results, names and numbers of other seed types per unit weight. Some species which are not considered noxious weeds in grading, like smooth, downy and Japanese brome grasses, are considered noxious weeds by DU for the purposes of establishing perennial native grass mixtures.

Current Materials

Native forage grasses currently being used in Canada include cultivars, harvested wild-type seed, and common seed grown from cultivars or wild seed.

A ***cultivar*** is a plant variety which has undergone genetic restriction through selection by plant breeders, and which has been registered by a certifying agency. There are currently 10 native grass cultivars registered for use in Canada. Nine of these are listed in this table. Of these, five were released by Agriculture Canada.

Table 1. Native grass cultivars registered for use in Canada[2]

Common Name	Cultivar	Release Agency	Scientific Name
slender wheatgrass	Adanac	Ag. Canada	*Elymus trachycaulus (Agropyron trachycaulum)*
	Highlander	Alberta Environmental Centre	
	Revenue	Ag. Canada	
awned slender wheatgrass	Hillcrest	Alberta Environmental Centre Ag. Canada	*Elymus trachycaulus* var. *subsecundus (Agropyron trachycaulum)*
Western wheatgrass	Walsh	Ag. Canada	*Pascopyrum smithii (Agropyron smithii)*
Northern wheatgrass	Elbee	USDA (SCS)	*Elymus lanceolatus (Agropyron dasystachyum)*
streambank wheatgrass	Sodar	USDA [SCS; ID & WA AES]	*Elymus lanceolatus (Agropyron riparium)*
reed canary grass	Palaton	US [Land O'Lakes, IA]	*Phalaris arundinacea*
	Vantage	USDA [IA AES]	
	Venture	US [Pioneer Hybrid, Int'l]	
	Rival	Ag. Canada	

Abbreviations:

SCS	**United States Department of Agriculture (USDA) Soil Conservation Service Plant Materials Center**
USFS	**USDA Forest Service Shrub Sciences Laboratory**
AES	**State Agricultural Experiment Station**
Ag. Canada	**Agriculture Canada**

An *ecovar* is similar to a cultivar in that it is a plant variety which has undergone selection by plant breeders. It differs in the degree to which it has been genetically restricted; that is, in the uniformity of its characteristics. An ecovar is usually defined by its ecological niche, or the set of soil, elevation, precipitation and other conditions under which it will grow and develop normally. A cultivar is generally selected for all of these criteria as well as others, such as drought-tolerance, seed production, disease resistance, and so on. The more

[2]adapted from Haas, 1988 and Canadex Field Crops report, 1991 and updated

selection criteria are set, the more genetically alike the individuals within the variety are. Ecovars retain much more genetic variety than do cultivars, and theoretically will be more adaptable to environmental changes as a result.

Wild-type **seed is that which is harvested directly from native populations of plants. Native plant populations generally are very narrowly adapted to local conditions, and will not grow and reproduce to their potential if moved very far from the collection area. In nature, native plant populations show more genetic diversity than either cultivars or ecovars. One important point to note is that harvesting seed from a site is in itself a selection process, which reduces genetic variability -- only those plants which bear ripe seed on the particular day(s) and year(s) of harvest will be represented in that lot of seed. The method of harvest also is a factor.**

This may not seem significant unless one considers that in populations of certain grasses, only a small proportion of individual plants may be reproductive in an given year. Preliminary findings of breeding work being done on needle and thread grass (*Stipa comata*) show only 20% of individuals in test plantings producing 80% of the viable seed (S. Wright, pers. comm. and these proceedings). Wright also found that only 16% of those reproductive plants produced seed in the second year. This means that, in this example, the vast majority (80%) of individual plants would go unrepresented in a single year's seed harvest. It also means that the second year's harvest would have consisted largely of seed from plants which were not reproductive in year one.

Many plants in a population use rhizomes or other means to reproduce, and experience unreproductive periods. These factors increase the likelihood that they will go unrepresented in a single seed harvest. Harvesting more frequently during a given season and harvesting over a period of years will increase the amount of genetic variability (and adaptability) in a harvested seed lot. Frequent harvest also may limit the amount of seed available to prairie fauna and increase the possibility of physical and other damage to wild sites. Users of wild-harvested native seed may wish to consider these factors in light of their needs and objectives for use.

American cultivars - Because locally developed cultivars are not available for most native grass species, American cultivars are frequently used in Canada as well. Table 2 shows a number of American native grass cultivars and their selection criteria. Note that three of these currently have Canadian registration pending.

Table 2. American native grass cultivars suitable for use on the Canadian prairie provinces[3]

Cultivar	Origin	Year Released	Release Agency	Selection Criteria

[3] adapted from Haas (1988) and updated

Cultivar	Origin	Year Released	Release Agency	Selection Criteria
COOL-SEASON NATIVE GRASSES[4]				
Green needlegrass (*Stipa viridula*)				
Lodorm	North Dakota	1969	ARS	Low seed dormancy
Indian ricegrass (*Oryzopsis hymenoides*)				
Nezpar	Idaho	1978	(SCS)	forage amount & leafiness, reduced dormancy
Slender wheatgrass (*Elymus trachycaulus*)				
Pryor	Montana	1988	SCS; MT	drought & salinity tolerance
Primar	Montana	1946	SCS; OR, WA & ID AES	Vigour, forage production, disease resistance
Reed Canarygrass (*Phalaris arundinacea)* - Canadian cultivars available; see table 1.				
Basin wildrye (*Elymus cinereus*)				
Magnar	Saskatchewan	1979	SCS; ID AES	Seed yield
Beardless wildrye (*Elymus triticoides*)				
Shoshone[5]	Wyoming	1980	SCS; ID & WY AES	Salt tolerance
Bluebunch wheatgrass (*Pseudorigneria spicata*)				
Secar	Idaho	1980	ARS; WA, ID, OR, WY & MT AES	forage production, spring recovery, seed yield, early establishment
Goldar	Idaho	1989	SCS	forage yield, basal area
Streambank & Thickspike (Northern) wheatgrasses (*Elymus lanceolatus*)				
Sodar	Oregon	1953	SCS; ID & WA AES	Ground cover
Critana	Montana	1972	SCS; MT AES	Ground cover
Elbee	Alberta & Sask.	1980	SCS	Rhizome development
Western wheatgrass (*Pascopyrum smithii*)				
Rosana	Montana	1972	SCS; MT AES	Seedling vigour
Rodan	N. Dakota	1983	ARS; SCS; ND AES	drought resistance, leafiness, vigour

[4]as of Sept/94, Canadian registration is pending for Lodorm green needlegrass, Critana streambank wheatgrass and Rodan Western wheatgrass

[5]Note: winter kill reported in central Saskatchewan

WARM-SEASON NATIVE GRASSES				
Big bluestem (*Andropogon gerardii*)				
Bison	N.Dakota	1980's	SCS; ND AES	
Blue grama (*Bouteloua gracilis*) - no locally adapted cultivar available; see table 3				
Indian grass (*Sorghastrum nutans*)				
Tomahawk	N.Dakota			
Little bluestem (*Schizachyrium scoparium*) - no locally adapted cultivar available; see table 3				
Prairie sandreed (*Calamovilfa longifolia*)				
Goshen	Wyoming	1976	SCS; MT & WY SCS	Forage & seed production
Sand bluestem (*Andropogon hallii*) - no locally adapted cultivar available.				
Sideoats grama (*Bouteloua curtipendula*)				
Killdeer	N. Dakota	1968	SCS	Early maturity, vigour, forage production, disease resistance
Switchgrass (*Panicum virgatum*)				
Dakotah	N.Dakota	late 1980's	SCS	

NB: 1) The geographical limit for ND and MT cultivars is 250 mi. north of the US border
2) A 1,000 ft. increase in elevation equals a move of 175 mi. northward

Abbreviations:

SCS United States Department of Agriculture (USDA) Soil Conservation Service Plant Materials Center
ARS USDA Agricultural Research Service Grass Breeding Project
USFS USDA Forest Service Shrub Sciences Laboratory
AES State Agricultural Experiment Station
Ag. Can. Agriculture Canada

ID Idaho
MT Montana
ND North Dakota
OR Oregon
WA Washington
WY Wyoming

Recent Research and Development

Some research & evaluation highlights are shown in table 3.

