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LCMR Final Status Report - Detailed for Peer Review -Research

I. Native Grass and Wildflower Seed

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Minnesota Department of Agriculture
Agronomy Services Division

A. Legal Citation M.L. 1991 Chapter 254, Article 1, Section 14, Subdivision 6(e).

Appropriation $130,000
Balance $ 4,100

Native grass and wildflower seed. This appropriation is to the Commissioner of Agriculture in cooperation with the Commissioner of Natural Resources to develop the varietal, cultural, and market information necessary to encourage expanded commercial production of Minnesota origin native wildflower and grass seed.

B. Compatible Data: The information collected during the biennium ending June 30, 1993, from projects funded under this section that have common value for natural resource planning and management and for various agricultural production systems will be in a format that can be adapted for use by other public agencies, private organizations, and individuals. The expense of integrating the information into other data management systems will be the responsibility of the agency, organization, or individual receiving the information.

II. Narrative

This program is designed to develop germplasm, cultural, and market information needed to promote an increase in production of native grass and wildflower seed. Current demand for these kinds of seed far exceeds supply in both the quality and the number of species available for public and private use. Technical information on how to produce seed from selected species and market information are needed in order for potential growers to decide whether or not they should invest in the production of these kinds of seed.

III. Objectives

A. **Development of germplasm and cultural information.**

A. 1. Narrative: Developing methods which can be used to produce seed from native grasses and wildflowers along with methods by which the diversity of individuals in a naturally occurring population can be maintained are problems to be solved in this part of the project.

The Center for Alternative Plant and Animal Products will review and evaluate new and existing information and methods in order to develop guidelines for growers to produce and maintain diversity in native grass and wildflower seeds. The information resulting from this objective will also be presented at scientific meetings and in professional journal papers.

A. 2. Procedures: Existing information on commercial production of approximately 25 species of native grass and wildflower seed will be reviewed and current practices evaluated under controlled conditions. Native germplasm will be collected and evaluated for several genera. Germplasm diversity of a model grass and model wildflower will be assessed between and within regions of the state and compared to commercially available seed. The results will be summarized in guidelines to commercial producers, addressing production techniques, seed and seedling identification, and maintenance of germplasm diversity. The systems developed in this objective will act as models for future research.

A. 3. Budget: LCMR Funds
a. Amount Budgeted: $70,000
b. Balance: $ 0

A 4. Timeline for Products/Tasks:

	July91	Jan92	June92	Jan93	June93
a. Literature review		X	X	X	X
b. Establish species list	X	X			
c. Identify production practices	X	X	X		
d. Characterize populations	X	X	X	X	
e. Evaluate production practices	X	X	X	X	X
f. Develop production guidelines					X
g. Prepare seed identification materials		X	X	X	X
h. Collect germplasm	X	X	X	X	X

A. 5. Status: Two graduate students joined the project under the guidance of Drs.

Hanchek and Strefeler. They have made many trips to collect seeds and several visits to producers, and will continue to do so as needed. Seeds of over 28 species and/or varieties from 50 sites have been collected for use in preliminary propagation trials, detailed studies, and genetic research. Each collection is labeled to keep populations distinct. Not all species collected are included in the detailed research. The students have also attended conferences on native plants (one gave a paper at the 1992 North American Prairie Conference) and participated in the development of a growers group. This group formed after discussion between Dr. Hanchek and Jack Johnson of AURI.

Literature Review

The task of reviewing the literature began in August 1991, well ahead of schedule, and has continued throughout the project. Insufficient documentation of production methods exists in the scientific literature, despite many popular press articles, and what does exist is scattered widely throughout journals, conference proceedings, and monographs. In June of 1992, another graduate student, Eleanor Congdon, was engaged as hourly help, primarily for the literature review. Since her background is history, and thus library research, her help has greatly increased our ability to gather information.

The current bibliography has over 1085 entries entered into a commercial bibliographical database called Papyrus 7.0, created by Dave Goldman for Research Software Design of Portland Oregon. Citations include articles, books, conference proceedings, theses, and pamphlets. Each entry lists pertinent information such as year, author, title, publisher, etc. Where applicable, the call numbers assigned by the University of Minnesota Library system are included so that the citation may be reviewed by interested readers.

The bibliography's function is not only to find as many citations as possible concerning native plants and growth practices relating to them, but also to extract that information as needed. One third of the citations have appended abstracts, and 250 have more detailed notecards that give specific information concerning production procedures or requirements for plants native to Minnesota. The basic bibliography, without abstracts or notecards, is listed in **Table 1** in the appendix. The full bibliography will be available through the Center for Alternative Plant and Animal Products, and may be published in a format yet to be determined.

Species List

There are actually several different lists, each based on different criteria. Unfortunately, not many plants can be used to study a genetic problem and a specific production problem and at the same time be the commercially most attractive and environmentally most interesting. For the production portion of the research, the species list has been

developed through input from two sources. In collaboration with the bibliography, a species list was created by indexing Ownbey and Morley's Vascular Plants of Minnesota according to scientific name, but excluding ferns, woody plants, and introduced species, while including information on each plant's status on the State Noxious Weeds List, the State Endangered Plants List, and the State Protected Plants List. This index is **Table 2** in the appendix. In addition, suggestions were solicited from producers by Julia Bohnen. A list of species collected for germination trials is in **Table 3** of the appendix. For the genetic diversity portion of the research, the species that might be useful for highway reclamation are listed in **Table 4** of the appendix. A key to the numbers identifying the location of collection sites for the seed listed in **Table 3** and **Table 4** is listed in **Table 5** of the appendix.

Development of recommended production practices has included both the results of our experimental research and material found during the literature review. Details on specific plants are being collated into a computerized database and can be accessed as a Lotus 123 spreadsheet. As a result, 1303 plants will be listed, for which available information is given on topics such as fruiting structure, time of harvest, seed storage requirements, seed treatments, asexual propagation methods, production treatments for established plants, a plant's preferences for soil, moisture, and light, root structure, and genetic information. All details in the spreadsheet are accompanied by a reference number which refers to the source of the information in the bibliography. A total of 44 columns for different types of information, and for references, have been set up in the spreadsheet. This database also shows that much information is lacking for many of Minnesota's native plants. The spreadsheet will be available to the public through the Center for Alternate Plant and Animal Products, and it may be published through them in a format yet to be determined. For a complete listing of the columns set up in the spreadsheet and a sample output of one of the plants, see **Table 6** in the appendix.

