# Right-of-Way Rehabilitation of Sandy Roadside Slopes in Ontario, Canada

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**Revegetation of sandy slopes following road construction is difficult because of a number of factors, including droughtiness, infertility, and temperature extremes. The Ontario Ministry of Transportation and Communications conducted studies to examine alternative plant species for revegetation projects along Northern and Central Ontario roadsides. Studies focused on the use of three sedge and three grass species in relation to standard treatments. The six study species were (a) *Carex aenea*, Sedge; (b) *C. Houghtoniana*, Sedge; (c) *C. lucorum*, Sedge; (d) *Andropogon scoparius*, Little Bluestem; (e) *Panicum virgatum*, Switchgrass; and (f) *Sporobolus Cryptandrus*, Sand Dropseed. After a program of seed collection, germination testing, and test plot planting, the potential of these plant materials for revegetation is better understood. The practicality of using the sedges studied for revegetation will be limited by a number of factors, including scattered, small seed sources and variable and low-seed germination rates. The grasses studied have more immediate potential for revegetation. Although seed is commercially available, one difficulty may be locating seed sources from areas with a climate similar to Central and Northern Ontario.**

Sandy roadside slopes can present difficult conditions for plant growth because of droughtiness, infertility, and surface temperature extremes. In many cases, revegetation attempts on these slopes have resulted in patch growth, requiring further maintenance or replanting (Figure 1).

The Ontario Ministry of Transportation and Communications (MTC) has identified such a situation along some roadways in Northern and Central Ontario. Traditional mixes of grasses and legumes have proven unsuccessful in many cases. Legumes lack a resistance to most herbicides commonly used along Ontario roadways, whereas grasses tend to decline in vigor along with the rapid depletion of nutrients applied during planting.

A lack of vegetative cover along roadways can result in increased soil erosion and potential siltation of nearby streams. Also, many travelers often find it unsatisfactory from an aesthetic perspective.

In 1982 sedges (*Carex sp.*) were proposed as potential material for revegetating problem slopes. The feasibility of using sedges native to Ontario was assessed.

Several sandy roadside slopes that lacked vegetation were visited. These slopes were traditionally difficult areas in which to establish a permanent vegetation cover. All plant species on the slopes were identified, and observations of soil type and moisture were made.

**FIGURE 1 Typical sandy roadside slope presenting difficult revegetative conditions.**

Six sedge species were found growing naturally on the sandy slopes, three of which have been the focus of subsequent studies. Three grasses also believed to hold promise were investigated. A discussion of the detailed laboratory and field research conducted on these six species is presented in this paper.

## APPROACH

A discussion of the tasks completed from 1984 to 1987 follows.

## SPECIES SELECTION

Early feasibility studies suggested six sedge species as candidates for further research:

- *Carex aenea*,
- *C. arctata*,
- *C. communis*,
- *C. houghtoniana*,
- *C. intumescens*, and
- *C. Lucorum*.

The six sedges were believed to hold promise because they possess the following important characteristics:

- Compatible with standard maintenance techniques and equipment,
- Able to stabilize the surface soils,

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- Adaptable to wide climatic variation,
- Herbicide resistant, and
- Low potential to become a weed problem.

Of the six, three were selected for further study (*Carex aenea, C. houghtoniana, and C. lucorum*) because they were native to Ontario and were characteristic of the sandy, droughty, habitat that causes revegetative problems along roadsides.

The grasses selected were Little Bluestem (*Andropogon scoparius*), Switchgrass (*Panicum virgatum*), and Sand Dropseed (*Sporobolus cryptandrus*). Each occurs in Ontario, primarily along the sandy shorelines of the Great Lakes. All three are known from habitats prone to droughty and infertile conditions.

## LITERATURE REVIEW

An extensive literature review and a contact program were carried out to obtain information on seed collection, germination treatment, storage, planting techniques, and planting schedules. Although no published data were located for the three sedge species selected for study, other sedge research had been documented for species in Europe and in the United States.

Some literature on the three grass species studied was also reviewed. Much more published data were available for these elements of the prairie and shoreline flora than for sedges.

Individuals involved in revegetation research were contacted. However, very few individuals had experience with the sedge species targeted for detailed investigations.