Table 3. Current Canadian Breeding Programs

Researcher(s)	Cooperating Agencies	Location	Species
Dr. Barb Darroch & Dr. Richard Hermesh	Alberta Environment Centre Ag. Canada	Vegreville, AB	alpine bluegrass, slender wheatgrass (awned and awnless), broadglumed wheatgrass, spike trisetum
Dr. Peter Walton	U. of Alberta	Edmonton	wheatgrass & wild rye crosses
Dr. Scott Wright	Ag. Canada, Ducks Unlimited	Melfort, SK	*Stipa spartea*, *Stipa comata*
Dr. Ray Smith	U. of Manitoba, Ducks Unlimited	Winnipeg, MB	*Bouteloua gracilis*, *Schizachyrium scoparium*
Dr. Paul Jefferson	Ag. Canada, Ducks Unlimited	Swift Current, SK	*Bouteloua gracilis*, *Calamovilfa longifolia*
Dr. Paul McCaughey	Ag. Canada, Ducks Unlimited	Brandon, MB	*Bouteloua gracilis*, *Schizachyrium scoparium*

Table 4. Current Evaluation Programs

Researcher(s)	Cooperating Agencies	Location	Species
Dr. Colin McKenzie	Brooks Hort. Stn	Brooks, AB	*Agropyron* spp.
Dr. Jane King	U. of Alberta	Edmonton	*Festuca campestris*, (rough) *F. hallii* (plains), northern rough fescue
Dr. Scott Wright	U. of Saskatchewan, Ag. Canada	Saskatoon, SK and Melfort, SK	*Stipa spartea*, *Stipa comata*; seed production physiology
Dr. Drew Smith	Newfield Seeds, Ag. Canada, U. of Sask. (Horticulture Dept.)	Nipawin, SK	*Puccinellia nuttalliana, Puccinellia distans*

Other research

The University of Manitoba Faculty of Agriculture (Plant Science) and Ducks Unlimited are cooperating on herbicide trials using nine species of native grasses (R. Arnott, Ducks Unlimited, pers. comm.) Newfield Seeds also is conducting herbicide trials on new grass cultivars.

Proposed breeding programs

Dr. Ken May, of Agriculture Canada's Lethbridge Research Station, is interested in the assessment and selection of native bromes and fescues, as well as two warm-season grasses. He proposes assessing four native brome grasses for reclamation potential, in cooperation with Clare and Cathy Tannas of Cremona, Alberta. They are *Bromus anomalus* (nodding brome), *B. carinatus*, *B. ciliatus* (fringed brome), and *B. pumpellianus* (Northern awnless brome). Dr. May anticipates variety registration in 1998. He also is interested in selection for variety development of three native fescues: *Festuca campestris* (rough fescue), *F. idahoensis* (bluebunch fescue) and *F. hallii* (plains rough fescue). The two warm-season grasses of interest are *Schizachyrium scoparium* and *Bouteloua gracilis*; these will be evaluated for selection and varietal development.

Drs. MacCaughey, May, Wright and Jefferson, in cooperation with Ducks Unlimited Canada, will be evaluating 12 native grass varieties and new selections for winter survival, plant growth, seed production and nesting cover. The native grass species under evaluation will be northern and western wheatgrasses, green needlegrass, sand reed grass, sand dropseed, big and little bluestems, Indian grass, side-oats grama and switchgrass. The study will describe varieties suitable for wildlife and reclamation plantings.

Management: Practical Aspects of Native Material Use

Ecology

Native species are limited to particular geographic areas for a number of reasons. Local strains or ecotypes evolve which are best adapted to the local climate, soil and day length of a particular area. These adaptations restrict the movement of materials from one location to another, depending on the distance between the source and target location. When moved from their place of origin, they may flower and set seed too early to take full advantage of conditions (poor biomass production), or too late to produce viable seed. Usually, southern strains won't produce viable seed in northern latitudes, and vigorous growth into late fall increases their susceptibility to winter injury (Rogler, 1943).

Southern cultivars moved northward show an increase in forage yield over local strains, but their susceptibility to winter kill and their failure to set seed didn't justify moving them more than 100-200 miles northward for forage production purposes.

Another factor that has a bearing on selection and management of forage grasses is the way they use and store energy. ***Cool-season*** plants, such as needlegrasses and wheatgrasses, are so named because they experience peak activity primarily in spring and fall. Cool-season grasses have something of a dormant period in the hot period of the summer, when they slow growth and may turn brown.

Warm-season plants, such as the bluestems and blue grama, usually remain dormant until late spring or early summer. Their metabolism is better-suited to the high temperatures and intense sunlight of summer than are cool-season plants. They are often used in seeding summer rangelands because they are actively growing at a time when the cool-season forage species are not, providing forage later in the summer.

Warm-season species evolved in southern North America and are the dominant type of grass in the tall-grass prairies of the midwestern U.S. and south-central Manitoba. The mixed prairie, aspen parkland and foothills communities common to British Columbia, Alberta, Saskatchewan and the rest of Manitoba tend to be dominated by cool-season species, which evolved further north (Weaver, 1954). In these communities, warm- and cool-season components, regardless of dominance, have important roles in maintaining the ecological stability of each.

Cultivars vs. Wild-type seed (will ecovars bridge the gap?)

There is debate about the use of cultivars versus wild harvested ecotypes.

Cultivars

Advantages:

high purity
predictable availability, germination and seeding rates
proven pedigrees
high pure live seed (PLS) content
high germinability
maximum allowable content of "non-seed" material
usually available in fairly large quantities

Disadvantages to using cultivars rather than wild type seed:

few species available
new cultivars take many years to develop
some existing varieties are not locally suitable (winter kill or fail to set seed)
possibility for competition with and replacement of native populations
influence on gene pool (lowering genetic diversity which may be important to long-term survival of species and communities).

Wild Seed

Advantages:

wild harvested seed is the only seed source for many species
site suitability is more likely if local sources from habitats similar to the restoration site are used.
recent technology allows large harvest at low cost, and harvest of species not currently available in sufficient quantity through other means
genetic diversity is greater within wild populations

Disadvantages:

difficulty in <u>certifying</u> quantities of PLS for most species or mixes collected by wild harvest.
amount of chaff in the mix and the germinability of the live seed are variable.
seed production is significantly affected by weather and other factors such as fire (Mahler and Walther, 1988).
wild seed harvests are often comprised of a small proportion of the total population, rasing concerns of restricting the genetic base.
seed of forbs and easily-shattered grasses can be difficult to collect
seed not usually available in large quantities

Ecovars

Recent work toward the development of ecovars is partly an attempt to reach a compromise between the use of cultivars and the use of harvested wild seed in reclamation and wildlife plantings. Ecovars retain much of the natural genetic variability that cultivars do not, yet they are more broadly adapted than plants from local wild-type seed. Registered ecovars also feature some of the predictability of cultivars without requiring as much time to develop and register them -- three to five years from collection to registration as opposed to 10-15 years in the case of a cultivar. Ducks Unlimited has been working with Agriculture Canada and the Canadian Seed Growers Association to establish certification for ecovars used in reclamation. Formerly, reclamation grasses were included with forage grasses for grading purposes. Since January, 1993, there has been provision for certification of native species as reclamation grasses.

Political/Institutional Issues

The procurement of native plant material from the wild, and limitations on collection may depend on the following:

protective status of the site
intended use of collected seed (sale? multiplication? personal use?)
presence of rare species
allowed percentage of available harvest
type of equipment used
site condition (drought-stressed? excess moisture?)
recent changes to site by fire, haying or grazing

Other institutional barriers to production and use of native grass species can include:

licensing
export/import regulations
industry development regulations
basis of native materials research on production agriculture (solutions to date have included use of the TZ test and certification of some varieties as reclamation grasses)
no provision in the permitting process of many jurisdictions for the collection of native grass or wildflower seed (some issue on *ad hoc* basis), but none of the western Canadian provinces has procedure or criteria in place to issue permits for the collection of wild seed, except for those used for scientific collection on protected Crown lands (parks, refuges, etc.).

Native Grass Seed Production in Western Canada

Of all forage grass seed acreage inspected in 1991, 99% was in western Canada. The prairie provinces alone produce 92% of the country's forage grass seed.[6]

The pie diagram in figure 1 shows the amount of pedigreed forage grasses grown in Canada, based on inspections done by Agriculture Canada. Unfortunately, the amount of common or wild type seed grown is unknown, but the numbers the figure presents an idea of how much native and introduced forage seed is grown in western Canada. Although the trade in native forage species is not currently significant in terms of acreage or mass of seed produced, 1994 figures (presented by D. Murrell in these proceedings) suggest that it is a growing industry.

[6] calculated from figures published in the CSGA annual report, 1991/92

Figure 1. Pedigreed forage grass grown and inspected in Canada

Current prices indicate that until the supply of native grass seed increases, or the demand decreases, producers will enjoy considerably greater profits from fewer planted acres than those growing conventional forage grasses. Nearly all of the producers and users interviewed agreed that native seed prices fluctuate widely from year to year. The Conservation Reserves Program and various large reclamation projects in the U.S. have greatly increased demands for native plant materials. Increased U.S. demand has reduced Canadian native seed supplies and increased prices on both sides of the border (B. Wark, pers. comm.).