Seed and Seedling Identification

The species currently included in the seed and seedling identification materials are listed in **Table 7** of the appendix. Development of this resource has continued to the end of the grant period. Several sets of slides will be available from the University of Minnesota Extension Service Distribution Center.

Production Practices

To identify successful production practices, site visits were made to several Minnesota producers. Generally it was observed that successful producers are innovative individuals with the ability to apply agricultural and horticultural skills and techniques to the diverse palette of native plants. Some specialization has occurred, with some of the producers focusing on production of grasses, while others may produce only native wildflowers.

Agricultural engineering skills also prove useful as the diverse plant forms and growth habit make seed harvesting and processing a challenge. A detailed survey summarized in February 1992 compiled information about production facilities and products being marketed.

As part of the evaluation process for production standards, growers were consulted. We learned that standard horticultural techniques can be used successfully with the majority of our native plants. Greenhouse trials have been underway since August 1991, and formal trials examining the effects of stratification, scarification, and after-ripening are ongoing. Special emphasis is being placed on *Spartina pectinata, Lilium philadelphicum, and Phlox pilosa* (one grass, one non-grass monocot, and one dicot). The effect of gibberellic acid (GA) in enhancing rate and uniformity of germination has also been examined. We have found that all of these treatments can be effective on native plants, but the application is highly species dependent. Our results, obtained under conditions similar to those of some producers, are very encouraging. A list of the additional species for which germination trials have been conducted is in **Table 8** of the appendix.

The often impervious seed coat of legumes usually needs to be damaged or worn in some way to allow gases and water to enter or to reduce the mechanical pressure on the embryo so that germination can proceed. In trials comparing scarified versus not scarified seed, physical scarification of several leguminous species has resulted in 22 - 83 percent germination. Non-scarified seed had from less than one to 63 percent germination.

For some species, grasses in particular, a period of after-ripening is required. During the after-ripening period, physiological processes occur bringing the seed nearer a state in which it is able to germinate. The length of the after-ripening period varies for different species, but usually involves storage for two months or longer after harvest.

Many of our native species require a cold moist period to promote germination. Several approaches can be used to accomplish chilling treatment. Some producers sow their seed outdoors and allow nature to take its course. Refrigeration can simulate winter under more controlled conditions. Stratification treatments consisted of 4 to 12 weeks on moist blotter paper in petri dishes in the 1992 trials or in moistened germination medium for the 1993 trials. Germination can be adversely affected, however, by too much cold moist stratification as well as too little.

Gibberellic acid may be effective in circumventing other more time-consuming treatments, and can substitute for cold moist stratification in many instances. However, over-exposure to GA can cause plant growth abnormalities such as excessive elongation which could potentially affect the salability of the plant or its establishment upon transplanting. Appropriate GA concentrations and treatment lengths were examined for several species.

For many species, it is unlikely and probably biologically undesirable that 100 percent germination occurs in a very short period of time. Due to variability within a population, seed will germinate over a sometimes much extended time frame. Uniformity of germination is important in plug production from seed. Increased uniformity occurs when more seeds germinate in a shorter time frame. Optimum uniformity can be achieved by applying the appropriate treatment to the seed. However, germination results for two populations of a species may vary depending upon inherent physiological differences and upon environmental conditions prevailing at the site of origin. Results from the germination trials will be available after the data has been analyzed and summarized.

In some instances, seed germination may not be the factor most limiting to native plant production. Many growers commented in the surveys on small quantities of seed produced by different species. Can cultivation improve quantity and quality of seed yield? Is insect predation on seeds a major problem? Can we document and examine seed production? Field plots established at the Minnesota Landscape Arboretum are addressing these questions. Individual plants of *Spartina pectinata, Tradescantia ohiensis, and Petalostemum purpureum* (one grass, one non-grass monocot, and one dicot) are being monitored for seed yield and factors affecting it. At the same time, transplants from the prairie are being monitored similarly while growing in cultivated field conditions near the prairie.

Preliminary data suggest that simple field cultivation can increase seed yield and/or vegetative growth in certain native species. Seed yield in *T. ohiensis* was increased dramatically in cultivation within the first season of transplanting. *S. pectinata* did not flower in either the prairie or the cultivated plot, probably due in part to the unseasonably cool weather during the 1992 growing season. *P. purpureum* flowered in both treatments; however, flowering occurred too late in the cultivated plot for seed to fully develop before the growing season was interrupted by a hard frost. In both the cultivated *P. purpureum* and *S. pectinata*, substantial vegetative growth was realized in the first growing season. This study will, of necessity, continue through the 1993 growing season to allow a second year of data to be collected. The work described here forms Julia Bohnen's master's thesis and will be presented in detail with full analysis and peer review in her thesis manuscript and defense, planned for late fall of 1993.

Characterize Populations

Seeds of the species for genetic diversity research were collected in 1991 and 1992 and germinated in the greenhouse. The goal is to obtain at least 25-30 plants of each of the collected populations. The populations are then characterized in three ways:

1. Seedling tissue and leaf tissue is analyzed using isozyme analysis. The resulting banding patterns show if there are genetic differences

within and between populations. Some of the isozymes used were: ACP, ADH, EST, G6PDH, GDH, GOT, IDH, MDH, PRX, PGI, PGD, and PGM. Preliminary results are listed in **Table 9** in the appendix

2. Morphological differences within and between populations grown in the greenhouse were observed. These include number of flowers, number of leaves, height, number of stems (grasses only), and time of flowering. **Table 10** of the appendix contains the observations for each species.

3. Morphological differences within and between populations grown in the greenhouse and later transplanted into the field were also observed.