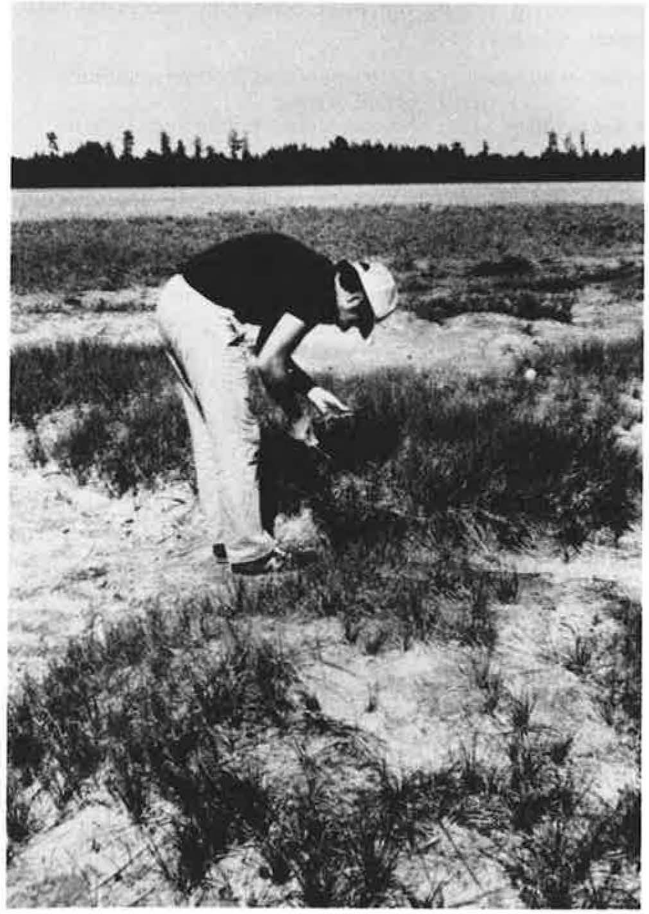

**FIGURE 2 Seed collection area for *Carex luconum*, near Petawawa Ottawa.**

## SEED ACQUISITION

Although grass seed was easily obtainable from American seedhouses, no commercially available seed was identified for the sedges. Seed was harvested from wild populations (Figure 2).

This complex process first involved the identification of possible locations of seed sources, which were determined from a search of herbarium records housed at the University of Toronto. Of approximately 18 stations located for the three sedges, 9 of the largest reported populations were visited. It was expected that these locations could support seed collection. The locations were selected from geographic areas with climatic conditions similar to the proposed field study location.

The seed collection area examined ranged from across the southern edge of the Canadian Shield, from Georgian Bay easterly to Ottawa. At each location, a number of factors were assessed: species presence, seed ripening stage, amount of seed, habitat, and accessibility for collection.

Although the total collected seed of *Carex lucorum* and *Carex houghtoniana* was less than 1 kg, it represented sufficient amounts for testing and planting. *Carex aenea* populations provided only enough material for germination testing. Several trips were required to monitor the ripening progress of *Carex houghtoniana*. Seed collection coincided with the apparent optimum ripening stage.

The grass species selected were available only from American seedhouses. Numerous seedhouses were contacted to locate the desired species and to find out where the seed had been grown. Although some Canadian seedhouses had stock for the study grasses, it had been obtained from the Midwestern United States.

Recently harvested, viable seed was desired from plants grown in a climatic zone similar in winter hardiness to that of the study area for winter hardiness. Agriculture Canada was contacted to clear the importation of the seed into Canada for research purposes.

## SEED TESTING

A series of tests was performed on the sedge seed to determine means by which to maximize germination and therefore enhance growth. The grass seed imported from the United States had already been cleaned and tested for viability by the seedhouse.

The selection of testing techniques was determined from a review of literature. Numerous germination studies have been completed for graminoid species such as *Scirpus sp.* (*1*), *Cyperus sp.* (*2*), and prairie grasses (*3*). Some *Carex sp.* (*4–6*) had also been examined.

A tremendous variability of treatments and results, and the lack of existing information on the three sedge species, was addressed by testing the most commonly successful treatments, which were

- Wet stratification — Keeping the seed cool and moist for a period of time;
- Scarification — Mechanically thinning the achene (tough, inner seed coat);
- Prechill — Keeping the seed cold but dry for a short period of time; and
- Heat treatment — Heating the seed before germination.