Constraints on Native Seed Production and Use

Availability of Local Seed/Cultivars

Shortage of local native seed was found to have been a limiting factor for both producers and users. In 1980, when Ducks Unlimited Canada began looking for alternatives to introduced forage grasses for long-term dense nesting cover plots, no Canadian sources of seed existed. Biologists at DU began using northern US cultivars developed by the US Soil Conservation Service. By the mid-1980's, DU's native seed requirements had become fairly large (about 45,000 lbs. annually; B. Wark, pers. comm.), but were still being met using American sources. When its usual native seed supplies became short, prices increased dramatically and Ducks Unlimited embarked on a program of contracting local seed producers to grow and supply northern US cultivars of native grass seed for its use. A significant portion of DU's requirements for native seed in Manitoba and Saskatchewan is now met by Canadian production. In Alberta, much of DU's seed is supplied by Canadian seed companies which import native cultivars directly from United States suppliers. Currently this amounts to 100,000 lbs. annually.

Wild-type seed may be desired in situations where the aim is to closely approximate the distribution of local species and genotypes, for example, in re-establishing wild-type plant populations in nature reserves and wildlife areas.

Cultivars/ecovars may be a better choice for general reclamation over a larger geographical area.

Cost of Seed

Most of the native grass seed users interviewed indicated high cost of native seed as being the most limiting factor in its use. Low availability appears to be the primary cause of high native seed prices. Please note that figures 2 through 4 are based on average prices of several western Canadian seed companies between 1991 and 1993, and that the less available species (fig. 4) are based on prices from only one or two sources. 1994 information (as presented by D. Murrell in these proceedings) indicates that acreage dedicated to producing pedigreed native grass seed climbed to 1800 acres, an increase of 80% from 1993. Greater availability and a steady demand should support continued growth in native seed production, and presumably lower cost.

As locally-adapted cultivars are developed and are commercially released and marketed, availability should increase and costs will fall. The costs of commonly-used native cultivars such as slender wheatgrass (fig. 2) are similar to those of introduced cultivars (figure 3). Slender wheatgrass is commonly used in introduced plantings, as well as native plantings, because of its salinity tolerance. It is widely available and well-promoted. The four native species depicted in figure 4 are commonly used in reclamation plantings, but are mostly available to seed suppliers as wild-harvested seed. Their high prices reflect low availability and, in the case of needle and thread grass, difficulty in processing the long-, curly-awned seed.

Seed companies with exclusive rights to new cultivars are responsible for promotion and marketing of the cultivar. Some of the users and smaller suppliers interviewed expressed concerns that cultivars of lesser-known species or varieties, such as native forage and reclamation grasses, may be suffering from underexposure to the public. Large seed companies often favour the use of varieties of introduced species which are more familiar to the public and to their own staff. Knowledge about a variety and its uses, added to its availability, influences consumer use and ultimately affect the cost of seed. Cooperation of seed users with plant breeders and seed suppliers in developing, growing and promoting new cultivars has proven to be an important factor in the western Canadian native seed industry.

Figure 2. Graph showing average prices in western Canada for a selection of introduced forage/reclamation grass cultivars. Graph showing average prices in western Canada for a selection of introduced forage/reclamation grass cultivars. Graph showing average prices in western Canada for a selection of introduced forage/reclamation grass cultivars.

Figure 3. Graph showing average prices in western Canada for a selection of native forage/reclamation grass cultivars.

Figure 4. Graph showing average prices in western Canada for a selection of native reclamation grasses for which cultivars are not currently available.

Issues in Development and Management of Native Plant Materials

Development

Cooperation among users, suppliers and breeders of native seed. Ducks Unlimited has set an industry example by filling its large native seed needs with species and varieties developed, grown and tested in western Canada by cooperating agencies. Government and private plant breeders need to know what species and selection criteria users are interested in and they need funding to develop them. Seed growers need financial help when taking a risk on new species and varieties. Given the risks that growers, suppliers and users face, any agreements they can form to use each other's services can to achieve their individual objectives.

Review and revision of selection and licensing criteria and of seed grading, packaging and labelling requirements to account for differences between native and domestic agronomic varieties and their respective uses. A separate noxious weed list should be established for grading, packaging and labelling seed to be used in reclamation and other native plantings.

Management

Policy and legislation on the collection of wild seed from public lands. Development of provincial and federal procedures and criteria for the issue of permits is required immediately.

Guidelines on seed production, harvest and storage for producers and suppliers of native plant materials.

Information and statistics on production and use of native plant materials. Native plant materials are distinct from non-native agronomic varieties in a number of ways. Separate classification and treatment of statistics would draw attention to differences in characteristics and uses and would allow easier monitoring and market research by groups growing, supplying and using native plants.

Formation of a native plant council for Saskatchewan. A native plant council can bring together individuals and agencies (government and non-government) and facilitate the sharing of expertise and money among them. This could include cooperative funding of demonstration projects and producer-led research, provision of information and materials to the public and feedback to government on policy and legislation, native plant selection criteria, etc.

Seed Production of Native Grass

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Grasses are frequently sown to stabilize soil and to provide forage for livestock. Seed production, however, is essential for the supplies to establish these stands. Grass seed production first became commercially important in Saskatchewan during the 1930's with the need to stabilize large areas of abandoned Saskatchewan farmland. Crested wheatgrass and smooth bromegrass were prolific forage and seed producers and were easily suited to commercial seed production. Native grass seed production was limited primarily to slender wheatgrass. Selections of native stands from near Revenue, Saskatchewan formed the genetic base for the variety released by that name in 1970. Development of a variety for slender wheatgrass was less difficult than for other native grasses because the grass is one of the few self-pollinating grass species.

Native grass seed production was an important agricultural enterprise in the early 1930's throughout the Great Plains of United States because of the need to revegetate large areas of broken farmland which was seriously threatened by erosion. The Soil Conservation Service of USDA collected seed from native stands of western wheatgrass, blue grama, big bluestem, little bluestem, and buffalo grass to provide the seed stock for its revegetation programs (Crider and Hoover, 1937).

The advantages for native grass seedings for uncultivated lands include cover which blends with surrounding native vegetation, control of erosion, adaptation to local moisture conditions, improved uniformity of grazing and adequate nesting conditions for wildlife. Native grasses require minimal maintenance and will resist weed invasion without fertilization and irrigation.

There are three types of grass seed production. Stands of introduced species are cultivated specifically for seed production. Native species may also be sown in cultivated stands for seed production. The seed production from cultivated stands under intensive management often far exceeds the yield of native harvest. This production is also important for species with limited natural stands. The third type of grass seed production is simply the harvest of native stands for seed. Cornelius (1950) compared the seed yields of cultivated and native stands. For the seven species he evaluated, harvestable yields of seed from native stands occurred only 36% of the time. Average yields over a nine year period were only 57% of the seed yields obtained under cultivated management.

Efficient native seed production is essential for feasible use of native seeds in revegetation programs. The high cost of native seed has restricted the use of native plant materials. If the production methods could be improved to stabilize and increase the seed yields and to streamline the processing requirements, the cost for the use of native materials would be more economical.

The key for production of native grass seed is to understand the adaptation of each species and to grow the grass only where it is well adapted. Many native species may survive, but will produce virtually no seed when grown outside their natural environment. Species differ widely in the type of soil and climate to which they are adapted. When considering native grass seed production for a field, the grass must be adapted to environmental conditions of the field (Atkins and Smith, 1967).

The principle of adaptation is also important in a geographic sense. Native seed of a species will only be adapted within a limited radius of the location where it was originally selected. Varieties of native plants are selected for superior performance in a defined region. These selections are known as an ecotype or ecovar, a term which is synonymous to a cultivar of any grain or oilseed crop. If an "ecological variety" is planted more than 500 km north or 350 km south of its origin, the plant may have difficulty completing its normal growth cycle. For movement east and west, an increase in elevation of 500 meter is similar to moving 450 km north. Varieties developed from "northern" ecotypes mature earlier, grow shorter, produce less forage, and are more susceptible to plant diseases when moved south or east of their point of origin. Varieties developed from "southern" ecotypes mature later, grow taller, produce more forage and have greater risk of winter injury when moved north or west of their point of origin. Because of the importance of adaptation for growing native species, use pedigreed seed of varieties which were selected within 500 km of the field selected for native seed production. Consider how the change in altitude may affect the suitability of the grass for your region (Atkins and Smith, 1967).

Unlike the selection of plants for cultivars of self-pollinated grains, breeders of native grass varieties strive to maintain diversity of the other characteristics in the species population while selecting for a specific trait such as low seed dormancy or seedling vigour. This variability in the variety is important for the survival and adaptation of the species in nature because of the variability of weather patterns.

I. **Major Native Species of Saskatchewan Grasslands**

Northern wheatgrass (Elymus lanceolatus, Agropyron dasystachyum), the most abundant wheatgrass in the Brown and Dark Brown soil zone, is found throughout the prairies on medium to heavy textured soils. Rarely it is also found in pure stands on sandy textured soils. Northern wheatgrass begins growth in early spring and produces mature seed by the middle of July. Recommended varieties for Saskatchewan include Critana and Elbee. Sodar, which is known as streambank wheatgrass(Elymus lanceolatus, Agropyron riparium), is considered by taxonomists as a type of northern wheatgrass (Smoliak and Bjorge, 1990).