Genetic Diversity Research

Grasses

Andropogon gerardii

1) Morphological Differences.
Several populations were grown in the field in the summer of 1992 and the following characteristics were observed and recorded; plant height, number of stems and number of inflorescences. Within populations, there was variability observed in all characteristics studied. The highest variability was observed in plant height, followed by both the number of stems and inflorescences. Between populations, there was little or no difference in the means observed for both shoot and inflorescence number. It was also noted that the time of anthesis and senescence (stem discoloration) varied within populations.

2) Isozyme Analysis.
Preliminary results of starch gel electrophoresis indicate that there is little genetic variation within the populations. Isozyme analysis will be completed this summer.

Schizachyrium scoparium

1) Morphological Differences.
The same characteristics were observed and recorded as in *Andropogon gerardii.* Within populations, there was variability in all characteristics. Inflorescence number showed the most variability and the least variability was observed for plant height. Between populations, there was variation in mean shoot and inflorescence number and very little variation in mean plant height. There was also variation in time of

anthesis.

2) Isozyme Analysis.
Starch gel electrophoresis indicates so far that there is little genetic variation within the populations.

Forbs

Monarda fistulosa.

1) Morphological Differences
Despite several germination attempts, plants died in the greenhouse and no field data could be collected. However, this summer several populations will be grown again in the field.

2) Isozyme Analysis.
Because of difficulties during laboratory procedures, the results are still inconclusive.

Liatris spp.

1) Morphological Differences.
Several populations of *Liatris aspera*, *Liatris ligulistylis*, *Liatris punctata*, and *Liatris pycnostachya* were grown in the field and the following characteristics were observed and recorded; number of leaves, leaf length, leaf width, and dry weight of the aboveground plant parts. There was variation within the populations for all characteristics with the most variability observed for leaf number. Little variation was observed between populations in number of leaves, length, width and dry weight.

Floral traits will be evaluated this summer and fall, the first season of flowering for these seedling populations.

2) Isozyme Analysis.
Isozyme polymorphism's in *Liatris* was observed for the following isozymes: Acid phosphatase (ACP), Alcohol dehydrogenase (ADH), Aspartate aminotransferase (AAT), and Phosphoglucomutase (PGM). This indicates that isozyme diversity exists with populations of *Liatris* and hence, genetic diversity for these enzymes in these populations.

Continuatic Genetic Diversity Research

1) Morphological Differences.
About 30 individuals from each population will be grown again in two field locations (St. Paul and Morris, MN) for this summer. Additional populations will be grown from seed collected not only in Minnesota, but also from neighboring states. Similar characteristics will be observed and recorded by late September to early October. At the end of the growing season plants will be removed from the field and overall dry weight will be recorded. The St. Paul field will be used to obtain a two-year data (1992 and 1993) while the Morris location will just provide one-year data (1993 only).

2) Isozyme Analysis.
Starch gel electrophoresis will continue throughout this summer. Leaf tissue will be collected from both locations, St. Paul and Morris, for the analysis.

Cultural management practices for maintaining genetic diversity

As soon as all the data from the field observations and the isozyme analysis are completed more detailed recommendations on management of seed production practices will be forthcoming.

General Conclusions for all species in this study

The preliminary results show that genetic diversity is greater within local populations than between populations. This is common in many natural populations of plants and animals. The significance of these results is that seed from fairly large geographical areas (> 200 mile radius) can be intermixed or planted throughout a region without significantly or permanently altering the genetic integrity of natural populations in that region. It may even be possible to plant seeds from the species examined in this study anywhere in the state regardless of its point of origin, without any negative impact on natural populations.

Management of genetic diversity in seeds will best be achieved by collecting seeds from several populations in distinct areas within a given region and using these as the foundation plantings for seed production. This approach will maximize genetic diversity in the source population and reduce genetic drift. Limiting seed collection and distribution to a small geographical area would increase the effects of genetic drift and decrease the genetic diversity in the seed produced. The resultant plantings may then have a negative impact on natural populations in the vicinity.

These recommendations are based on a limited amount of genetic information and are only preliminary in nature. Upon completion of this study we will have a good base to make recommendations but more work on the genetics of these and other species are needed to insure that proper methods of collection, production and distribution are used to minimize the impact of future plantings on natural populations.

Finally, we feel it is vital that a practical and objective set of guidelines are developed. These should be sound for the environment and economically feasible for the producers; otherwise any effort in this area will prove futile. The State of Minnesota needs to find ways to promote production of native plants in a commercial setting. The alternative and current practice of collecting seeds from the wild will ultimately result in adverse affects on natural populations and increase their vulnerability to the loss of species in the future.

Kerstin Concibido's master thesis will deal with the population genetics of *Liatris* spp. in Minnesota.

A. 6. Benefits:

a. The information developed by this objective can be used by anyone who is interested in producing Minnesota origin native grass and wildflower seed resulting in a supply which is closer to meeting demand.

b. Existing stands of native grasses and wildflowers will suffer less unregulated seed harvest because supplies will be commercially available.

c. The quality of plantings of native species along roadside and on other public lands will increase significantly if these seeds are more rapidly available.

d. Models developed in this objective will be applicable to other research into native grasses and wildflowers.

B. **Assess present supply and demand of native grass and wildflower seed, analyze the scale potential of Minnesota's native origin seed industry and future market demand.**

B. 1. Narrative: An inventory of present supply and demand of native grass and wildflower seed must be ascertained to encourage appropriate levels of public and private investment. The focus of this objective is to collect and examine primary information and data on the native grass and wildflower seed industry, and make them available for use by the interested public including present and potential producers, consumers, and investors.

B. 2. Procedures: Producer and consumer surveys will be conducted to: 1) determine the current production and consumption level and geographic distribution of seed source and destination, and 2) identify present and prospective producers and consumers. Market information and data will be collected through telephone and/or in-person interviews and mail responses. A customized database will be developed and maintained to better manage the available industry data. Results of the survey will be entered into the database for processing and analysis.