Wet stratification and prechill treatments simulated overwintering conditions for the seeds while the heat treatment simulated high temperatures often found at ground level in the sand flats that some of the sedge species naturally populate. Testing was completed by using variations in the duration and temperature for each of the treatments.

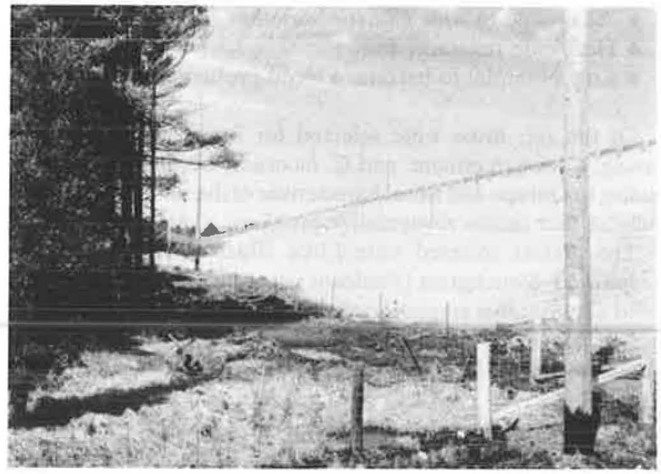

**FIGURE 4 Roadside study area south of Gravenhurst, prior to planting.**

## TEST PLOT PLANTING

Both the sedge and grass species were planted to determine how they performed in a field trial. The site selected for planting was on an approach fill of a newly constructed overpass 10 km south of Gravenhurst, Ontario (Figure 3). The test plots were located on north- and south-facing slopes constructed of fine, sandy soils taken from a nearby borrow pit.

Before preparation of the planting bed, the soil was sampled for nutrient levels (Figure 4) and was found to be low in nitrogen, phosphorus, potassium, and magnesium. Within four test areas (two on the south- and two on the north-facing slope), numerous individual plots were established. The plots were prepared by raking and fertilizing before seeding. Fertilizer (5-20-20) was evenly applied to each plot at a rate of 700 kg/ha using a perforated container. The fertilizer was raked into the upper soil layer.