Western wheatgrass or bluejoint (Pascopyrum smithii, Agropyron smithii) occurs on heavy textured clay soils and well drained low lying areas. It is also found on saline soils adjacent to water courses and shallow lake beds. Western wheatgrass greens up in early May and produces seed during the middle of August. The grass tolerates drought by remaining dormant, but will recover quickly when rains begin. The grass regrows well during the fall. Recommended varieties for Saskatchewan include Rosana, Rodan, and Walsh (Smoliak and Bjorge, 1990).

Slender wheatgrass (Elymus trachycaulum, Agropyron trachycaulum), also known as western ryegrass, is a short-lived perennial cool season bunch grass found throughout the prairies on moist to well drained low-lying soils. This wheatgrass is known for its tolerance to moderately saline soils. Slender wheatgrass begins growth in mid-spring and produces mature seed in August. Because the grass remains green during fall, it is a desirable for grazing. It is relatively tolerant of grazing and trampling. Suitable varieties for Saskatchewan include Primar, Revenue, and Adanac (Smoliak and Bjorge, 1990).

Green needlegrass (Stipa viridula) occurs throughout the prairies, but not in dense stands. It is more prevalent on plains and slopes with moist medium to heavy textured soils. Green needlegrass begins growth early in spring and remains green late into fall if grazed. Seeds are mature during the middle of July (Smoliak and Bjorge, 1990).

Reed canary grass (Phalaris arundinacea) is long lived perennial cool season grass found along river banks and sloughs. Although it is able to tolerate flooding for up to two months, it is also able to withstand drought. It is adapted to both slightly acidic and slightly alkaline soils. Reed canary grass begins growth early in spring and continues to grow throughout the growing season. Seeds mature during the middle of July (Smoliak and Bjorge, 1990).

Blue grama grass (Bouteloua gracilis) is the most abundant grass of the short grass prairie, preferring medium to heavy textured soils. It is a warm season bunch grass adapted to neutral or slightly alkaline soils and will tolerate slightly to moderately saline soils. Blue grama grass starts growth late in the season, but recovers rapidly from drought and is resistant to grazing and trampling. Its seeds will mature in late July to early August (Campbell et. al., 1966).

II. **Agronomic practices for native grass seed production**

The agronomic practices for producing grass seed are similar for both native and introduced species. Seed yields of grasses vary with moisture conditions; therefore, irrigation or relatively dependable rainfall to supply 35-50 cm of moisture are essential for consistent grass seed yields. Many grasses, especially some native species, will only produce seed under excellent moisture conditions. Without adequate moisture, seed head formation may be inadequate to justify the harvest of the seed crop. Under dryland, harvest of the grass as forage or pasture may be necessary to obtain revenue from a grass seed field in a year when it has not set seed (Atkins and Smith, 1967).

A. Pedigreed seed production

Certified production of grass seed must follow the regulations as outlined in the Canadian Seed Grower's Association Circular 6. For grasses, there are only three pedigreed seed classes: breeder, foundation, and certified. The regulations explain acceptable previous cropping history for the field, crop inspection procedures, suitable age of the stand for certification, and isolation requirements. Since most of the grasses are cross-pollinated, isolation distances are as high as 400 m. Check to see that the isolation regulations are met (CSGA, 1993). Pedigreed seed usually sells at a premium compared to common seed. The extra work associated with pedigreed seed production is worth the effort.

B. Field selection and preparation

A weed-free field is essential for native grass seed production because many native species are very slow to germinate and establish. Heavy weed pressure will weaken the new seedling, lower seed yields and may, through competition, eliminate the seedling from the stand. The field selected for grass seed production must be free of noxious perennial grassy and broadleaf weeds. Presence of noxious weed seeds in the sample disqualify the seed for market as pedigreed seed (Dodds et. al., 1987).

Prior to seeding the grass, weed control is easily achieved with broad spectrum herbicides and cultivation. Weed control options are severely limited once the grass is sown. The only remaining option for many weeds may be roguing by hand or with a backpack sprayer within the stand which is very time consuming and costly. A clean weed-free field may be left unattended for several weeks with only minimal weed growth. When the field is free of quackgrass or Canada thistle, it may be left untilled for an entire season without the appearance of quackgrass or Canada thistle.

Achieving this degree of sanitation may require one to two years of planning. Eradication of quack grass is essential prior to seeding any grass. Glyphosate application at 1-2 liter per acre in the fall prior to sowing the grass will control perennial weeds such as quackgrass, Canada thistle, and sow thistle. A fallow or partially fallow field provides opportunity to control several flushes of annual broadleaf and grassy weeds prior to seeding.

C. Seeding equipment

Native grasses may be sown with any conventional planting equipment if shallow seeding and adequate packing are achieved. Although air seeder cultivators and hoe drills have successfully established grasses, disk drills are the most common grass seeding implement. Zero tillage implements are also suitable for sowing grasses. The addition of depth control bands to disks and agitators in the seed box relieve many of the difficulties associated with seeding grasses. All good grass seed drills have the following features:

1) a packing wheel ahead of the disk opener to level and firm the soil,
2) depth control bands on the disk opener to maintain shallow penetration
3) a trailing packer wheel to ensure good seed to soil contact
4) agitation in the seed box to prevent bridging of seed.

Once the weed pressure is under control, it is time to prepare the seedbed. The seeds of most native grasses are tiny and slow to emerge. A firm seedbed is essential for shallow placement of the seed into the soil. Packing following the last tillage operation will help to firm the soil. Some grass seed producers roll their fields before seeding to improve control of seeding depth. A rainfall following the final tillage operation will also prepare a firm and moist seedbed for placement of the grass seed.

D. Seeding rate

The seeding rate for the various grasses is dependent on the row spacing of the seeding implement, the quality of the seed, and the number of seeds per unit weight of seed. Pedigreed seed of cultivated grasses have high germination rates. With native seeds such as green needlegrass, germination rates are frequently only 20-25%. Seeding rates will need to be adjusted for seed lots with less than 80% germination. The number of seeds per kilogram of several common native species are listed in Table 1. Because of the potential for loss of 50-75% of the seeds before the plants become established, most guidelines recommend a seeding rate of 60-100 seeds per meter of row (Alberta Agriculture, 1993). Using this guide, the seeding implement is easily calibrated by driving over a sheet of plywood and counting the number of seeds in a meter of seedrow. It is wise to sow sufficient seed to establish a satisfactory stand of grass. The cost of reseeding would exceed the savings from reducing the seeding rate. Although successful establishment of the grass can be achieved with less seed if weather and moisture conditions are favourable, seed costs are minor compared to other expenses. Sowing at a lower seeding rate, however, will produce more vigourous seedlings and higher seed yields.

Table 1: Comparative Seed Size of Some Common Native Grasses (Alberta Agriculture, 1993, Atkins and Smith, 1967)

Species Name	Number of Seeds / Kilogram
Blue Grama Grass	1,567,000
Green Needlegrass	399,000
Northern Wheatgrass	341,000

Slender Wheatgrass	352,000
Reed Canary Grass	1,175,000
Western Wheatgrass	242,000

E. Use of cover crop

Early maturing cover crops are often sown with the grass seed to protect the emerging grass seedlings from extreme weather conditions. Crusting is less likely to restrict emergence of the grass seedling when a cover crop is sown. Although establishment of the grass is improved, the competition from the cover crop will depress the yield of at least the first grass seed crop. When the grass seed crop is sown without a cover crop, the income lost during the establishment year is more than compensated for by the improvement in yield of the first grass seed crop (Dodds et. al., 1987).

A promising establishment technique for grass seed fields sown without a cover crop is being developed by Heather Loeppky of Agriculture Canada at Melfort. She is evaluating several combinations of tillage treatments and planting dates. Although the study is still not complete, one observation is clear. Weed populations in newly established grass seed fields are reduced when tillage does not accompany the seeding operation. After the final tillage operation, seeding is delayed for one to two weeks. The field is sprayed with glyphosate just prior to seeding the grass. The seedbed may be prepared by fall or spring tillage or without tillage. Weeds which are stimulated to germinate by the final tillage operation are killed by the herbicide application. The overnight dews and the occasional rain shower will firm the seedbed and allow the seed to be sown in moist soil. The minimal disturbance of the seeding operation will induce few weed seeds to germinate along with the grass seed crop.

F. Seeding depth

McKenzie et. al (1946) at Swift Current demonstrated the importance of shallow placement of the seed for crested wheatgrass, tall wheatgrass, smooth bromegrass, and Russian wild ryegrass. Although 80% of the slender wheatgrass seedlings were able to emerge from 5 cm depth, emergence of all grasses was improved with a seeding depth of less than 2.5 cm. McWilliams (1955) showed that emergence from September and October seedings at Mandan, North Dakota averaged greater than 75% for western wheatgrass and green needlegrass when they were sown at a depth of 1.25 and 2.5 cm. When the sowing depth increased to 4 cm, the emergence dropped to about 50%. Sowing at only 1 cm depth is very important for warm season grasses. The establishment of blue grama grass for April and early May seedings was greater than 80% when the seeding depth was less than 1.25 cm.(McWilliams, 1955).

