Recommended citation:


This manual was produced through the generous support of the Saskatchewan Ministry of Highways and Infrastructure and the Saskatchewan Ministry of Environment.

Cover photo: © Native Plant Society of Saskatchewan
# Table of Contents

PREAMBLE ........................................................................................................... 4
INTRODUCTION ................................................................................................... 4
WHEN TO USE NATIVES ...................................................................................... 6
PROBLEMS WITH CURRENT PLANTINGS .......................................................... 7
    Alien Plant Invasion ............................................................................................. 7
    Maintenance Costs ............................................................................................... 9
    Driver Safety - Visibility and Wildlife ................................................................. 10
ADVANTAGES OF NATIVE SPECIES ................................................................. 12
    1. Minimize Overall Costs .................................................................................. 12
    2. Maximize Motorist Safety ............................................................................... 14
    3. Reduce Erosion, Runoff, and Sediment Transportation ...................................... 15
    4. Control Exotic Species .................................................................................... 16
    5. Promote Biodiversity ...................................................................................... 17
    6. Enhance Visual Aesthetics .............................................................................. 19
ECOLOGICAL MANAGEMENT OF ROADSIDES ...................................................... 19
PURCHASING NATIVE SEED ............................................................................. 20
    Seed Analysis Interpretation ................................................................................ 20
    Types of Seed Available ...................................................................................... 23
CONCLUSION ......................................................................................................... 24
LITERATURE CITED .......................................................................................... 25
OTHER HELPFUL RESOURCES .......................................................................... 27
Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation
Reference Manual

**Preamble**

This manual is intended for the use of the Saskatchewan Ministry of Highways and Infrastructure and the recommendations contained within have been developed for use along roadways. Every attempt was made to review all available, relevant information sources during the writing of this publication. All information included is current at the time of writing, although the area of revegetation is in a constant state of flux; seed sources vary based on supply and demand and new research is always being added to the literature.

Several considerations regarding roadside revegetation have been factored into these recommendations such as time, scale, ecological benefits, long-term management, benefits to motorists, seedling establishment probability and persistence, similarity of seed mix to natural ecoregion composition, commercial availability of seed, cost, and practicality. Because so many factors were considered, compromises had to be made in various aspects, although the overall revegetation process is still achieved.

The intention of this manual is to serve as a guide so that project managers can become versed in using native species for revegetation and make informed decisions, thus enabling project success. Of course, no manual covering such a broad and complex topic can ever be completely comprehensive for every circumstance in every location, but it is hoped that the creation of this manual brings understanding and rational judgment to every unique situation.

This reference manual is to be used in concert with the accompanying field guide, “Saskatchewan Guidelines for Use of Native Plants in Roadside Revegetation – Field Guide.”

**Introduction**

Saskatchewan has more kilometres of roads per person than anywhere on earth (Forman et al., 2003, Saskatchewan Ministry of Highways and Infrastructure, 2007), with approximately 14,000 kilometres of paved road, 7,000 kilometres of thin membrane surface (TMS) roads and 175,000 centerline kilometres of gravel roads for a population of 987,939 (Saskatchewan Ministry of Highways and Infrastructure, 2006, Saskatchewan Bureau of Statistics, 2007, Berthelot and Carpentier, 2003). Further, sections of primary highways receive up to 5,000 vehicles per day, while the majority receives significantly lower volumes (University of Saskatchewan, 2000, Saskatchewan Ministry of Highways and Infrastructure, 2006). Because of this, Saskatchewan Highways is posed with a unique problem: how to maintain these roadways as efficiently as possible when they vary so greatly in usage and distribution, given a relatively small tax base.

Traditionally, whenever road construction occurred, the surrounding area that was disturbed was revegetated using one type or a mix of forage grass seed. This was
typically crested wheatgrass (*Agropyron cristatum*) or smooth brome (*Bromus inermis*) as it was widely available, established well and was relatively inexpensive. These species served their initial purpose of immediately stabilizing the soil, but had long-term ramifications such as increased maintenance costs (mowing and spraying road edges), increased pollution from spraying herbicides, invasion of surrounding native ecosystems and increased collisions with wildlife due to the food and cover they provide.

![Invasion of native prairie by smooth brome and crested wheatgrass (dark green) along highway 4 at Saskatchewan Landing Provincial Park. Notice that the extent of the invasion is well across the fence line (center of photo) and proceeds up the coulee bottoms. Only the steep hillsides remain unaffected, becoming islands of native prairie. This invasion is particularly devastating to species that occupy the moist coulee bottoms.](image)

Gradually, management practices have changed in favour of ecological perspectives. Today, many transportation departments in Canada and the United States are implementing strategies toward a more sustainable and environmental approach, and native plants are increasingly being used for roadside revegetation (Forman and Alexander, 1998). The Saskatchewan Ministry of Highways and Infrastructure is taking key steps to adopting a more environmental approach, as outlined in their 2008 Performance Plan, where one of the objectives is “Effective Environmental Stewardship” (Saskatchewan Ministry of Highways and Infrastructure, 2006).