B. 3. Budget

Budget	LCMR Funds
a. Amount Budgeted:	$35,000
b. Balance:	$ 0

B. 4. Timeline for Products/Tasks:

	July91	Jan92	June92	Jan93	June93
a. Producer and Consumer Survey	X	X	X	X	
b. Prepare collected data and establish database	X	X	X	X	
c. Review and analyze results			X	X	
d. Final report				X	X

B. 5. Status: Minnesota's native wildflower and grass seed industry is a small but rapidly growing industry. During the past decade, the production and utilization of native seeds have increased at an unprecedented rate. This was largely due to efforts of both the public and private sectors to improve the natural environment and eco-system; to protect the state's soil and water resources through the restoration of native prairies and land reforestation, and to provide natural shelters for wildlife habitat.

In the 1992-1993 crop year, the estimated annual sales of native wildflower and grass seeds in Minnesota approached ten million dollars, according to industry sources. This figure included revenues from sales of seeds, seeded plants, and also service contracts for seeding, planting, land preparations and other related consultation work. The most noticeable development in the native seed industry was the service-related sales or the new value-added component of the native seed business, which many believe will increase more rapidly than previously expected.

Traditionally, state and federal government agencies were predominant buyers and users of native prairie seeds. In recent years, however, an emerging commercial market has drawn more and m non-government users, such as, private companies and ge l landscapers

who incorporated native seeds and plants into their various landscaping or land improvement projects. It is expected this consumer segment will be the main driving force for future market development.

However, Minnesota's native seed industry is still undergoing profound changes in its course of growth and development. Currently, most of the growers have small-scale operations and have not yet reached their full production potential. One of the most pressing issues facing the industry is the undefined market and market structure. Furthermore, lack of market information and statistical data on production and consumption, uncertainty about the future's market, and unpredictable market fluctuations have become major restraints and concerns for Minnesota's native seed producers. All these are common obstacles that most new business ventures experience during the early stages of development.

The objective of this market research is to address the supply and demand issues through the examination and assessment of Minnesota's native seed industry and its current and potential markets. Production and consumption information is assembled and analyzed to provide producers, consumers, investors and policy-makers with much needed information for decision-making.

Production and Supply of Native Grass and Wildflower Seed

Minnesota's native grass and wildflower seed production started a decade ago with a new and small market niche that initially drew very little attention for the first few years. At the time, the majority of native seed production and collection went toward building the seed stock and establishing small-scale production plots. To start a native seed business, producers had to first hand-collect "foundation seeds", the initial seed source, from undisturbed natural sites, or purchase such seeds from a supplier. Because of the limited quantities of foundation seeds, producers could only gradually build their seed stock through planting and re-planting. Therefore, it took at least three to five years to establish an adequate production field and harvest a mature crop for commercial sale.

In the mid-1980's, the Conservation Reserve Program (CRP) was implemented by the federal government, creating an enormous market for native or other prairie seeds, as well as bringing unlimited opportunities to an infant industry. Not surprisingly, the minimal available quantities of native seeds failed the overwhelming market demand, which resulted in high prices and a dissatisfied market. The negative effect has lasted until this day, when native seed users still refer to "over-priced and under-supplied" situations even though profound changes have since taken place in the marketplace.

In an effort to assess the current production and supply of native wildflower and grass seeds in Minnesota, the Marketing Division of the Minnesota Department of Agı ure (MDA) conducted the "Native Wildflower and Grass d Producer

Survey" (**Table 11** in the appendix) in the summer of 1992. The survey questionnaire was mailed to all current native seed producers in the state and helped generate production information and statistical data including: 1) current production; 2) production acreage; 3) geographic distribution of production and collection sites; 4) available species; 5) projected production expansion; and 6) major obstacles to industry development (from the producers point of view). The majority of Minnesota's native seed producers participated in the survey, providing a sufficient across-the-board representation of all variables such as production scale, management practice, customer base, production potentials, specialties and expertise. Some non-participants were surveyed via telephone interviews. After compiling and analyzing the survey results, a comprehensive summary of the supply side of the native seed market was completed.

A. Production and Supply

Minnesota's native wildflower and grass seed production is composed of two types: seeds harvested from established production fields, and seeds collected from natural sites and prairies. Currently, over one-half of the commercially available seeds come from cultivated production while the balance is acquired by wild collection. Among producers, 85 percent produce seeds through cultivation but 55 percent of them also collect from natural sites to supplement certain market niches or to provide for foundation seeds. There are fifteen percent of producers who depend solely on wild collection for seed harvests. The combination of cultivated and collected native seeds in the marketplace gives buyers and users an extended range of options regarding quality, quantity, variety, seed mixes and ecotypes.

1. Annual Production and Value

Due to the small size of Minnesota's native seed industry, there has been until now no government agricultural statistical reporting on the annual output quantity or value of the native wildflower and grass seed production. The 1991 Native Wildflower and Grass Seed Producer Survey was the first attempt to gather the primary output data and relevant production statistics. Based on the production estimates obtained through the producer survey and telephone interviews, the commercially produced native seeds totaled 127,000 pounds in 1991, of which, approximately 96 percent were grass seeds and 4 percent were wildflowers. However, as was indicated in the producer responses, it would be extremely difficult to estimate the total value of the native seed production due to the vast range of species produced and the enormous price difference

between and among various wildflower and grass seeds. Unlike other field crops such as corn and soybeans, the native seed crop has no "medium" or "average price" that can reflect a realistic value of the aggregate production. Most producers could not provide a complete sales volume and price break-downs for some 300 species produced in Minnesota. Seed prices spread from $3.00 per pound to well over $1,000 per pound -- a 3,333 percent difference. For computation purposes, the following table was developed that employed medium prices to provide a hypothetical output value.

Production Output and Value

	Production (lb.)	Medium Price ($ per lb.)	Total Value of Production
Grass Seed Production (96% of Total)	121,920	$9.70	$1,182,624
Wildflower Seed Production (4% of Total)	5,080	$110.00	$558,800
Total Production	127,000		$1,741,424

The 1991 Producer Survey shows that 50 percent of the native seed producers had been in production for less than five years; only 11 percent have been in production for more than ten years. Ninety-four percent of producers grow and sell grass seeds or seedlings, while 82 percent grow and sell wildflower seeds or seedlings. Seventy-nine percent of producers sell pure seeds; seventy-one percent sell seed mixes; and forty-three percent sell seedlings, plants or sod.