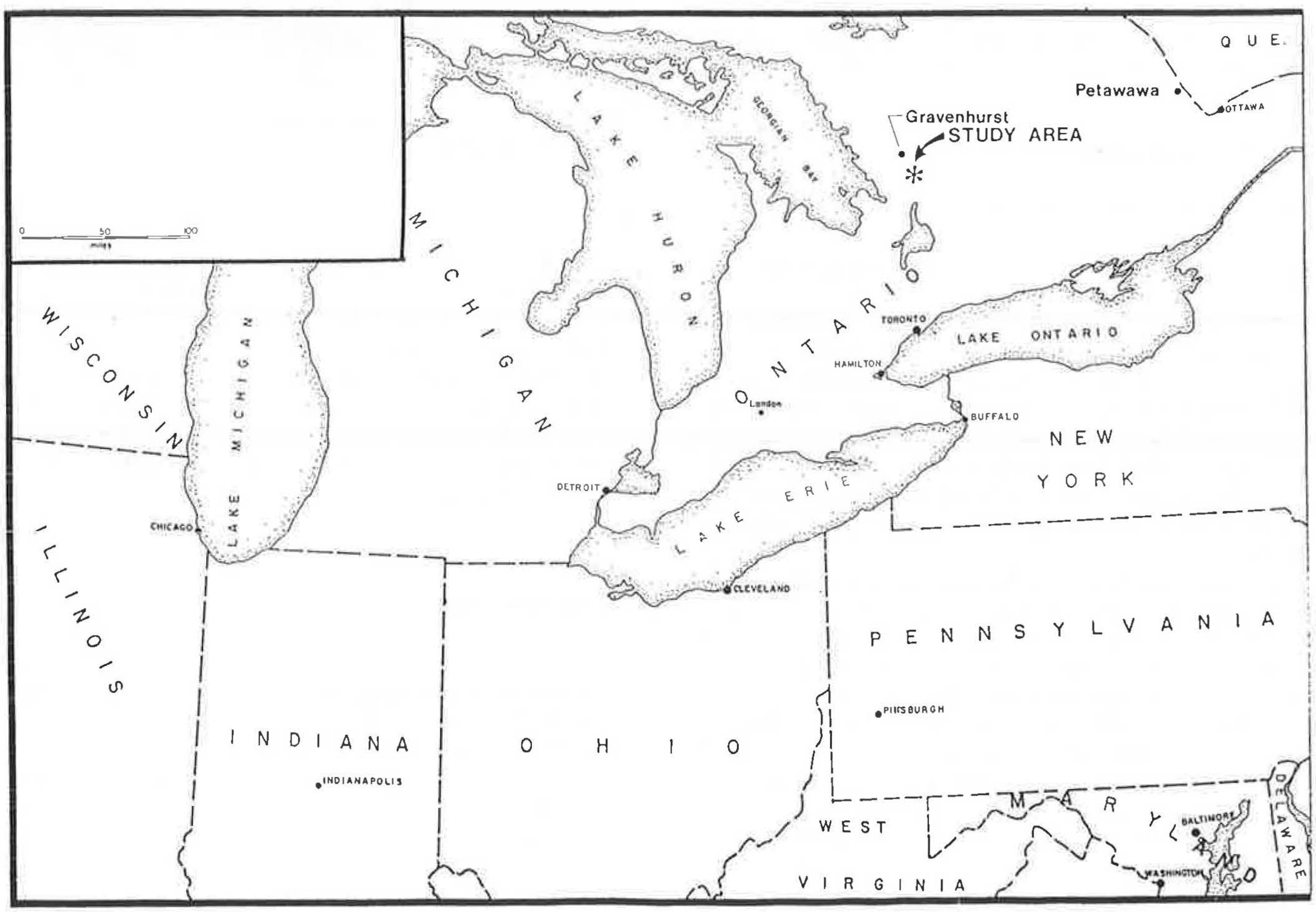


**FIGURE 3 Location of test plots.**

Half of the plots were seeded on September 23, 1985, and the other half on April 24, 1986. The plots were broadcast seeded at a variety of rates. Test grasses were seeded at 20 or 60 kg/ha, whereas sedges were seeded at either 20, 60, 80, or 100 kg/ha. Control plots without seeding were also established.

After seeding, the plots received a hydro-mulch application of shredded newspaper and straw, applied at a rate of 1600 kg/ha. The mulch was sprayed from the top of the slope. It tended to clump and move downslope slightly, providing an uneven cover. The slopes surrounding the test plot areas were seeded with a mix of Bird's-foot Trefoil (Lotus *corniculatus*), Canada Bluegrass (*Poa Compressa*), Creeping Red Fescue (*Festuca rubra*), Alsike Clover (*Trifolium hybridum*), and Ryegrass (*Lolium multiflorum*).

## TEST PLOT MONITORING

Growth was intensely monitored in 1985, 1986, and 1987. Observations were made of percent cover, height, vigor, and the presence of species and fruiting structures. A permanent record of plant species was provided by photographing each plot. A camera was mounted on a platform atop a 3.7-m-pole. The shutter was triggered electronically from the ground (Figure 5), and on each photograph, plant species distribution was indicated with a colored grease pencil.

Other visits were made throughout the season to monitor changing growth conditions. Winter observations were also made to examine snow cover depth and evidence of human disturbance (e.g., recreation vehicles).

**FIGURE 5 Photographs of each test plot were taken during the detailed monitoring task.**

## SUMMARY OF FINDINGS

A discussion of findings from both seed testing and test plot planting are presented.

## SEED TEST RESULTS

The number of tests conducted on the sedge seeds was limited; however, they have provided some very valuable observations.

- All sedges tested generally had poor germination success (0–70 percent).
- All sedge seeds were slow to germinate, taking on average almost 2 months.
- Germination rates varied substantially for the same species harvested from different populations.
- *Carex lucorum* provided the highest germination rates of the three sedges tested.
- Very few *Carex houghtoniana* seeds germinated.
- Of all germination treatments, only those including scarification appeared to result in increased germination rates.
- The grasses tested by the seedhouse provided much higher germination rates.

The range of germination rates for each of the test species is summarized in the following table. Rates for the grasses were determined by Sharp Brothers Seed Company of Healy, Kansas, and were generally higher than the sedge seed germination rates.

| *Species* | *Germination Rates (%)* |
|---|---|
| Little Bluestem | 78 |
| Sand Dropseed | 77 |
| Switchgrass | 97 |
| *Carex lucorum* | 1 to 70 |
| *C. houghtoniana* | 0 to 5 |
| *C. aenea* | 1 to 36 |

The detailed results of sedge germination testing are presented on Figure 6.