G. Time of seeding

The best time for sowing the seed production field is any time just prior to a nice soaker. Spring is often the best time for seeding grasses. Soil moisture conditions are excellent because of the spring snowmelt. Rain showers are more frequent. The seedling can develop its root system before the wind and high temperatures increase the demand for water. During the cool spring season, soils are less prone to crusting which could easily prevent emergence of the delicate grass seedlings. Cool season grasses begin germination at 5-8 degrees Celsius while warm season grasses begin germination at 10-12 degrees Celsius. Cool season grasses can be sown earlier than warm season grasses (Dodds et. al, 1987).

Spring seeding is very important for the warm season grasses and for areas prone to infrequent summer precipitation and high evapotranspiration. Warm season grasses should be sown as soon as the soil warms up in spring. McWilliams (1955) found that seedings of blue grama grass produced satisfactory stands when sown on April 20 and May 10 at Mandan, North Dakota. The June 1 seeding produced stands with less than 70% emergence.

Cool season grasses, however, are more flexible in their seeding date than warm season grasses. Late spring to early summer seedings of most cool season grasses gives the seedling sufficient time to establish itself for development of seed tillers during the winter. This option is the best choice when weed control on the seed production field is questionable. McWilliams (1955) found that, over a six year period, the emergence of seedlings from late summer and early fall seedings of western wheatgrass and green needlegrass were superior to spring plantings when seeding into undisturbed cereal stubble. Kilcher (1961) studied a range of seeding dates for five years and found that the optimum seeding period for green stipa grass, a variety of green needle grass, was the month of October for Swift Current, Saskatchewan. The establishment of streambank wheatgrass, a type of northern wheatgrass, was superior for early September and late May to early June seedings.

Some native grasses have a high degree of dormancy which will prevent germination for up to several years. Grasses such as green needlegrass, western wheatgrass, and beardless wild ryegrass establish better when sown late in fall. The over wintering of the seed in the soil helps to break the seed dormancy (Dodds et. al, 1987, Holzworth et. al., 1990).

H. Row spacing

Seed production of grasses is favoured by sowing in widely spaced rows. Patterson et al. (1956) identified several advantages for row plantings of grass seed fields. Planting in wider-spaced rows reduces the seed requirements which reduces input costs. Secondly, the stands can be tilled with a row crop cultivator or gang rototiller to control weeds. Thirdly, the stands will have higher grass seed yields, especially as the stand ages. Fourth, roguing of the field is more thorough and easier. McWilliams (1955) found that green needlegrass produced over 100 kg/ha/year more seed in rows spaced 76 and 107 cm apart as compared to rows spaced 46 cm apart. Crowle (1966) found that slender wheatgrass produced about 100 kg seed /ha higher yields in rows spaced 91 cm apart as compared to rows spaced 30 cm apart. There was no benefit for wide row spacing of slender wheatgrass under irrigation. Black and Reitz (1969) found that 76 cm as a row spacing was superior to wider row spacings for seed production of green needlegrass.

The costs of maintaining the rows for strongly rhizomatous grasses such as northern and western wheatgrass usually outweighs the benefit of sustained seed yields. Stroh (1971) found that seed yields were higher when western wheatgrass was allowed to become a solid stand over four seed production years compared to cultivation to contain the creeping of the grass. A walking row treatment stimulated seed production, but the invasion of weedy annual grasses negated any benefit of this costly cultural practice. The most profitable management approach was to seed the grass with 90 cm row spacing to provide space for the extension of the rhizomes for several years. Holzworth et. al. (1990) suggest that northern and western wheatgrass should be cultivated in two directions after harvest to prevent the formation of a dense sod. Seed production of blue grama range was increased from 6 kg seed/ha to 13 kg seed/ha by spraying 30 cm strips of range with glyphosate and leaving alternating 15 cm strips of undisturbed vegetation (Mcginnies, 1984).

I. Weed control

Weed control with herbicides in seedings of native grass is still at the experimental phase, but are a powerful tool for controlling weeds during the seedling stage of the grass. Buctril M, Lontrel, Pardner, and 2,4-D amine are registered for application to reed canary grass and slender wheatgrass during the seedling year. 2,4-D amine should not be applied to the grass prior to the three leaf stage. Buctril M and Pardner may be applied at any growth stage during the seedling year. Based on the response of other grasses, applications in the year of seeding to green needlegrass, northern wheatgrass, and western wheatgrass are also safe, but the use of these products on these three grasses has not been registered (Saskatchewan Agriculture, 1994).

Control of wild oats in native grasses is necessary because the separation of this noxious weed from wheatgrass seed is very difficult. Curry et. al. (1994) reported that tralkoxydim controlled wild oats and green foxtail in native seedings of northern, western, and slender wheatgrass and green needlegrass. Green needlegrass was injured, however, by the application of tralkoxydim. Fenoxaprop was suitable for northern and western wheatgrass and green needlegrass, but slender wheatgrass was injured by this product. Imazamethabenz provided good control of wild oats without injury to any of the tested grasses. Difenzoquat also provides good control of wild oats.

J. Irrigation management

Although irrigation is not essential for successful production of native grass seed if rainfall is favourable, the possibility of providing water to the crop during dry periods reduces the risk of poor seed head production. Frequent light applications after seeding promote germination and reduce crusting of the soil. Irrigation in late August or early September to bring the soil profile to field capacity will promote good vegetative growth. Adequate water supply in early spring also promotes development of seed tillers (Holzworth et. al., 1990). Western wheatgrass prefers a couple of weeks of spring flooding for maximum seed production. Irrigate the grass at the boot stage and just prior to and after flowering. Application of water during flowering should be avoided because pollination will be reduced (Najda, 1994). Bring the soil profile to field capacity after harvest to promote healthy vegetative growth during the fall (Holzworth et. al., 1990).

Smika and Newell (1966) found that grass seed yields of western wheatgrass were highest when the crop was irrigated in the spring and at heading. Each irrigation filled the soil profile to a depth of 1.5 meter. Crowle (1966) found that slender wheatgrass seed yields averaged over a five year period increased from about 200 kg/ha to about 600 kg/ha when irrigated to supply a total of 56-64 cm of total precipitation over the growing season. The dryland site failed to produce a seed crop in the fifth year of the study.

K. Fertility management

The forage yields of many native grasses respond poorly to fertilization (Lorbeer et. al., 1994), but high nitrogen fertility is important for high seed yields. General fertilization guidelines for grass seed production are 70 kg N/ha broadcast during the fall. Phosphorus is of limited benefit for seed yields. Smika and Newell (1966) found that the best treatment for western wheatgrass seed yields was 88 kg N/ha applied in the fall when the straw residue was burned in spring. When the straw was mowed and removed immediately after harvest, seed yields responded linearly up to at least 132 kg N/ha applied in the fall. In contrast, slender wheatgrass seed yields were higher without nitrogen fertilizer on dryland at Scott, Saskatchewan (Crowle, 1966). With adequate moisture, fall application of nitrogen to native grass seed fields is a good practice.

L. Harvest of native grass seed

Determining the proper time of harvest is one of the most difficult but important decisions for the grower of native grass seed. Most grasses readily shatter when fully ripened and an entire crop may be lost from a strong wind if left standing too long. Green needlegrass and reed canary grass are among the most vulnerable grass crops to seed shattering. Often the producer must compromise between seed maturity and seed shattering. Swathing at the first indication of shattering and combining when dry is the least risky strategy. The medium dough stage is the best time for swathing. When the top of the seed head begins to shatter, the bottom of the head will be only starting to fill. If the crop is swathed too early, some of the later developed kernels will not germinate (Tober, 1988). The windrow may also be very difficult for the combine to pick up when the crop is grown in widely spaced rows. Inter-row cultivation and development of high crowns in older stands prevent the driving of machinery across the plant rows.

Direct combining is often the best choice for short grasses and grasses which easily dry in the field. The grass seed crop should be direct combined at the hard dough stage. Green needlegrass are well suited to the use of a stripper header which will attach to conventional combines. If warranted, a second harvest of seed is possible with this header. Other types of stripper harvesters are suited to chaffy seeds which are collected in a tank located directly behind the reel. The moisture content of seed harvested by direct combining is much higher. Care is required to prevent the seed from overheating which will injure the germination of the seed. The freshly harvested seed may overheat in the truck box if left for several hours. Passing the seed over a scalper to remove green stems will reduce the risk of heating. The seed should be placed into an aeration system as soon as possible to dry the seed (Tober, 1988).