2. Acreage in Cultivation and Wild Collection

Minnesota's commercial native seed production takes place in twenty-five counties across the state, with an estimated 2,000-plus acres of production fields and wild collection sites. This figure does not include prairie remnants or roadsides. Cultivated acres account for less than half of the total acreage, but have been increasing due to production expansion and the establishment of new production fields. Many of the wild collection areas are leased prairie lands from farmers or private landowners, or public land permitted for seed collection by Minnesota Departments of Natural Resources and Transportation, or the U.S. Fish and Wildlife Service under the United States Department of Interior. Harvests from such wild prairies will remain as a vital source of production and continue to provide foundation seeds, new gene-pools, and commercial seed crop for sale.

3. Geographic Distribution of Native Seeds Production

Minnesota's current native seed production has a wide array of geographic locations and natural landscapes. To better categorize the production sites, Minnesota counties are grouped into six regions: Northwest -- Region 1, Northeast -- Region 2, West-central -- Region 3, East-central -- Region 4, Southwest -- Region 5, and Southeast -- Region 6. This also helps to define the ecotypes produced and used in a specific geographic region. (**Table 12, Figure 1** in the appendix: "Minnesota Native Wildflower and Grass Seed Regions").

In 1991, almost one-third of Minnesota counties hosted one or more native seed production and collection sites, which stretched from the northwest corner of the state down to the south border. The twenty-five producing counties included: Kittson, Marshall, and Polk of Region 1 (Northwest); Itasca, Carlton, and Pine of Region 2 (Northeast); Clay and Stevens of Region 3 (West-central), Sherburne, Ramsey and Sibley of Region 4 (East-central); Lyon, Murray, Cottonwood, Jackson, Watonwan, Martin, and Faribault of Region 5 (South-west), and Freeborn, Waseca, Steele, Dodge, Wabasha, Winona, and Houston of Region 6 (Southeast). The site map indicates that 1991 production was concentrated in the southern part of the state, mainly south of the Twin Cities metro area. (**Table 12, Figure 2** in the appendix: "Native Wildflower and Grass Seeds, County Production Sites").

4. Species Information

As mentioned earlier, Minnesota's native seed producers supplied approximately 300 species of wildflower and grass seeds to the market in 1991 (**Table 13** in the appendix: "Native Wildflower/ Grasses By ID Code"). The best selling varieties included the following grasses and wildflowers: Switch Grass (*Panicum virgatum*), Big Bluestem (*Andropogon gerardii*), Indian Grass (*Sorghastrum nutans*), Side-Oats Grama (*Bouteloua curtipendula*), Native Tall Grass Prairie Seed, Purple Prairie Clover (*Petalostemum purpureum*), Maximillian Sunflower (*Helianthus maximilliani*), Lead Plant (*Amorpha canescens*), and Yellow Coneflower (*Ratibida pinnata*). Some of these varieties are produced in large volumes, from hundreds to thousands of pounds, while others, mostly forbs, may only be available by the ounce or even one-half ounce.
Every year, new grass and wildflower seeds are added to the species list as producers plant more "experimental" seeds in their production fields in order to explore new market niches and expand the diversity of marketable seeds. Usually, producers first offer a new and unknown species to the market. If successful, in one or two years, this new species will draw attention from buyers and users, and eventually gain market acceptance.

Some of the best selling species are listed below by common name and scientific name with estimated quantities produced (**Table 12, Figure 3** in the appendix: "1991 Production: Major Species"):

Species	**1991 Production Estimates**
Grasses	
Switch Grass (*Panicum virgatum*)	40,000 lbs.
Big Bluestem (*Andropogon gerardii*)	15,000 lbs.
Indian Grass (*Sorghastrum nutans*)	12,000 lbs.
Side-Oats Grama (*Bouteloua curtipendula*)	9,000 lbs.
Native Tall Grass Prairie Seed	5,000 lbs.
Big Bluestem "Roundtree"	3,000 lbs.
Big Bluestem "Bonilla"	2,500 lbs.
Wildflowers	
Purple Prairie Clover (*Petalostemum purpureum*)	55 lbs.
Maximillian Sunflower (*Helianthus maximilliani*)	25 lbs.
Lead Plant (*Amorpha canescens*)	25 lbs.
Yellow Coneflower (*Ratibida pinnata*)	20 lbs.

B. Native Wildflower and Grass Seed Producers

1. Producer Information

Thirty-five percent of Minnesota's native seed producers are full-time growers or collectors of seeds. They contribute over 60 percent of seed sold in the consumer market. Another 55 percent produce on a part-time basis, providing less than 40 percent of the total quantity. The last 10 percent are hobby farm operators, who have yet to reach a salable scale. Their seed production currently serves in-house use: establishing production fields and building seed stock. The producer group primarily consists of individual farmers, with only a few proprietorships, owned businesses, or incorporated enterprises. (**Table 12, Figure 4** in the appendix: "Full-time, Part-time and Hobby Farms: Their Share in Native Seed Production").

2. Size of Operations

"Small-scale production" best describes Minnesota's native seed industry. Most producers operate on less than 30 acres of production land and wild collection fields. Because of time-consuming labor intensive production methods, small operations, especially at the early stages, prove to be more feasible and manageable. For many producers, small size yields better results in capital investment, controlled production expansion, quality control, and market development. A successful and well-balanced native seed operation involves a full range of activities similar to that of business enterprises: production, pricing, sales, promotion and long-range planning. The small size does not undermine the complexity of the native seed operation, which is considered a very non-typical farm enterprise.

C. Production Cost

Based on information provided by native seed producers, there is no "average" or "standard" production costs that can accurately reflect the capital and labor inputs different producers invest in their own seed production. As a result, costs vary considerably, depending on many variables, such as: land conditions, species grown, length of production cycle, cultivation methods, grower's experience and expertise, overhead, and intensity of labor involved in production management.

For cultivated production, the cost factors to be considered include land (either purchased or leased), equipment, seeds, labor, fuel and other energy consumption, chemicals, cleaning or processing equipment, or fees paid for such services if there are no in-house facilities. To many producers, especially those who grow wildflowers or have a smaller production acreage, labor input ranks high on the list, especially when hand-weeding, hand-

harvesting, hand-collection, and hand-cleaning is part of the production practice.