There are many benefits to taking this environmental initiative. Obviously, the primary focus is to have successful roadside revegetation projects using native species, but from an economic standpoint it supports the native seed industry eventually resulting in decreased costs for native seed in the future. From a public relations standpoint, it raises the awareness of the uses and benefits of native plants, and conveys a responsible environmental image for the Saskatchewan Ministry of Highways and Infrastructure.
Three terms are often used interchangeably to describe site remediation using native species: restoration, reclamation and revegetation. Restoration involves the re-establishment of original site characteristics including structure, diversity and function. The objective is to obtain as close a resemblance as possible to the ecosystem that existed prior to disturbance. Reclamation is “the process of returning land to its former or other productive uses” (Powter, 2002). Reclaimed land is simpler than fully-restored land, but still retains a high degree of ecological function (Gerling et al., 1996). As roadsides are continually exposed to abnormal levels of disturbance and are engineered for human use, reclamation is the best feasible goal. Revegetation is merely establishing vegetation to replace the ground cover lost to a disturbance (Powter, 2002). Revegetation is a component of both restoration and reclamation and will be used to describe the activities in this manual, as the aim is to establish a successful native plant community to replace lost ground cover.

**When to Use Natives**

Although native species are ecologically a better alternative to introduced species for revegetation, there are cases when using native species may not always pay off in the long run. For example, trying to establish a native plant community near a hayfield is pointless. These hayfields are usually seeded to brome or crested wheatgrass with alfalfa or clover as a legume companion. Even if the roadside seed bank is exhausted of its seed from these introduced species, it only takes a few growing seasons for the adjacent hayfield to recolonize the roadside area to some degree, either through seed dispersal or from rhizome encroachment. Even established stands of native grass are often invaded by these aggressive introduced grasses. Although natives may persist on the reclaimed site at low levels, it may be only a matter of 5-10 years before the site closely resembles the adjacent hayfield.

Generally, it is not wise to attempt native revegetation when perennial invasive grasses such as smooth brome, crested wheatgrass, Kentucky bluegrass or quack grass occur next to the revegetation site unless it is certain that they can be permanently eradicated. It is also not advisable to revegetate areas with natives when large stands of invasive perennial weeds are present. If these weeds occur only in the area to be revegetated and if time allows, intense eradication efforts may make the site suitable to plant native species; however, it must be certain that these eradication efforts were successful before planting the native species. Another situation where planting natives should not be done is when topsoil containing noxious weeds will be used on the site. In situations where native species are not to be used, they should be replaced with non-aggressive tame species.
Areas that are acceptable for using native species for revegetation include sites surrounded by other native areas, sites that are surrounded by non-invasive introduced species, and areas next to annual cropland. Annual cropland may contain many different kinds and quantities of weeds, but most if not all are annual weeds and will pose little threat to native revegetation. Areas with low levels of perennial weeds may also be suitable for revegetation with natives, provided that the weeds are monitored for spread and controlled accordingly.

**Problems with Current Plantings**

**Alien Plant Invasion**

While roadways were designed to transport people and cargo, they often also facilitate the movement of invasive weeds through accidental introduction from passing vehicles, or by ditches acting as spread vectors. In some areas, the problem of weeds spreading along roadways is so severe that maps of weed infestations can be overlaid on road maps (Jackson Hole Weed Management Association, 2007).

Studies have shown that mud stuck to the exterior of vehicles may contain many live seeds (100-180 seeds/kg of mud in one study) which may be capable of germination once dropped from the vehicle (Hodkinson and Thompson, 1997, Clifford, 1959, Jackson Hole
Weed Management Association, 2007, Wace, 1977, Schmidt, 1989, Lonsdale and Lane, 1994). In the most extreme cases, one study found that two years of car wash sludge contained 18,566 live seeds from 259 species, while another study found that a single car driven 15,000 kilometres for one growing season contained 3926 live seeds from 124 species (Wace, 1977, Schmidt, 1989). Once these seeds become established in an area, it is very difficult, time-consuming, and costly to eradicate them. Even if all of the above-ground plants are killed, some species’ seeds are capable of staying viable in the soil for decades or even centuries (Spira and Wagner, 1983, Brown, 2001, Darlington and Steinhauer, 1981). Often, long-term management is the only way to deal with these infestations, but it is a poor compromise as these populations are rarely contained and instead act as seed sources to infest other nearby areas. Left unchecked for even one growing season, these can quickly spread to adjacent land, or the seeds may be picked up by passing vehicles and deposited many kilometres away, perhaps in weed-free areas.

Noxious weeds are of particular concern as they are more aggressive than other weedy species, posing a greater threat to natural and agricultural systems and the economy. These species produce thousands of seeds per plant, and may even produce up to 1 million seeds per plant as is the case for Scentless Chamomile (*Matricaria perforata*) (Alberta Agriculture and Food, 2001). Another estimate calculated that one knapweed (*Centaurea spp.*) plant and its progeny were capable of producing 5.1 trillion seeds over a ten year period that, when fully germinated, could cover an area of 36,513 acres (Jackson Hole Weed Management Association, 2007). Noxious weeds already cover over 100 million acres in North America alone, and cost the U.S. economy $122 billion annually (Jackson Hole Weed Management Association, 2007). In Saskatchewan, it is estimated that noxious weeds cost the agricultural industry over half a billion dollars annually in crop losses alone (Canadian Plains Research Center, 2006).
Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation
Reference Manual

Figure 3. Leafy spurge (Euphorbia esula) infestation along highway 11 in the Lumsden Valley. Patches of these yellow flowers are steadily spreading across Saskatchewan. Eradication is costly and difficult, and management is often the only feasible solution.

In the case of weed invasion, the best defence is a good offence; it has been shown that many weeds are not able to gain a foothold in a healthy prairie, as they have adapted to colonize disturbed areas (Wruck and Hammermeister, 2003). Without the disturbance, weed seeds have less bare soil to germinate and have difficulty competing with well-established native plants, whose root systems dominate the soil profile and capture most of the available resources (Wruck and Hammermeister, 2003).