Table 2: Recommended methods for harvesting native grass seed (Tober, 1988)

Grass Species	Harvest Method	Harvest Stage	Lodging	Shatter Risk
Blue Grama	Direct combine or strip	Hard dough	Low	Low
Green Needlegrass	Swath or strip	Medium dough	Low	High
Northern Wheatgrass	Swath or direct combing	Hard dough	High	Low, but high at maturity
Reed Canarygrass	Swath or direct combine	Medium dough	Low	High
Slender Wheatgrass	Swath or direct combine	Medium to hard dough	Low	Low, but high at maturity
Western Wheatgrass	Swath or direct combine	Hard dough	High	Low

Several grasses require special processing to allow the seed to flow through conventional equipment. Needle and thread grass seed and green needlegrass seed must be run through a hammer mill or a debearder. The process breaks up straw in the sample and removes awns and outer glumes from the seeds.

M. Residue management

The management of straw from grass seed fields can have a significant impact on seed yields. The mowing and removal of western wheatgrass straw after harvest increased seed yields by over 60% relative to burning the residue in spring (Smika and Newell, 1966). Holzworth et al. (1990) recommend light grazing in fall or cutting the stand very short for hay following a killing frost. Patton et. al. (1988) found that the seed production of bluebunch wheatgrass and Columbia needlegrass was increased for several years by burning. Seed production of Idaho fescue in this study was reduced the first year after burning, but, after five years, had increased above the control.

III. Summary

Seed production of native grasses is important to supply the seed stock for revegetation of rangeland. The most important factor to consider for native seed production is the adaptation of grass to the field selected for seed production or vice versa. Many native grasses will not establish if sown in a field to which it is not adapted. Others will persist in the field, but will not set seed. Adequate isolation of the grass seed field from contaminating pollen sources is essential for pedigreed seed production. A priority for establishment of a grass seed field is the control of noxious weeds prior to sowing the grass, because the roguing of many weeds in the crop can only be achieved by hand or with a backpack sprayer. Because shallow placement of the seed is so important for emergence, the seedbed must be firmly packed prior to seeding. The seeding implement must have adequate agitation in the seed box and provide thorough packing of the seedrow to insure good seed to soil contact. Time of seeding is best in spring for all grasses, but cool season grasses also do well when sown in late spring to early summer. Row plantings with wide spacing usually produce higher seed yields than solid seedings. Good weed control during the establishment year will promote the development of vigourous seedlings. Harvest of the grass seed crop is usually performed with a conventional combine. Swathing and combining or direct combining are commonly practiced, but some species are suited to use of stripper headers. Fall management of the grass seed field is important to sustain the seed productivity of grass fields. Removal of the straw and fertilization with nitrogen are essential cultural practices to promote the development of next year's seed crop.

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BACK TO THE FUTURE: RESTORATION ISSUES IN GRASSLANDS NATIONAL PARK

Dr. Stephen McCanny, Grassland Ecologist, Parks Canada
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Grasslands National Park is designed to represent the grasslands ecoregion of Canada. In promoting an ecosystem that has the components and functions of a natural grassland, the park must develop a program to manage the 2012 ha (7.7 sections) of land currently owned by Parks Canada that has been either recently cultivated or sown to exotic grasses (1). In addition, smooth brome has replaced virtually all the native grasses along the banks of the Frenchman river. Exotic grass stands are a concern because of evidence that their insect and bird fauna are poorer than those in native prairie (2,3). Of more immediate concern to the park is the potential for noxious weeds to spread from abandoned fields in the park to surrounding farmland. Another potential problem lies in the invasion of badlands by yellow sweet clover. It may pose a threat to rare species in this habitat.

The park has initiated a number of projects and partnerships to develop its capacity to plant native perennial cover on disturbed land. These include the examination of native hay as a source of seed and mulch for restoration, the identification of seed production sites in the park and tests of different planting methods for restoring abandoned and crested wheatgrass fields.

The University of Saskatchewan is examining the production of native hay on uplands, where needle and thread grass and blue grama grass predominate, and in lowlands where western wheatgrass is common. They have examined the application of Roundup to stimulate seed production (4). Preliminary results after one moist field season show no improvements in yield.

A student from the Natural Resources Institute at the University of Manitoba was contracted to prepare a map of potential seed collection sites in the west block of the park. She has identified 30 sites in the park and examined them carefully for the presence of rare species and weeds. The sites have been mapped with a Geographic Positioning System. Test strips were harvested with the hand held seed stripper from Prairie Habitats in Argyle, MB. We will return to these sites next year with the larger pull-type seed stripper.

A four year experimental program began this year as a collaboration between the University of Regina, Agriculture Canada and Parks Canada. One of the objectives is to test impoverishment as a technique for influencing the competition between native seedlings and crested wheatgrass. The addition of a straw mulch promotes growth among the soil microflora and draws down the available nitrogen pool. Late successional species compete much more effectively under these low nitrogen conditions (5). This treatment has been combined with Roundup application and four seeding techniques in all possible combinations to examine seedling establishment in crested wheatgrass. A similar experiment is being carried out in an abandoned field with the substitution of mowing for the Roundup treatment. Preliminary results are not yet available but there was good establishment of blue grama grass in most treatments (50-100 seedlings/m^2).

We will also be using our wildlife inventory program to examine the biodiversity of native and disturbed lands. Paired sites of disturbed and non-disturbed land will be used as the context for a variety of bird, mammal and insect inventory studies.

Our main priority in restoration work is the stabilization of cultivated land so that soil erosion and weed infestation are minimized. With 537 ha to restore and our choice of 30,000 ha of native grassland to collect seeds from, I believe that a program of seed collection and planting will succeed in establishing native cover within a period of 10-12 years. At that point the restoration of exotic grasslands will be considered. Well adapted species, such as smooth brome and crested wheatgrass, must be accepted as a permanent part of the flora but their dominance of large portions of conservation areas can be countered with long range restoration strategies. Our goal is to move back to a future time when humans promote the diversity and natural function of the landscape.

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NATIVE SEED EXPERIENCES

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Introduction:

I have been given an interesting and challenging area to discuss today. The topic is DU's native seed experiences. It would be improper for me to discuss only DU's past experience with native plants because even though DU has used native plants expensively over the past few years we have just embarked on a planning process to identify and develop native species that interest us from a wildlife point of view. This process will take time to develop and to be honest we have more questions than answers on nearly all native plants. This has been an exciting process.

To understand DU's interest in native plants I need only put up part of our mission statement:

> "dedicated to the increase of North America's waterfowl resources through restoration, preservation, and creation of prime breeding habitat in Canada.
>
> Development of this habitat on a multi-use concept benefits wildlife and the general environment and provides water for agriculture and recreational use."

The key is the restoration, preservation and creation of prime breeding habitat. Uplands are a key component of the habitat and are one of the major focuses of the Prairie Care program. The upland cover that we strive for is a diverse cover that in a perfect world would look very much like native cover. Recreating the prairie is not practical considering the resources DU has available. However our revegetation program focuses on using native plants to the extent possible.

During today's talk I would like to cover: DU's history with native plants, evaluation of the mixes that DU uses, parameters for new plant development, DU's priorities for new species, and the DU opportunity.

History of DU's Involvement with Native Plants

* 1986 - Signing of the North American Waterfowl Management Plan (NAWMP) between partners located throughout the United States and Canada. The goal of this agreement is to sustain a continental breeding population of 62 million ducks by the year 2002.

* 1989 - Development of Prairie Care program. Prairie Care focuses on land cover, reduced tillage and retained wetlands. This program is delivered, on behalf of the NAWMP partners, by DU and the Saskatchewan Wetland Conservation Corporation.

* Prairie Care has the following options: land purchase, land lease, conservation demonstrations, and modified agricultural use. Land purchase is the part of the program where the native species are used to develop the dense nesting cover desired. From 1989 to the end of 1993 DU has managed to seed some 20,000 acres to a native mix. Under the lease program approximately 31,000 acres to an introduced mix. Finally approximately 18,000 acres have been seeded under the modified agricultural use option.

* The primary native mix that DU has been using consist of Northern Wheatgrass, Western Wheatgrass, Slender Wheatgrass plus Green Needle Grass. Other species are used based on availability and suitability. Due to the large acres we have to deal with the flexibility to use a broad range of species has been limited. The cultivars used have been developed throughout the west with most of the species originating from the northern U.S. The main reason for Saskatchewan using these species has been because of availability and the wildlife cover they produce. Also the agronomics for growing these cultivars are at least partially known. DU Saskatchewan has become quite successful at growing these mixes.

* In Manitoba, DU has had a longer experience, on a relatively smaller area. This has allowed them to look at different mixes and at various seeding methods to get more diversity. Mixes plus have looked at various seeding methods to get more diversity. DU in Manitoba has been utilizing native plant material for eight or nine years now. Originally three or four cool season grasses were utilized across whole fields. Once these stands had been managed, usually by burning, observations indicated different plant species growing on different parts of the field.

Concern regarding the lack of diversity and cover on certain parts of their fields led DU Manitoba into looking at changing their mixes and eventually into "sculptured seeding". The objective of this approach is to re-establish, wherever possible, native plant material that is well adapted to different soils and drainage areas across a field.