According to industry estimates, overall production costs run from $300 to $1,000 per acre of crop for grasses and from $1,000 to $10,000 per acre of crop for wildflowers. The seed producers who were interviewed all came up with vastly different figures, because each one of them is doing it differently than the others. Consequently, there is no consensus on the cost estimate that this study seeks to establish. To understand the basics of the cost factors, we must first review the production process that incurs various capitals and labor expenses.

1. Production cycle:

Producers begin initial production with a small piece of land and hand-collected foundation seeds. After the initial seeding, the first few years yield no salable crop as all seed harvests are consumed for re-planting and production field expansion. Upon achieving a sufficient size, producers finally have a mature crop to sell. Depending on the geographic location and seed species in production, this may be a 3 to 5 year "lag time" before any capitol or labor investment can be recovered. The "opportunity cost" or potential earning opportunities for this time period if the producer engaged in another occupation has to be incorporated into the cost factor.

2. Labor input:

From planting to harvesting, field work heavily depends on hand labor for many producers, especially those who grow wildflower seeds. Initial planting, weed control, hand harvest of mixed seed varieties that mature at different times of the season, and post-harvest seed cleaning all require intensive hand labor. In addition, field preparation and routine management such as spraying and burning also require labor input. For the majority of the producers, field labor or man-hours constitute one of the biggest cost items. In 1991, wages for Minnesota farmers or farm workers averaged $5.63/hour, according to agricultural statistics reports. However, total labor costs are extremely hard to determine, as each producer devotes various amounts of man-hours in native seed production depending on what they grow and how they grow it.

3. Capitol input and operating cost:

a. Land: Initial land purchase may range from $500 per acre to $1,200 per acre, depending on the geographic location such as in the northwest or southwest of Minnesota, and quality of land. To lease or rent land, producers pay an average of $90 to $120 per acre per year.

b. Equipment: Producers either purchase new equipment or utilize existing equipment with some modifications to accommodate seed production. For seed cleaning and processing, some special equipment may be required. Cost of maintenance and depreciation should be included.

c. Initial seed source: Some producers purchase rather than collect foundation seeds when establishing production fields. Per acre cost of seeds ranges from $100 per acre to $500 or more per acre, depending on the species grown.

d. Chemicals: Fertilizers and herbicides are used in production fields. Cost of chemicals ranges from $30 to $60 per acre per year.

e. Energy use: This includes cost of fuels and electricity for operating machinery and equipment for field work such as tilling, harvesting, etc.

f. Overhead: Administrative, marketing, promotion, and miscellaneous operation-related expenditures may vary from producer to producer.

If a production field yields 100 pounds per acre of grass seeds at a selling price of $9.00 per pound, the grower will receive $900.00 of sales revenue per acre. Less production expense, the profit margin can be very different for each producer.

D. Native Wildflower and Grass Seed Prices

As a high-valued crop, native wildflower and grass seeds carry an extremely broad price range, a result of many deciding factors for each individual species, such as, cost of production, quantity produced in a particular year, consumer demand, and other unique characteristics of the species. For native grass seeds, which is usually purchased by the pound and sometimes in large volumes, prices vary from $3 per pound to $70 per pound. The most popular species sell for $7.00 to $10 per pound. Wildflower seeds. on the other hand, are a more valuable commodity and normally sell by th[illegible]ce. Prices start

from $3.50 per ounce (about $60 per pound), and reach an upper range of $150 to $200 or more per ounce. At the higher price scale, seeds may be sold in lesser quantities than ounces.

Prices for the same grass or wildflower seed also vary from producer to producer. For a specific species, the quoted price can be $20 per pound or $100 per pound. It is due to the methods of cultivation, economies of scale, and experience or expertise of the producer. As a result, producers often buy seeds from each other in order to "stabilize" a potentially volatile price situation. The "flexibility" of seed price to the producers is not a marketing advantage because consumers find it inconsistent and unpredictable, causing difficulties in making purchasing decisions.

E. Markets

Minnesota's native wildflower and grass seed markets consist of wholesale, retail, government purchase, and out-of-state sales. In 1991, all growers sold seeds or seedlings in the wholesale market or to the government. Eighty-six percent had a retail market, and 71 percent marketed their products to other states including Iowa, North Dakota, South Dakota, Wisconsin, Illinois, and Canada. Over two-thirds of producers re-invested portions of the seed production for in-house use -- i.e., re-planting and field expansion.

In the retail market, on-farm sales and mail order were most popular, with 30 percent and 36 percent of total retail sales respectively. Retail customers are mainly farmers, land-owners, businesses, and homeowners. The wholesale market serves volume users including: private businesses and seed companies, who purchase 81 percent of wholesale seeds; general landscapers, who purchase 13 percent; and retail nursery and garden centers, who purchase 6 percent. Government procurement always involves large quantities and varieties of seed species. Buyers in this group include Minnesota Departments of Transportation and Natural Resources, U.S. Fish and Wildlife of the U.S. Department of Interior, and local government agencies such as counties, cities or townships.

Overall, the retail market share was 27 percent of total sales in 1991, while wholesale had 31 percent, government purchase, 32 percent, and producers' in-house use, 10 percent. In-state sales held a 68 percent market share, and out-of-state sales had 32 percent. (**Table 12, Figure 5** in the appendix: "Minnesota's Native Seed Market") and (**Table 12, Figure 6** in the appendix: "Native Seed Sales: Minnesota Market & Out-of-State Market").

Only 17 percent of seeds and seedlings were sold beyond a 200-mile radius of the production origin, according to the 1991 Producer Survey. Of the 87 percent of seeds and seedlings that were marketed within a 200-mile radius, 51 percent were sold within a 100-mile radius, and 34 percent were sold within a 50-mile radius.

F. Production Trends and Projections

The annual production and sales of native wildflower and grass seed have been increasing steadily during the past ten years, especially since the late 1980's. Initially, the production expansion stemmed from a new market demand when the Conservation Reserve Program (CRP) was implemented. Since then, there have been many other driving forces that contributed to the development of the native seed industry, including environmental concerns, increased public awareness and consumer acceptance, continued government purchase and utilization, and implementation of various nature conservancy programs. It is also believed that earlier promotional efforts have started to pay off.