**Maintenance Costs**

Roadside management in Saskatchewan is relatively labour-intensive, requiring time and money. In 1989, the federal and provincial governments across Canada spent $103.1 billion on transportation (16% of the GDP), more than what was allocated to health care (Forman et al., 2003). In Saskatchewan in 2005, $307.6 million was spent to maintain and upgrade roads, with $1.2 million of that spent on mowing an estimated 35,100 hectares of roadside (Saskatchewan Ministry of Highways and Infrastructure, 2006).

Ironically, management practices such as this not only add to current budget expenditures but may actually increase future budget expenditures by requiring increasing amounts of maintenance. Mowing reduces plant height so that wildlife are not as attracted to the ditch as a food source and so that drivers can see any wildlife present in the ditch. However, frequent mowing causes an unnatural amount of disturbance and weakens the plant community. This makes the area more vulnerable to invasion by weeds, which will require increasing amounts of mowing and spraying, resulting in a vicious cycle. Frequent mowing also reduces or eliminates the species that don’t tolerate disturbance, which simplifies the whole plant community (i.e., reduces biodiversity) and leaves it less able to act as a buffer against detrimental factors (Forman et al., 2003). Mowing at the wrong time may also spread seeds or viable plant parts of weedy species, enabling their spread.

By planting native species, maintenance is greatly reduced. For example, crested wheatgrass will die back over the course of decades and may require ploughing and reseeding (Wruck and Hammermeister, 2003). Once established, a native stand will never need to be reseeded and a dense network of native plants will out-compete most weeds. This resilient network will remain indefinitely, protecting against future invasions and requiring little management. Additionally, an established native short- or mixed-grass upland community will not need mowing as it will reach a shorter overall height than introduced species such as smooth brome. In the first few years after seeding native grasses, productivity may be higher and plant height may seem like a concern, but these plants are capitalizing on a flush of available resources. These resources will become depleted, forcing the plants to send roots deeper to reach available resources resulting in decreased top growth and increased drought tolerance.
States such as Washington, Iowa, Idaho and Texas have all implemented roadside revegetation and management strategies more congruent with the environment while at the same time cutting costs and minimizing labour. For example, the Washington State Department of Transportation recently implemented a plan to leave vegetation growing along road edges that was neither a fire hazard nor damaging to pavement. These plants were formerly sprayed, which left the road edges bare and susceptible to invasion by weeds. This simple, new strategy has saved time and money, and the new plants now provide a natural barrier against weeds without being a visual impairment (Forman et al., 2003).

Driver Safety - Visibility and Wildlife

Maximizing motorist safety is one of the main objectives of transportation authorities and involves many different facets (Forman et al., 2003). Obviously, transportation infrastructure maintenance is one of the most effective and easily-manipulated ways to enhance motorist safety, while weather is a factor that cannot be controlled. Factors such as wildlife encounters fall somewhere between the two extremes. While wildlife cannot be completely controlled, their behaviour can be influenced by taking certain measures. Collisions with wildlife are a serious problem in Saskatchewan, accounting for more collisions than any other single factor including road condition and driver inattention (Saskatchewan Government Insurance, 2004; Table 1).

| Table 1. Factors influencing vehicle collisions/accidents in Saskatchewan. |
|-----------------------------|-----------------|-----------------|
| Contributing Factor²        | Total Collisions| % of Total Collisions |
| Human Condition (Combined Factors) | 12,110          | 22.9            |
| Human Action (Combined Factors)    | 13,703          | 25.9            |
| Vehicle Condition (Combined Factors) | 1,104           | 2.1             |
| Environmental Condition (Combined Factors) | 25,992         | 49.1            |
| Animal Action (Wild)          | 10,694          | 20.2            |
| Animal Action (Domestic)      | 347             | 0.7             |
| Road Condition                | 8,557           | 16.2            |
| Loose Gravel                  | 506             | 1               |
| Snow Drift                    | 560             | 1.1             |
| Obstruction/Debris on Road    | 382             | 0.7             |
| View Obstructed/Limited       | 803             | 1.5             |
| Sun Glare                     | 235             | 0.4             |
| Construction Zone             | 158             | 0.3             |
| Soft or Defective Shoulders   | 76              | 0.1             |
| Lane Marking Inadequate       | 6               | 0               |
| Traffic Control Device Not Working | 33             | 0.1             |
| Weather Conditions            | 1,598           | 3               |
| Uninvolved Vehicle            | 1,363           | 2.6             |
| Uninvolved Pedestrian         | 206             | 0.4             |
| Other Environmental Condition | 468             | 0.9             |
| Total for Environmental Condition | 25,992     | 49.1            |
| Grand total for Contributing Factors | 52,909     | 100             |
Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation Reference Manual

1Table adapted from SGI’s “2004 TAIS Annual Report”.
2Individual factors have been listed for the ‘Environmental Condition’ section only; all other sections (Human Condition, Human Action and Vehicle Condition) have had their individual factors summarized in “total collisions”, as no other single factor in these sections outranked “Animal Action (Wild)”.