Manitoba's mixes include many C4, C3, and forbs that are now available commercially. For those species not available, DU is working on developing "ecovars" with the other agencies interested in similar species. This is a topic I will get into further later.

DU Saskatchewan's Questions/Concerns About Native Mixes

DU constantly evaluates our experiences with native mixes in Saskatchewan and we have benefitted from the longer experience of our Manitoba counterparts. Some of the questions and concerns that we use to evaluate are:

* Adaptability: DU is using seed from native grass cultivars developed in the northern U.S., with much of the seed coming from northern U.S. growers. Research has shown that movement of seed more than 100 miles north or south will result in a decrease in survival and performance of those grasses (Jacobson, 1986). There are large differences in climatic conditions between where the plants are selected for and where they are seeded resulting in less than optimal performance of the plants. We ask ourselves is this a big concern? How drastic a change is there in adaptability of species from one part of the province to another? We know that we are pushing the adaptability limit and that is why we are interested in "ecovar" development.

* Sustainability: What will happen to these stands over the long term? What effects will management have on these stands? Will succession occur and when? In this case DU is doing internal research to try and answer some of these questions.

If we look at native prairie the reasons for its resilience is because of its diversity. Techniques like sculptured seeding may play a role in the future. One of our challenges is that many of the dominant grasses, forbs or shrubs found in Saskatchewan do not have: seed available, agronomic information or management knowledge. How do we go about developing these species? Again the reasonable answer is development of an ecovar.

* Habitat: Presently DU staff are developing a strategy for multi-species habitat development. While desired habitat development has not yet been clearly defined it is clear that the requirement will go beyond our current plantings. The native mix now being used does supply waterfowl nesting cover and appears to give habitat for many other animal species but the exact amount is not known. More work is being done in this area.

Parameters for New Plant Development:

New plant development for DU will be a long process due to the information required and the fact that much of the work will be costly. The key to accomplishing new plant development will be finding partners who are interested in putting resources into this work. DU has come up with a test process to identify the species from three types of plants grasses, forbs or shrubs that should be considered for development. This test consists of three questions:

1. Is the plant "ecologically" suited to the area of proposed use? The plant should ideally be dominant to the region or regions, be widely adapted, and should do well in mixtures of other species in the Dense Nesting Cover mix.

2. What is the plants contribution to the desired habitat? This will be the most difficult to define and will likely occur during the multi-species work.

3. Can the plant be propagated, grown in our mixtures and be successfully maintained through management? The plant must have quantities of harvestable seed that can be sown by using available equipment on large acreages.

To give you an example let's look at American Hedysarum. To judge whether this is a good species to consider in the parkland area ask the three questions and put a subjective rating to each question. This is the only way that we could come up with a form of rating different species.

Rating Formula:

V = Ecological Suitability (scale of 1 to 10 with 10 being best)

P = The probability of actually being able to develop an ecovar. (scale 1 to 10 with 10 being best)

C = Cost of development to D.U. with 1 representing low cost and 10 representing a high cost.

With American Hedysarum the following calculation was completed:

V = 10
- perennial forb of legume family, nitrogen fixing.
- able to grow on infertile soil.
- provides good structure to nesting cover.
- variable growth habit, lowspreading to erect form.
- important food source to many species.

P = 10
- plants readily produce seeds and is easy to collect.

C = 2
- important forage for ruminants, nectar source for bees, food source for birds.
- due to ability to grow on poor soils could become a reclamation species.

Saskatchewan staff from the various regions were asked to identify 5 additional species in each category for the arid mixed-grass, mixed grass and fescue prairie regions. It is interesting how these ended up quite similar in a lot of areas as outlined below:

ARID MIXED GRASS PRAIRIE	MIXED GRASS PRAIRIE	FESCUE PRAIRIE
I. Grasses (*doesn't include the species DU is already using)		
Western Porcupine	Western Porcupine	Western Porcupine
Needle and Thread	Needle and Thread	Plains Rough Fescue
Sand Grass	Awned Wheatgrass	Awned Wheatgrass
Nuttail's Salt Grass	June Grass	Nuttail's Salt Grass
Northern Reed Grass	Little Bluestem	Northern Reed Grass
II. Forbs		
Goldenrod	Dotted Blazing Star	Goldenrod
Prairie Cone Flower	Goldenrod	American Hedysarum
Milkvetch	Three-flowered Avens	Milkvetch
Winterfat	American Hedysarum	Winterfat
Licorice	Wild Peavine	Licorice
III.Shrubs		
Western Snowberry	Western Snowberry	Western Snowberry
Chokecherry	Willow	Chokecherry
Buffaloberry	Wood's Rose	Buffaloberry
Saskatoon	Saskatoon	Saskatoon
Rose	Chokecherry	Rose

Priorities

This is an extremely large number of species to be considered for development. DU had to look at these and decide on what species should be considered a priority. Many of the priorities were set by partners who expressed interest in working on ecovars that would assist them in achieving some of their goals.

Several agencies have taken a leadership role in ecovar development here in Saskatchewan like:

- Ag. Canada - needle and thread, porcupine grass, awned wheat grass, winterfat, prairie sandreed, western and northern wheatgrass.
- University of Saskatchewan - Winterfat
- Shand Greenhouse - Winterfat

Funding of these ecovars has come from many sources including Green Plan, Ag Canada, and private industry, including DU. Studies include identifying areas of adaptation, collection and reproduction of seed, and investigating the agronomics of growing. In most cases the projects are at least five years in duration indicating that this will not be a fast or cheap process.

The other priority species that DU have identified for development in Saskatchewan include: Nuttail's Alkali grass, June grass, northern reed grass, Hedysarum, milk-vetch, and purple prairie clover.

The DU Opportunity

Over the past two years, DU Saskatchewan has purchased over 50,000 lbs of native seed per year. The seed purchased consists of green needlegrass and northern, western and slender wheatgrass. Our goal is to get the grass seed in Saskatchewan if possible. In 1994 a total of 21,000 lbs of this native seed came from outsider of this province. The majority of the seed imported is western, northern and green needlegrass. DU Saskatchewan feels that there may be an opportunity to produce that seed in Saskatchewane and increase value-added activity in the agricultural economy. We also realize that our seed demands are not large enough to change the amount produced here extensively but would like to get other people thinking about purchasing Saskatchewan grown seed and starting the ball rolling. DU has started that process by contracting acres of native seed through one of the seed companies in Saskatchewan.

The second opportunity with DU is in the development of the ecovars identified earlier in this speech. DU does not have the resources to take many of these ecovar projects on. But if anyone here is interested in working on an ecovar we would be interested in talking to you and possibly forming a partnership to complete the work.

If you have any questions about DU's plans you will find quite a few people from DU in the audience from both Saskatchewan and Manitoba. Don't be afraid to talk to them about native plant development. Thank you for your attention and I hope you have a better understanding of Ducks Unlimited Canada and our direction in native plant development.

SEED SUPPLY OF NATIVE GRASSES

Dorothy Murrell
Forage Seed Specialist
Saskatchewan Agriculture & Food
Prince Albert

Native grasses are those species of grass which have evolved in North America. More specifically, they are species or populations of species which have developed and are adapted to discrete climatic and soil zones within North America.

There are currently five commonly available native grass species in Saskatchewan. They are slender wheatgrass, streambank wheatgrass, northern wheatgrass, western wheatgrass, and green needle grass. Several other species show promise for increased cultivation for seed production, including Canada bluegrass and some of the fine fescues. Still other species are harvested either by mechanical means or by hand from native stands, such as blue grama grass, sweetgrass, rough fescue, needle and thread grass, and porcupine grass.

Seed companies specializing in native plants sometimes publish lengthy lists of the species which they can provide. Their seed is collected from both native and cultivated stands.

I. Production Issues

Seed production of native grass species ranges from cultivation of monocultures to seed collection from native stands, either mechanically or by hand. Many of the native grasses have peculiarities which, while suiting them very well to their native habitat, make them difficult to cultivate. Agronomic problems of cultivated stands include slow germination, low seedling vigour, and consequent slow field establishment, lack of registered weed control products, and a short stand life. Some grass seed species require two years for establishment, produce one to three sometimes small seed crops and then cease seed production. For these reasons, **seed production of native grasses is not for the inexperienced grass seed producer.**

Native grass stands, and individual plants within stands, may not produce seed every year. In some years, environmental conditions trigger the production of flowering tillers. Seed from these native plants can be harvested. Seed harvest from native stands is common in the Great Plains of the United States. Mechanical seed strippers are often used, and sometimes the seed stand is swathed and combined. Hand or mechanical harvest of small mixed grass stands is another method of collecting native grass seed. This type of harvest may be valuable for seeding reclamation projects which are close to the seed source. Small hand-operated seed strippers are available which beat the seed into a collection bag. Timing of seed collection from native stands must be determined, because not all plants within a species mature at the same time, and all species do not set seed each year. Several consecutive harvests per season, and bulking seed lots over two or three years, is probably necessary to maintain the genetic diversity of the population. Harvesting more than once may also help to deal with the shatter characteristics of some species. While seed shattering is an advantage in the natural environment to help to spread seed, it can increase harvest losses substantially.