Producers reported an average annual increase of at least 20 percent to 30 percent of production and sales in 1990, 1991, and 1992. The fastest growing market segments include the following:

1. Commercial retail and wholesale or non-government purchase:

   Although government has been, and still is, one of the biggest buyers, sales to the commercial retail and wholesale market have been going up at a higher rate compared to the annual increase in government purchases. Producers became less dependent on the one major customer than they had been in the previous years. Greater commercial market development is considered the leading factor in the latest production expansion.

2. Increased production and utilization of wildflower seeds:

   Native wildflower seeds have always held a very small percentage of native seed production and sales, due to the more complex, difficult cultivation process, and higher prices. However, more consumers choose to buy wildflowers as they become more informed or have seen previous good results of the plantings. Government users also plan to increase wildflower seed purchases in proportion to grass seeds in the future.

3. Out-of-state sales:

   The last few years have seen an increase in the number of non-Minnesota buyers from the surrounding midwestern states. This user group includes government buyers such as state agencies with large procurement potentials.

Most producers have increased cultivation acreage, seed species, and total production since the 1991 Producer Survey. As more production fields mature and new producers start producing salable seeds, the available native seed supply will generate more markets, uses, and public interests. The projected 20 percent to 30 percent annual increase in native seed production for the next two to three years will provide at least an additional 25,000 to 38,000 pounds of marketable seeds to the consumers, whose number has been rapidly increasing. Better prices, higher quality seeds, seed mixes, seedlings, and more diversified post-sale services will further enhance the marketability and utilization of native wildflowers and grasses. Producers will become more skilled and sophisticated in production and marketing as the consumer market gets more competitive due to increased volumes and number of suppliers. Many producers have already started to diversify their operations by offering more service-related sales such as installation contracts and consultation services. This value-added service sector will contribute an increasingly large share of earnings and profits in the future and help attract more large volume users as well as individual consumers.

The producer group will benefit from the newly founded "Minnesota Native Wildflower and Grass Producers Association" that organizes the cooperative efforts to further develop the industry and provides leadership and a unified voice for Minnesota's native seed growers.

G. Major obstacles to industry development

Many producers reported that they had not been operating at full production potential due to various reasons, i.e., financial, technical or marketing constraints that most of them had encountered at different stages of production. Over 40 percent of producers listed "lack of financial resources" as one of the limiting factors in native seed production. Thirty-three percent considered "inadequate technical assistance or information" as another concerning issue. Seventy-three percent identified "market constraints" as the single biggest obstacle for the industry's future expansion. Twenty percent commented on lack of public and consumer education, and 13 percent expressed dissatisfaction with the current public policies such as state support and initiatives for industry development. (**Table 12, Figure 7** in the appendix: "Obstacles to Production Expansion").

1. Financial:

This refers to a lack of financial resources or unavailability for production and operating loans and unwilling lenders. Due to the risks involved in native seed production, a long production cycle, and consequent delayed capital repayment on any borrowed funds, very few public or private lenders or financial institutions are willing to grant loans to native seed producers.

2. Technical:

Producers have had difficulties finding technical resources. There is very little technical information or assistance available to growers regarding methods of cultivation and production management. Up-to-date research or technical literature and manuals are also lacking.

3. Market Constraints:

For producers, market constraints include many marketing aspects, ranging from the unavailability of market information and data, undefined consumer needs, uncertainty about the future's market, competition, low profit margins, inconsistency in government purchases and possible over-supply. Producers find it difficult to make market projections and production planning because of these factors. The market unpredictables may be very detrimental to native seed producers who have to bear the production costs for three years or longer before harvesting a mature crop for sale. If the market situation changes during this extended period of time, the producer's final sales and profitability will be affected. It is risky to produce a crop without sufficient market information or short-term and long-term projections. As a result, market fluctuations have already caused large carry-overs for some of the producers. To achieve full production potentials of the native seed industry, the above-mentioned issues need to be addressed.

4. Consumer education:

Lack of consumer education and market promotion is perceived by native seed producers as another barrier to production expansion, as many uninformed consumers are not able to distinguish "native" wildflowers and grasses from "wild" flowers and grasses. Many consumers shy away from native wildflower and grass seeds but opted to buy imported or genetically improved cultivars simply because the latter cost less. Up till now, there [illegible]een no organized

effort to educate the public and potential users on the advantages of Minnesota origin seeds. The market potential has not been fully explored.

5. State policy incentives:

Last but not least, producers are concerned about state agency purchases, certification standards, current "competition" between seed production and harvest by the various state agencies versus that of the private growers, and the short-term and long-term policy initiatives that may either invigorate or hinder the industry growth.

Despite all the above-mentioned obstacles and concerns, many producers remain optimistic and have committed more land and labor resources to increase their current production capacity. This is due to the fact that the production is market-driven and the market demand for native wildflowers and grass seeds in Minnesota continues to be strong. The following chapter will examine the consumption and utilization of native seeds to provide some useful analyses of current markets and the outlook for the future.

Demand and Utilization of Native Wildflower and Grass Seeds

The commercial utilization of native wildflower and grass seeds in Minnesota was initially explored by a few government and private users in the late 1970's and early 1980's. These early pioneers started planting native seeds in order to preserve and re-generate these diminishing but potentially beneficial native prairie species. During the early years, the scarcely available seed source prevented adequate expansion for commercial use and resulted in high purchase prices. However, the small scale also enabled the producers and users to focus on pilot production and experimentation in order to build experience and expertise in seed cultivation and commercial planting.

Gradually, the commercialization of native prairie seeds started to gain popularity. In the mid-1980's, more consumers, especially farmers enrolled in CRP, became interested in prairie grasses and wildflowers that were of Minnesota origin. As a result, seed purchase and utilization began to increase. This new market development received support from the Minnesota state government. One of the earliest state initiatives was the creation of the "Minnesota Wildflower Task Force" in 1987, whose duties were to help increase the public awareness of the benefits of native prairie flowers and grasses and to promote their uses through educational approaches.