In 2003, Saskatchewan had the fifth highest reported number of wildlife collisions in Canada (Canada Safety Council, 2006). In 2005, $28 million was paid in claims from wildlife collisions which resulted in 254 injuries and 3 deaths (Jones, 2006). As the number of cars and wildlife populations both increase, the annual cost for insurance claims in Saskatchewan is expected to rise approximately $1 million per year (Canada Safety Council, 2006, Saskatchewan Ministry of Environment, 2002). Not only is this costly in term of human life, property and the economy; it is also devastating to wildlife populations. Studies have found that, in some cases, road-kill estimates averaged approximately 1 vertebrate animal per 10 kilometres and that the road-kill rate may actually exceed natural causes of death from predation and disease combined (Forman et al., 2003). Recently in the United States, collisions with wildlife overtook hunting as the lead cause of wildlife death from humans (Forman and Alexander, 1998).

There are many reasons for why animals are attracted to roadsides. Historical wildlife corridors connecting feeding, watering, or breeding grounds are now intersected by roads; crossing the roads while traveling along these corridors is necessary for the animal’s survival and/or reproduction. Wildlife also may be attracted to the pavement’s heat on cool spring and fall days, or to lick the salt used for de-icing roads. Another reason is that grasses planted after road construction traditionally have been introduced forage varieties, which tend to become green earlier in spring or are more lush than native grasses, and therefore preferred by ungulates. Weeds such as sweet clover (Melilotus spp.) have a dual negative effect of being a preferential food source to ungulates and a visual obstruction to drivers. Additionally, foraging animals encountering a road will sometimes turn to follow it, increasing the likelihood of a collision (Forman and Alexander, 1998). Predators and scavengers have also recognized that ungulates use road edges, and will follow roads in search of prey/carrion, further compounding the problem (Forman and Alexander, 1998).

So how can managers attempt to control the number of animals on or around roads? Numerous techniques have been used in an attempt to reduce the number of wildlife-related accidents, with limited success. Reflector devices placed along roadsides have not been shown to deter deer from the crossing the road (Canada Safety Council, 2006). Similarly, one study found that wildlife warning signs were ignored by 60% of drivers (Aberg, 1981). Other methods such as fencing in conjunction with overpasses/underpasses do prevent wildlife collisions, but they inhibit natural animal movement, fragment habitat and animal populations, provide predators with bottlenecks to corner their prey and are prohibitively expensive to use on a large-scale basis (British Columbia Conservation Foundation, 2007, Canada Safety Council, 2006). Other methods such as the electronic Wildlife Protection System being tested in Kootenay National Park, British Columbia have only gone through preliminary trials, so their effectiveness is not proven and their cost is still prohibitive on a large scale basis.
Planting native species with low growth and lower palatability helps minimize the chance of a wildlife collision; animals are likely to be attracted to other nearby, more palatable food sources reducing time spent loitering in roadside areas, and drivers will be more likely to spot wildlife in the lower vegetation, giving them a chance to react to avoid a potential collision.

**Advantages of Native Species**

Using native species for roadside revegetation includes a number of benefits over monocultures and mixes of introduced species. Most importantly, they are natural components of the local environment and have evolved and adapted to survive in extreme environments such as those in Saskatchewan. Secondly, they fill a niche that might otherwise be left idle; each species plays a role in the overall ecosystem function, which is why biodiversity is so important.

Several departments of transportation in North America have set objectives for roadside management, many of which can be achieved by using native plants. The following is a list of commonly-stated objectives (Forman et al., 2003):

1. Minimize overall costs
2. Maximize motorist safety
3. Reduce erosion, runoff, and sediment transportation
4. Control exotic species, especially invasive and noxious weeds
5. Promote biodiversity
6. Enhance visual aesthetics

**1. Minimize Overall Costs**

As previously mentioned, the Saskatchewan Ministry of Highways and Infrastructure faces the unique problem of having to maintain many kilometres of roads with a relatively small tax base. Obviously, cost mitigation is at the forefront of any project manager’s mind. Using native species for revegetation was historically never a priority in part due to the unavailability of seed and the prohibitive cost versus the relatively inexpensive, readily-available tame species. With a recent flush of native seed production, however, this problem has largely been overcome and many native species are now readily available at similar costs to tame species. Furthermore, new native species are constantly being selected for mass production; the number of native species for reclamation already outnumbers the number of tame species, and many seed growers now offer affordable reclamation mixes that contain species native to the respective area.

It is difficult to fairly compare prices of native seed to tame seed for many reasons. Primarily, tame varieties have been grown in large quantities for many decades, resulting in large seed sources resistant to seasonal crop production fluctuations. This means that seed availability is never a problem and prices never spike due to a shortage. Natives, on the other hand, have been grown in large quantities for only a few decades, which has not been enough time to accumulate a large seed source. Because of this, seasonal crop
production fluctuations still drive availability to some extent, and cause price fluctuations
due to seed shortages. Some native species have been commercially-grown longer than
others, however. Western wheatgrass (*Pascopyrum smithii*) is one of the oldest
commercially grown native species, and has a widely-available, more seasonally-stable
seed source and is therefore relatively lower-priced than newly-developed native species,
which need several seasons of growth in order to increase seed supplies. It should be
noted that there are far fewer native seed growers than tame seed growers. However, the
number of native seed growers is steadily increasing every year.

Other reasons which may explain the higher cost and wide range of native seed prices are
the species themselves. Species with smaller seeds will result in more seeds per pound,
translating to a higher cost per pound. Obviously the higher number of seeds can cover a
larger area than a lower-priced pound of larger seeds. Other species may have a high cost
because they are difficult to harvest, or produce small quantities of seed. One of the best
ways to use these species and mitigate the cost is to incorporate them into a mix.
Depending on the percentage that a certain species comprises in a mix, one pound of seed
can be incorporated into many pounds of mix; at 5%, one pound of seed will go into 20
pounds of mixed seed. If the cost of the seed was $50.00/lb., it now costs only $2.50/lb.
for each pound of mix it makes.