Another issue which arises then is the effect of collecting seed from native stands on the subsequent life and diversity of the mother stand. Some jurisdictions are moving towards regulation of seed collection from wild lands to protect and conserve the natural habitat.

Grass seed production in general is very cyclical. Figure 1 shows that over the past five decades we have had fairly regular five-year highs and lows. I suspect that a demand and pricing curve would show the opposite pattern! This pattern shows the need to stay in production for several years. This industry is not one to jump in and out of and expect to hit the highs every time.

Remember, whichever species you decide to grow and market, seed quality is of utmost importance. Control of inseparable and prohibited weed species is critical to the success of your product in the marketplace.

II. Marketing

Although native grasses receive some media attention as being an opportunity for diversification, they are presently better described as having a niche market. The current marketplace for native grass seed comprises about 5% of the total grass seed market. Seed of tame forages, such as the wheatgrasses, wildrye grasses, and bromes, is far more in demand, and is generally much easier to produce.

One of the reasons that native species appear to be a golden opportunity is the retail price of their seed. Current high retail prices (eg. $14.90/kg for green needlegrass, $16.50/kg for northern wheatgrass) do reflect a high demand for the limited supply. However, from the seed grower's point of view they also reflect the difficulties of production. Prices will moderate as acreage of native species increases, but there will be seed grower resistance to low prices. In fact, seed growers and seed companies resist any promotion of these crops, as they fear that too much production will quickly cause a glut of this small market. They believe that promotion is better aimed at the end use of these species, in order to strengthen the demand; the production will rise to fit the demand.

Seed growers who are interested in native grass seed production **must** research the market prior to seeding. Contracts are often available from seed companies for cultivated seed production, and are a necessity for proprietary varieties. In addition, seed companies generally supply agronomic services such as field inspections, production advice, newsletters and grower field days. If seed will not be grown under contract, I recommend that you have a market lined up **before** you sow the stand.

III. The Market

Seed of native grasses is purchased and utilized by Ducks Unlimited, reclamation firms, government agencies and crown corporations which are responsible for management of crown lands, and farmers who wish to sow pastures to a native grass mixture. The seed companies refer to native grass seed sales as "grocery loads" because the load is made up of small quantities of each of several species or varieties.

The current Canadian market appears to be between 300,000 and 400,000 lb of native grass seed per year, encompassing over 15 species. (For comparison purposes, the total North American grass seed market, excluding the turf seed market, is somewhere between 60 and 90 million lb). Some simple mathematics quickly indicates that this market does not compute into many acres required per species. Ducks Unlimited is the largest single buyer of native grass seed with purchases of about 100,000 lb per year.

Probably 50% of the seed sold in Canada of the major native grasses is imported from the US. Two issues exist here. The first is that seed from the southern range of a widely adapted species such as northern or western wheatgrass may not be well adapted for use in areas in its northern range. In other words, distinct populations with distinct adaptations may exist. Some seed buyers believe that to be truly adapted to the site, seed should not be used more than 500 km from point of harvest. The other issue is that some imported grass seed, of both native and tame species, may be of low purity or contaminated with seed of weeds we do not want in Canada. Most Canadian buyers probably prefer to buy Canadian-grown seed, and pedigreed acres are increasing in number (Table 1). It appears that virtually all of the cool season grass seed, including the wheatgrasses, green needlegrass and needle and thread grass is produced in Canada. However, virtually all of the warm season grass seed purchased by major Canadian buyers, including switchgrass, big and little bluestem, indian grass, beardless wildrye, basin wildrye, and blue grama grass, is imported. These species could probably be grown for seed production in southern areas of the province, as their native habitat is the Great Plains of the US. Until the seed is produced in Canada it will continue to move in from the US.

IV. Varieties

Registered varieties exist for some of our native grasses (Table 1). Many of these varieties are proprietary, and to grow those varieties you must enter into a production contract with that company. Other native grass varieties are being developed by provincial and federal research centres and by seed companies.

V. Ecovars

"Ecovar" is a term coined by Agriculture Canada and Ducks Unlimited to refer to an "ecological variety", or a strain of a species which has been bred for genetic diversity rather than genetic uniformity. Currently, ecovar development is being carried out on a number of native grasses and forbs by research scientists across western Canada (Table 2). As they become available, there will be an opportunity for experienced grass seed producers to produce seed of these ecovars under contract.

Ecovar development will require a new set of criteria for varietal registration with Agriculture Canada, because variety description will include such a range of each feature. However, for wide scale plantings of native grasses the ecovar will presumably encompass the diversity it needs to adapt well to all micro-environments.

VI. Recommendations

There is opportunity for experienced growers to produce seed of native grasses. There is also opportunity to harvest seed from natural grass stands. Current high prices will likely moderate with more acres in production. Too much production will result in the supply curves pictured in Figure 1, with consequent upswings and downturns in demand and therefore in price. When you decide to produce native grass seed under cultivation:

1. Grow a species which is adapted to your climate and soil conditions. Read up on the species and on grass seed production in general.
2. Begin with very clean land. Wild oats and quackgrass are not allowed and are impossible to separate from most native grass seed.
3. Discuss market opportunities with seed companies and other buyers. Line up your market prior to seeding.
4. Be patient! Establishment may be slow.
5. Be diligent in weed control. High quality is your aim.

When you decide to harvest seed of a native stand:

1. Line up your market first. Seed buyers of species which bloom irregularly will likely be very interested in your product.
2. Look into hand and mechanical seed strippers, especially if your land is rough. Swathing and combining may work, but find out about the shatter characteristics of the species first.
3. Be prepared to harvest more than once if the stand shows differences in maturity, in order to capture the genetic diversity of the stand.
4. Do not harvest from protected or environmentally sensitive areas.
5. Know your plants. Avoid harvesting invader species or rare and endangered species.

Table 1. Varieties and Acreage of Some Native Grasses Seeded for Seed Production in Canada.

Species	Variety (Company)	Acres Inspected (Canada)		
		1994	1993	1992
Slender Wheatgrass *Elymus trachycaulus* & *E.t. subsecundus*	Adanac (Prairie Seeds) Revenue (Sask Wheat Pool) other proprietaries	481	258	283
Western Wheatgrass *Pascopyrum smithii*	Walsh (Prairie Seeds) other proprietaries	104	10	0
Northern Wheatgrass *Elymus lanceolatus*	Elbee (K. Long Seeds; Prairie Seeds; Richardson; UGG) Critana (US Public)	283	167	96
Streambank Wheatgrass *Elymus lanceolatus*	Sodar (US Public)	85	60	60
Reed Canary Grass *Phalaris arundinacea*	Palaton (Oseco; Seed Link) Vantage (Pickseed) Venture (Landis Seed) Rival (Brett Young) Bellevue (Pickseed)	444	215	265
Green Needle Grass *Stipa viridula*	Lodorm (US Public)	0	0	0
Needle and Thread Grass *Stipa comata*	experimental	.1	.1	.1
Porcupine Grass *Stipa spartea* & *S.s. curtiseta*	experimental	.1	.1	.15
Junegrass *Koelaria cristata*	proprietary	5	5	0
Canada Bluegrass *Poa compressa*	Reubens (Oseco; Pickseed; Prairie Seeds; Rothwell Seeds)	0	.03	.03
Alpine Bluegrass *Poa alpina*	proprietary	5.82	.25	.1
Prairie Sandreed *Calamovilfa longifolia*	proprietary	40	0	0
Tufted Hairgrass *Deschampsia caespitosa*	proprietary	27	0	0

Table 2. Native grass species currently in ecovar development programs.

Species	Lead Player and Location of Development Programme
Little Bluestem *Schyzachyrium scoparium*	Ray Smith, University of Manitoba, Winnipeg
Blue Grama Grass *Bouteloua gracilis*	Ray Smith, University of Manitoba, Winnipeg
Prairie Sandreed *Calamovilfa longifolia*	Andrew Kielly, Agriculture Canada, Swift Current
Awned Wheatgrass *Elymus trachycaulus subsecundus*	Bruce Coulman & Ken May, Agriculture Canada, Saskatoon & Lethbridge
Needle and Thread Grass *Stipa comata*	Scott Wright, Agriculture Canada, Melfort
Porcupine Grass *Stipa spartea*	Scott Wright, Agriculture Canada, Melfort
Plains Rough Fescue *Festuca hallii*	Ken May, Agriculture Canada, Lethbridge
Idaho Fescue *Festuca idahoensis*	Ken May, Agriculture Canada, Lethbridge
Mountain Rough Fescue *Festuca campestris*	Ken May, Agriculture Canada, Lethbridge
Brome *Bromus carinatus, B. ciliatus, B. anomalus*	Ken May, Agriculture Canada, Lethbridge

Figure 1. Grass Seed Production in Canada, 1946-1992.

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