## TEST PLOT RESULTS

The following points summarize observations made during both the 1986 and 1987 growing seasons.

- Spring planting had a much higher degree of success than fall planting for the grass species. More *Carex lucorum* appeared as a result of fall planting; however, even then less than 5 percent cover emerged.
- Slope aspect did not appear to affect plot results significantly.
- Both Little Bluestem and Switchgrass provided almost 50 percent cover when applied at 60 kg/ha.
- Other species tested, particularly the sedges, showed a poor growth response. *Carex lucorum* produced small amounts of cover on some plots. *Carex houghtoniana* did not grow on the test plots.
- The remainder of the slopes seeded with the mix of grasses and legumes generally possessed more complete vegetation cover than the study plots. That seed mix, applied at a rate of 100 kg/ha, provided an average slope cover in 1986 of approximately 50 percent.
- Numerous sprouts of test species, including *Carex lucorum*, were observed downslope of the study plots.

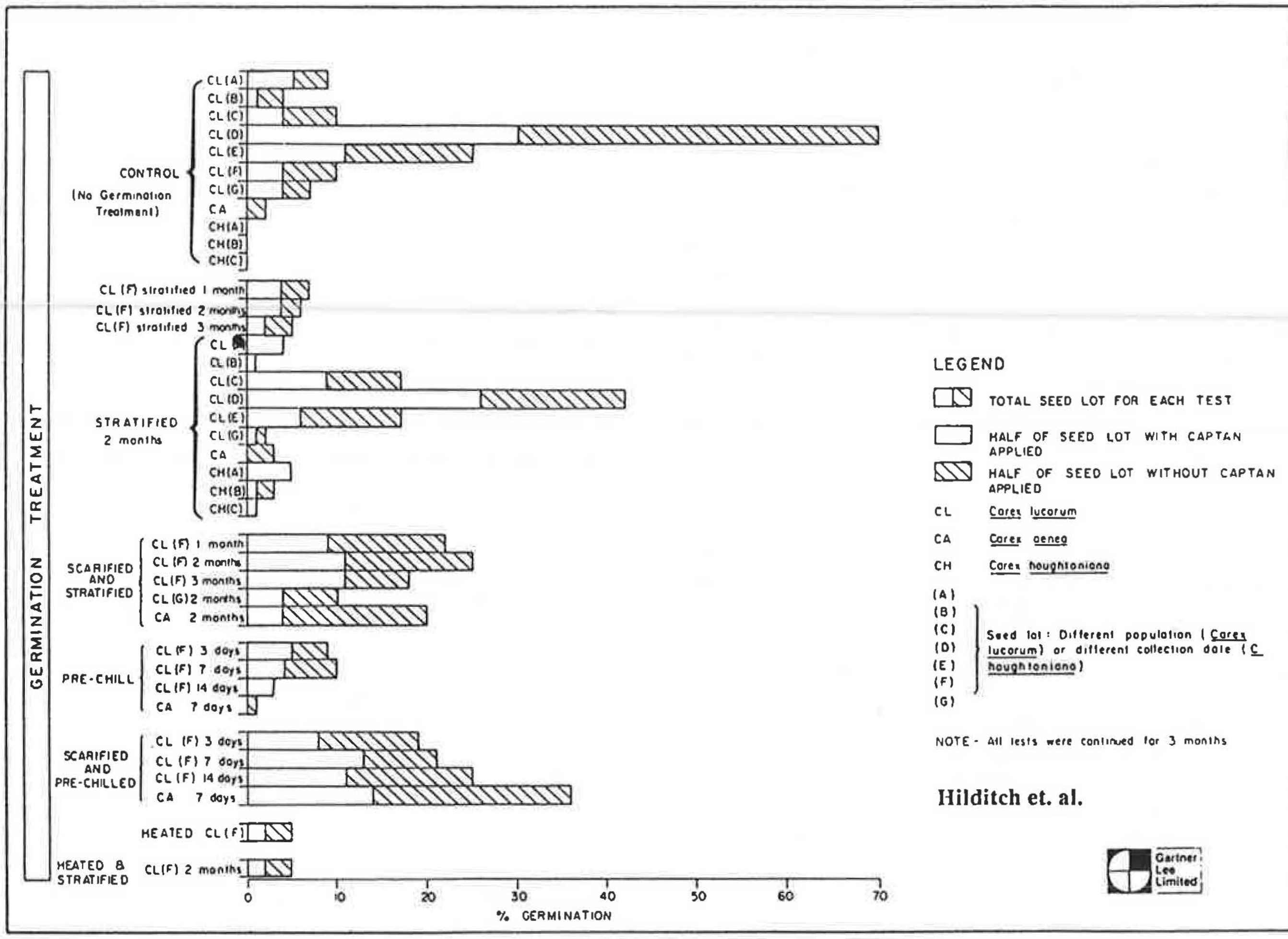


**FIGURE 6 Summary of sedge germination tests.**

- No winter kill was observed on any of the test plots from 1986 to 1987. The winter of 1986–1987 was relatively mild in the Gravenhurst area.
- Little change was observed in the plots following the first winter. Amount of coverage appeared to be very similar for the test species.
- On surrounding slopes, there was an increase in the amount of cover of Bird's-foot Trefoil in the 1986 season.
- Faced with a very hot, dry spring and summer in 1987, the study slopes were exposed to a long period of drought conditions. All test species appeared unaffected as did the Canada Bluegrass, Creeping Red Fescue, and Ryegrass. However, both the Alsike Clover and Bird's-foot Trefoil displayed moisture stress and exhibited declining populations. Much of the clover was dead by mid-season, 1987.

The vegetation cover for the test plots for both fall and spring planting are given in the following table; t represents a trace or less than 1 percent.

| *Test Species* | |
|---|---|
| *Fall Planting* | *Amount of Plot Cover (%)* |
| Little Bluestem | t |
| Switchgrass | t |
| Sand Dropseed | 0 to 2 |
| *Carex lucorum* | t |
| *C. Houghtoniana* | 0 |

| *Test Species* | |
|---|---|
| *Spring Planting* | *Amount of Plot Cover (%)* |
| Little Bluestem | 5 to 40 |
| Switchgrass | 20 to 30 |
| Sand Dropseed | 7 to 10 |
| *Carex lucorum* | 0 to 2 |
| *C. Houghtoniana* | 0 |