Table 2. Comparison between native and tame perennial grass species based on a current
(2007) price list of one of Western Canada’s largest native seed growers. Note the large price
range for native seed, for reasons previously discussed.

<table>
<thead>
<tr>
<th>Native Grass Species</th>
<th>Tame Grass Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Species Sold</td>
<td>57</td>
</tr>
<tr>
<td>Price Range (per lb.)</td>
<td>$2.49 - $400.23</td>
</tr>
<tr>
<td>Average Price (per lb.)</td>
<td>$33.35/$12.49$1</td>
</tr>
</tbody>
</table>

$1$ Higher price is the average price for all native species sold by this company; lower price is the average price for the species sold by this company that are recommended in this manual for roadside revegetation.

As previously mentioned, many seed growers now offer affordable native species mixes.
Generally, tame and native seed mixtures consist of a comparable number of species,
with native seed mixes costing roughly twice as much as tame seed mixes. This is
exceptional, given the wide range of native seed prices. Native seed mixes are generally
blended into a mix so that they are representative of the flora of the local ecoregion,
while keeping the cost affordable. This means that the species and percentages they
comprise in the mix may vary annually depending on seed availability and cost, as seed
growers usually set a price limit that the seed mixes must fall under. Certain seeds in the
mix may need to be decreased or substituted with another native seed if they become too
expensive to include.

Table 3. Comparison between native and tame perennial grass mixes, with two monoculture
references for price comparison. Information is based on a current (2007) price list of one of
Western Canada’s largest native seed growers.
In addition to set mixes, larger seed growers will often create custom blends based on the customer’s needs. However, depending on the species included in the mix and the mix ratios, the cost may be higher. The native seed mixes developed for Saskatchewan highways may cost more than commercially-available mixes, but are better suited to roadside revegetation for the reasons stated in the preamble.

A large portion of highway budgets are dedicated to maintenance, much of which is appropriated for mowing ditches and/or spraying herbicide to reduce vegetation. As mentioned, by using lower growing native grasses, the need for mowing is greatly reduced or eliminated. Also, because native grasses form dense networks that discourage weed infestations and generally do not pose a serious threat to road edge integrity, the need to spray will also be reduced (Forman et al., 2003, Robson and Kingery, 2006).

2. Maximize Motorist Safety

Motorist safety is of utmost importance, and many things can be done in order to improve road conditions and enhance safety; surprisingly, plants can play many different roles in achieving this. Native plants reduce headlight and snow glare by deflecting and absorbing excess light, which reduces driver eyestrain and minimizes situations where glare may obscure oncoming dangers (Forman et al., 2003, Robson and Kingery, 2006). Native plants also serve to reinforce road alignment, especially when lines may be hidden by ice and snow, which helps motorists stay on course (Forman et al., 2003). The patterned appearance of a native plant community (versus the homogenous look of a tame monoculture) provides further visual stimulation for drivers, which reduces “highway hypnosis” (Robson and Kingery, 2006). Because native grasses generally do not need mowing due to their shorter stature, they can be left to act as low-level barriers, catching snow and wind which directly translates to less drifting snow, decreased low-level turbulence, and increased motorist safety (Forman et al., 2003).

Native plants are also beneficial in alleviating the aforementioned problem with wildlife collisions. If the roadside contains smooth brome, animals will be drawn to the lush vegetation in the ditch to feed, a very common scenario in Saskatchewan. However, if lower growing, less lush native grasses dominate the ditch, the likelihood of animals coming to the ditch to feed is lessened (International Civil Aviation Organization - United States, 2005). If the area surrounding the roadsides is also native vegetation, the chance of animals loitering along the road may be lessened further; the uniformity in vegetation composition of the ditch and the surrounding land reduces visual cues such as

<table>
<thead>
<tr>
<th>Native Restoration Mixes</th>
<th>Native Forage Mixes</th>
<th>Tame Grass Mixes</th>
<th>Crested Wheatgrass Only</th>
<th>Smooth Brome Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Mixes Sold</td>
<td>15</td>
<td>5</td>
<td>7</td>
<td>N/A</td>
</tr>
<tr>
<td>Avg. Number of Species Per Mix</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>N/A</td>
</tr>
<tr>
<td>Average Price (per lb.)</td>
<td>$6.02</td>
<td>$4.88</td>
<td>$3.09</td>
<td>$2.64</td>
</tr>
</tbody>
</table>

1 Includes two introduced species; one is an annual cover crop.
a habitat transition, which tends to draw animals in. Animals will also choose other more suitable sites for resting, as low-growing native vegetation makes poor quality bedding and exposes them to predators. If an animal happens to be in the ditch, the low growth form of the native grasses will allow drivers to see it and react accordingly.

3. Reduce Erosion, Runoff, and Sediment Transportation

It is a common sight after recent road construction: wind scouring the soil surface and blowing clouds of dust and gullies forming as rain removes the topsoil. Often there are short-term mitigation measures such as spreading straw mulch or fibre matting to decrease wind erosion, or geotextile fabric or silt fences to slow water erosion, but long-term stabilization is the ultimate goal. Native grasses offer a long-term solution to reduce both wind and water erosion (Forman et al., 2003, Robson and Kingery, 2006). They establish and form dense stands quickly, reducing the potential for wind erosion by covering exposed soil and slowing wind velocity. In addition, the extensive root systems of native grasses bind the soil tightly to form a very stable soil matrix. A dense native prairie will reduce rain drop impact and decrease small-scale erosion (Forman et al., 2003). Native grasses also slow water velocity, which allows more to percolate into the soil profile, reducing large-scale erosion (Robson and Kingery, 2006). Again, because of their extensive root systems, water infiltration is increased as they are able direct more water deeper into the soil profile, which means less runoff and ponding (Robson and Kingery, 2006). Evapo-transpiration is also increased by the presence of a healthy native plant community, which reduces standing water more quickly than by passive means alone (Forman et al., 2003). If there is surface runoff, such as after a large storm, native grasses are able to trap much of the sediment load, preventing it from being lost or entering any nearby water bodies (Robson and Kingery, 2006). Not only is sediment prevented from entering water bodies, many pollutants in runoff such as heavy metals, fertilizer, herbicides, and other chemicals are also directed into the soil, where they are either taken up by the plants or bound in the soil profile (Robson and Kingery, 2006).

Figure 4. Dye absorbed by native grasses shows the extent of their root systems, which may extend up to 15 feet deep. Photo by John Carlton, KGS.
Even though it is not mentioned as a common highway objective, the reduction of local pollution is very important to the overall environmental health of an area. Reducing water-borne pollutants is one benefit of native plants, but they also reduce air-borne pollutants. Toxic compounds such as carbon monoxide, nitrogen and sulphur dioxide, benzene, formaldehyde and lead are among thousands of chemicals released in vehicle exhaust, much of which settles in the immediate area (BBC News, 2003, Bagley et al., 1996). Native plants are able to deal with many of these toxic chemicals by absorbing them and breaking them down into less harmful or innocuous substances, or binding them in the soil.

4. Control Exotic Species

Exotic species are a common sight along roadsides, where they flourish in the disturbance-prone habitat they are adapted to. Often, these occur not as single plants, but dense groupings crowding out other, more beneficial species. This problem is particularly serious if the exotic species is a noxious weed because it is particularly aggressive and may have other detrimental effects. This topic has been previously addressed in the section “Problems With Current Plantings – Alien Plant Invasion”. When fresh road cuts are left bare, weed invasion may be particularly severe due to the available nutrients, abundance of germination sites and lack of competitive vegetation (Robson and Kingery, 2006). Without proper management at this point, the chances for weed establishment are high, but by seeding native species as soon as possible after exposing bare soil, the chances for weed establishment are lessened. Most native grasses are quick to germinate and will readily establish in the first year. Although it may not be evident by looking at top growth, these seedlings are growing rapidly; most of their energy is being directed into producing extensive roots.

Figure 5. Extensive root systems of native grass blocking horizontal root growth of Canada thistle (*Cirsium arvense*), compared to the short-rooted tame grass species to the right, which do nothing to stop the spread of Canada thistle roots. Drawing by Judie Shore, Environment Canada.

Annual weed species may initially dominate the newly-planted site, but only flourish as long as there is little competition. Once the native community becomes established, the annual weeds will not be able to compete for resources with their shallow roots and will quickly be choked out. The dense ground cover formed by the native
community will also inhibit germination of any weed seeds that might be deposited on the site. Perennial weeds pose a larger and more long-term threat. Broad-leaf herbicide application during or after seeding native grasses may be required, along with other control measures, in order to give native seedlings a chance to establish. Once established, the native community should again be able to deal with potential infestations. The rate of spread of a perennial weed will be greatly reduced in established native prairie, as the dense ground cover provides little opportunity for weed seeds to germinate and the native plants will compete with the weeds for nutrients, light and moisture. This will give managers a longer window of time to treat the weed infestation before it becomes even more problematic.

5. Promote Biodiversity

Before explaining how native plants and biodiversity are related, and why biodiversity is important, biodiversity needs to be defined. Biodiversity, as defined by Environment Canada, is “The variety of different species, the genetic variability of each species and the variety of different ecosystems that they form.” (Environment Canada, 2006) Put simply, it is how diverse an area is; the higher the number of species in an area, the higher the biodiversity of an area, regardless of what kind of species are present (i.e., plant or animal, native or introduced).

High biodiversity is important not only because it means that many species are being supported, filling ecological niches and performing certain roles of natural processes, but also because collectively the plant community is more resistant to impacts and buffers these impacts better than as individuals. In fact, certain monocultures can actually serve as sites for disease or insect outbreaks, which will persist if not treated. For example, if a monoculture of a grass species susceptible to ergot (Claviceps spp., a seed fungus) is planted next to a site containing a mix of many species, some of which are ergot-resistant, and the whole area is exposed to ergot, it is likely the monoculture stand of ergot-susceptible grass will be devastated by the infection, while the adjacent site with the mix of many species will be only slightly affected. This is because the mixed-species site is composed of some species that are susceptible to ergot, but also many species that are either resistant or not affected at all. This is biodiversity in action.

Roadsides can promote biodiversity because local (<200m from road) growing conditions are enhanced by increased surface runoff from the road surface, ample light and heat, and increased levels of nitrous oxides and carbon oxides from traffic exhaust (Forman et al., 2003, Lamont et al., 1994, Cousins, 2006). In short, roadsides are a good place for many different types and species of plant to flourish.