## IMPLICATIONS FOR REVEGETATION

This program has numerous implications for the revegetation of sandy roadsides. The implications presented are based on one and a half growing seasons of monitoring. It is possible that some of the sedge seed planted in the test plots may take longer to germinate and appear. Long-term changes will require monitoring over a number of years. An analysis of the test plots over the long term will facilitate definitive statements about the test species.

## SEDGES

The practicality of sedges for revegetation will be limited by a number of factors.

- In Ontario, seed availability is limited to scattered, known populations. Collection for large-scale production of seed would be slow initially.

- Germination rates were generally low and variable. Commercial propagation over several years could reduce that variability. Vegetative reproduction (e.g., application of rhizome cuttings) may provide a less costly technique for revegetation. Further research into germination techniques and vegetative reproduction of sedges could prove beneficial.
- Most germination was slow. These three sedge species may not present an instant vegetative cover as do some of the more traditional cover crop grasses (e.g., Ryegrass).

These limiting factors do not likely relate solely to the three sedge species studied. Several authors have examined other sedges and grasses and have found similar results. Justice (*2*), for example, noted that with the nutgrasses (*Cyperus sp.*), the proportion of viable seeds produced per culm was extremely low. Justice suggested, that the plants were more likely propagated via vegetative reproduction (e.g., rhizome) than by seed.

Taylor (*4*) observed that *Carex flacca* germination rates were in excess of 90 percent in laboratory conditions; however, seedlings in the wild were very rare.

It is very likely that the sedges studied have specific requirements to stimulate germination. Isely (*1*) made similar observations with respect to *Scirpus* seeds. Those exact requirements may not have been met in these experiments. This may be especially the case with *Carex houghtoniana*.

## GRASSES

The grasses studied present more immediate potential as alternate revegetation species. The seed is commercially available in the United States, with high germination rates. It appears from a review of literature that the three grasses have not been used for revegetation in Ontario. They are, however, commonly used in several of the midwestern states. There are several examples of prairie flora used successfully along roadsides (*7–10*).

A potential difficulty in the use of the species in Ontario relates to climatic adaptability. The available seed comes from populations to the south of northern Ontario, from a different climatic zone. There would no doubt be benefits in locating native populations and promoting the harvest and propagation of those populations.

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