High biodiversity along roadsides has many different benefits, such as habitat creation/enhancement and habitat connectivity. Native plant communities can be useful to small, innocuous animals while not attracting larger animals that would pose a hazard to motorists. By having various types of plants, each with their own structure, many different types of small animals may be provided with suitable habitat (Forman et al., 2003). Birds will nest and forage, amphibians may breed and forage in the vernal pools,
small mammals may forage and seek shelter, and insects may spend their entire life cycle within these roadside areas (Forman et al., 2003). Some insects have even adapted to live only on certain types of plants. Monarch butterflies (Danaus plexippus) lay their eggs on milkweed (Asclepias spp.), upon which the larvae feed. By having milkweed in ditches, monarch butterfly habitat is created.

Habitat fragmentation occurs when a large continuous habitat is divided into smaller pieces, usually by human disturbance such as roads. This leads to small, isolated patches of habitat that are vulnerable to threats such as exotic species invasions, further reduction in size, isolation, and inbreeding of patch residents. When long stretches of bare roadsides are converted to native vegetation, this creates corridors for small animal movement (Forman et al., 2003). This, in turn, helps reduce the impact that roads have on migration, and increases genetic flow among and between populations. Ultimately, this keeps populations from being geographically and genetically isolated, thus avoiding inbreeding. When a large number of these corridors of native vegetation exist, they serve to link fragmented habitats, creating a network of suitable habitat to live within (Forman et al., 2003).

In addition to aiding genetic flow, roadside ecosystems also serve as a seed source to colonize new areas such as freshly disturbed soil or areas with exotic species. Native roadsides may also serve as standalone ecosystems where no connectivity is possible, essentially forming an island of suitable habitat surrounded by unsuitable habitat. In areas where agriculture has taken over as the primary ecosystem, native areas along roadsides are especially important as reservoirs of biodiversity and wildlife refuges.

There are many other benefits to having a diverse plant community, but ultimately the closer the community is to the original natural plant community the better. By having a diverse ecosystem, structural integrity and functionality are enhanced, promoting natural processes which ensures overall health.
6. Enhance Visual Aesthetics

Some may debate the importance of roadside visual aesthetics, but it cannot be denied that a road that looks pleasant is also more enjoyable to drive on, all things being equal. As mentioned in the previous section, the visual stimulation it provides may also keep drivers more alert, potentially reducing accidents. Former United States First Lady Claudia “Lady Bird” Johnson regarded roadside aesthetics so highly that, together with her husband President Lyndon Johnson, they created the Highway Beautification Act of 1965 (Miller Center of Public Affairs, University of Virginia, 2007). Visual aesthetics is a no-cost benefit from using native plants. Each species of grass and forb used in the revegetation brings its own unique color and texture to the overall look. Through the growing season, this look is constantly changing, providing a new view each week to motorists driving the same stretch of road.

Ecological Management of Roadsides

There are many things that managers can do to promote healthy roadside ecosystems without spending extra time and money. In fact, some actions may actually lead to long-term time and cost saving.
Reducing the amount of herbicide applied to road edges reduces the amount of harmful chemicals in the soil, resulting in a healthier, more efficient plant community. If small patches of persistent weeds need to be removed, an alternative to spraying is soil insolation. This requires placing a thick, black plastic sheet over the weed patch which will absorb the sun’s heat to the point where it is lethal to the weeds under it. Moistening the area before placing the plastic down improves its effectiveness (Wruck and Hammermeister, 2003). Mowing is another alternative to herbicides that has proven to be effective against certain weeds. Be sure to mow before seed set, as the seed will still ripen and germinate even after the plant has been cut. Mowing after seed set can even help to spread weed seeds. Delaying mowing until after ground-nesting birds have hatched and fledged will result in a larger local bird population. If spraying is unavoidable, spot spraying or wicking will concentrate the herbicide on the target area, resulting is less wasted herbicide and thus less pollution. Remember, herbicides should never be used around water bodies.

Salting roads only when necessary in appropriate amounts will minimize raising soil salinity levels, which affects plant populations. Animals will also be less attracted to roadsides if excess salt is not available for consumption.

**Purchasing Native Seed**

**Seed Analysis Interpretation**

Whether buying seed or having it collected from nearby native areas, seed lots should be tested by an accredited seed analysis lab so that proper seeding rates can be established. When submitting a sample to the seed testing facility, make sure the seed lot is thoroughly mixed so that a representative sample is produced. Contact the seed lab
regarding how many samples are needed, and in what quantities. Remember that the seed analysis report can only be as accurate as the samples taken.

Seed analysis reports tell managers the seed purity and the percentage of those seeds that are live, both of which are needed for properly calculated seeding rates. They also list any diseases that were present in the seed lot, as well as any crop or weed seeds. This is particularly important, as sowing a seed lot full of a disease or noxious weed would intentionally introduce this to the local area, where it would likely persist and become an increasingly severe problem. Seed lots containing noxious weeds should never be planted. Seed sellers generally do not sell seed with noxious weed seeds or disease in them, but will sell seed lots with small amounts of other weed or crop seeds (this includes other native species not part of the dominant species in the seed lot). These seed lots are generally safe to plant, as the crop and weed seeds contained in them are innocuous and present at low levels. When purchasing native seed, seed sellers usually attach seed analysis tags so that the person receiving the seed knows exactly what the seed lot contains.

Official seed analysis reports should have the following:

1. The seed testing company’s name, address and logo.
2. A statement of accreditation, including the lab’s federal accreditation number.
3. A statement of seed testing methods used.
4. The species tested and whether it meets minimum Canadian standards.
5. Other data such as purity, percentage of live seed, germination percentage, inert matter content, weed and other crop seed content, diseases found, and a list of the noxious weeds found. All of these should have measures associated with them, not just a presence/absence rating.
6. The stamp and signature of the seed analyst. The date should also be included.
Figure 8. A typical seed analysis certificate. Due to the lack of protocol standardization regarding native seed testing, always choose a reputable seed lab. If seed analysis certificates are missing any of the information listed above, it should be requested from the seed lab.
Recently, the Association of Official Seed Certifying Agencies developed a coloured tag system that identifies the source of the seed and tracks its genetic line to the present. Different colours represent how much testing has been done to a specie’s lineage, and information is also provided on how many generations it has been bred (Association of Official Seed Certifying Agencies, 2007). These tags provide invaluable information that can be used to increase the success of a revegetation. Currently, these tags are not mandatory but may be requested from participating seed testing facilities on qualifying seed lots.

The seed analysis reports can be very technical, and the results can sometimes be confusing for those not familiar with them. In this case, the seed lab should be contacted for an explanation of terms. If seed analysis reports will be frequent, one should take the time to familiarize themselves with the structure and terminology of the seed analysis report.

### Types of Seed Available

There are an increasing number of seed suppliers and species of native seed available, but not all seeds are created equal. There are three main types of seeds: wild harvested, ecological varieties, and cultivars.

**Wild-harvested seed** is native seed that has come directly from a natural area. Because no selection for certain traits has taken place, this type of seed has the broadest genetics of any type, which should ensure its survival across a wide range of environmental extremes. However, because of the varied genetic diversity, characteristics such as growth and germination are often unpredictable and not uniform across the population. For example, only half of the seed may germinate the first year, while the rest may germinate in following years. Wild seed can be harvested from the local area (possibly even the revegetation site before construction begins), and some seed producers also sell native seed that they have wild-harvested.

**Ecological varieties** are the middle ground between wild-harvested seed and cultivars. Like cultivars, they are grown commercially and have a large, relatively stable seed source that is less costly than wild-harvested seeds (but still costlier than cultivars). However, they differ from cultivars because they contain most of the genetic variety that their wild parent plants had, as little breeding selection is done. Because of these characteristics, ecological varieties are often used as a replacement for insufficient quantities of wild-harvested seed. The most widely-known type of ecological variety is the Ecovar™, developed by Ducks Unlimited and consisting of ecological varieties of many species. However, other seed producers are regularly introducing their own brands of ecological varieties.

**Cultivars** are types of plants that were wild-harvested many generations ago, but have since been selected and bred for certain traits such as production and nutritional quality, usually for the forage industry. This type of seed is the most widely available and the least expensive, but is also the least similar to wild-harvested seed because of intense
selection and generations of isolated breeding. In essence, the breeding is a trade-off; the species exhibits more uniformity across the population and may perform well regarding a few selected traits, but at the expense of narrowed genetic diversity. Because of this, they also may be less equipped to deal with environmental extremes.

When ordering seed, be sure to request the required species by both their common and scientific names, and upon arrival check to see that these names match the ones requested. Ordering seed only by their common names may get unexpected results, as many different species may go by the same common name, or a single species may have different common names in certain regions.

Remember that all native seed sold is not necessarily native to the revegetation area; check with the seed supplier if unsure. Keep in mind that sources unusually high in elevation or in extreme northerly or southerly locations will be the most distinct due to the environmental conditions at those sites. A general guideline of up to 500 km north and up to 250 km south is recommended for seed sources. Although longitude has less of an effect on vegetation differences and therefore no recommended east-west distance is provided, elevation changes of 300 m equate to a 280 km movement northward (Romo and Lawrence, 1990, Joyce, 1994). The closer the seed source is to the planting site the better, as it will have local genetics that have adapted to the local conditions. Generally, any seed grower within the Prairie Provinces is acceptable; seed growers in the northerly United States may also be an option, but care must be taken to ensure that they do not introduce any foreign species. A seed analysis should be done to determine if the seed is acceptable for use in Canada. Also, there may be duties levied at the border, and Canada Customs and Border Services may require you to have a broker to import your seed. Because of the ecological differences, time, cost and paperwork involved, this should only be a last resort.

Conclusion

Almost every reclamation process is long, complicated, costly and fraught with potential pitfalls, and using native species for reclamation is no different. Although every reclamation process is unique due to location, conditions, and reclamation techniques, project managers will be able to find commonalities among them. This experience will lead to more informed, insightful decision-making, resulting in a higher degree of success. Until experience is obtained, it is recommended that project managers consult with those that have experience, and to use common sense and foresight in their decisions.

Ultimately, using native species for roadside revegetation will not only benefit motorists, Saskatchewan Ministry of Highways and Infrastructure and the environment, it will contribute to the evolution of the seed industry and revegetation techniques. Now that consequences of past decisions are apparent, corrective measures can be taken so that similar problems will not arise from current decisions.
Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation
Reference Manual

Literature Cited


Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation Reference Manual


Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation Reference Manual


Other Helpful Resources


Saskatchewan Guidelines For Use Of Native Plants In Roadside Revegetation
Reference Manual


Iowa Department of Transportation Roadside Vegetation. Ames, IA: Iowa Department of Transportation.


University of Saskatchewan, College of Agriculture, Department of Soils (1936). Reconnaissance Soil Survey Of Saskatchewan From The International Boundary On The South To The Top Of Township 48 On The North. Saskatoon, SK