During the late 1980's, market development further accelerated as a result of continued increase in demand and utilization. The number of producers also doubled. Lar[illegible]lume sales to government agencies remained strong, wh[illegible]ore and more medium and small-volume users entered the marketplace. Generally, government purchases absorbed the lion's share of the native seed supply, a situation that had created adverse market fluctuations during budget shortfalls which led to drastically reduced seed purchases. The growing number of non-government commercial users, however, could help reduce such impacts by bringing stability and profitability to the native seed market. Since the early 1990's, strong commercial sales have helped to strengthen the market structure and supply-demand mechanisms as commercial users have become more active in seeking seed sources, supplies, or installation contractors. The commercial sector started to play an increasingly significant role in market expansion. In 1992, the volume of sales reached an all-time high.

In order to provide a comprehensive assessment of the current and potential demand for native wildflower and grass seeds, a consumer survey was conducted in 1992 to assemble actual consumption statistics. The survey drew participation from all major native seed users and potential users in Minnesota. Through the cooperation of the Marketing Division and the Agriculture Statistics Service of the Minnesota Department of Agriculture, a survey questionnaire was developed (**Table 14** in the appendix: "Native Wildflower/Grass Seed Consumer Survey") to generate statistical information and data which included the following:

a. Current market demand and utilization of native seeds;
b. Geographic areas of seed consumption;
c. Seed sources;
d. Consumer information;
e. Species in demand;
f. Consumer market trends and projections; and
g. Limiting factors or obstacles in native seed utilization.

Through extensive research work, the Marketing Division developed a list of current and potential native seed users including wholesale and retail nursery and garden centers, green-house facilities, landscaping firms, construction contractors, and federal, state, and local government agencies. The consumer survey was designed for institutional or volume users, and therefore, did not include individual users such as private landowners, homeowners or farmers. More than six hundred consumer survey questionnaires were mailed to the prospective participants throughout the state. Twenty-eight percent responded to the survey, a considerably higher-than-average percentage rate that indicated an interest and enthusiasm from consumers about the uses of native plant species. Among the survey respondents, 35 percent were identified as current users or potential users, who had either purchased and used native prairie seeds (29 percent) or had made definite plans to do so in the near future (6 percent).

The majority of users, 72 percent, reported to have purchased and used native seeds for five years or less; 24 percent had purchased and used native seeds for the past five to ten years, while 7 percent had purchased and used native seeds for more than ten years. In general, native grass seeds had been in use for a longer period of time, were purchased in larger quantities, and had a larger number of users than wildflowers.

A. Current market demand and utilization of native seeds

In Minnesota's native seed market, the overall consumption volume falls into the vicinity of 97,000 pounds annually, of which, approximately 72 percent were grasses and 28 percent were wildflowers. In comparison, Minnesota's native seed production has a 96 percent grasses and 4 percent wildflowers ratio mix, which creates a discrepancy between market supply and demand. The discrepancy has caused confusion and misjudgment in the marketplace as producers and consumers became frustrated due to different expectations. (**Table 12**, **Figure 8** in the appendix: "Native Wildflower & Grass Seeds Production and Utilization Ratio").

The latest report from the native seed producers and consumers revealed that the increase in market supply and demand for wildflowers had exceeded that of grasses, and the trend will continue in the coming years. However, in an attempt to adjust to a more desired ratio mix of wildflowers and grasses as demanded by the market, producers need to take caution when making production expansion plans to avoid unjustified shifts or even over-supply of either wildflowers or grasses.

In addition to the Minnesota market, Minnesota producers also supply approximately 40,640 pounds of seeds to out-of-state buyers, whose numbers have been increasing. The annual carry-over of seed stock is estimated at 20 percent of total production, or 25,400 pounds. The carry-over portion is either sold in the following year or kept for in-house use.

Besides seed sales, other marketable products and services such as seedlings or plants, land preparation, installation and custom planting, post-planting management, and consultation services all play an important role in continued market expansion. These products and services enhance sales activities and add value to a basic product.

In Minnesota, native wildflower and grass seeds are purchased by users for different planting projects which may involve large or small volumes of planting acreage. Seed utilization includes the following five main categories with respective percentage volumes consumed: 1) residential and commercial landscaping -- 47 percent; 2) parks and recreation projects -- 13 percent; 3) roadside and highway construction -- 11 percent; 4) land improvement and set-aside acres -- 10 percent, and 5) seed production and miscellaneous uses such as re-sale -- 19 percent. **(Table 12, Figure 9** in the appendix: "Native Seed Utilization").

B. Geographic areas of seed consumption

An estimated two-thirds of native seed users are geographically concentrated in central Minnesota, especially around the seven-county metro area, while the rest spread across southern Minnesota (19 percent) and northwest and northeast Minnesota (15 percent). Many of these users, however, may have more than one planting sites located in other counties or regions, which are not shown on the user distribution map. **(Table 12, Figure 10** in the appendix: "Geographic Distribution of Native Wildflower & Grass Users").

C. Seed source

The survey reported that Minnesota consumers prefer to use 100 percent locally grown species. But due to various reasons such as seed availability and prices, seed users may also frequently purchase non-native species from other states. In the marketplace, Minnesota's growers supply over two-thirds of all wildflower seeds purchased, while the rest comes from non-Minnesota sources. However, local growers provide a larger share of grass seeds in the market, ninety percent, compared to ten percent of non-Minnesota grass seeds.

Almost 80 percent of users purchase seeds from sources within a 100-mile radius; among them, half of the users buy seeds within a 50-mile radius. Only two percent go beyond a 200-mile radius for seed purchased.

Among non-Minnesota suppliers, Wisconsin ranks No. 1 on the list, with a 15 percent market share of non-Minnesota seeds, followed by, in descending order, North Dakota, 10 percent; Iowa, 8 percent; Colorado, 8 percent; South Dakota, 5 percent; and Nebraska, 5 percent. Other suppliers also include Idaho, Indiana, Kansas, Michigan, Missouri, New Hampshire, New Jersey, Pennsylvania, and Vermont.

D. User information

Among the user group, two-thirds represented the commercial sector which consists of wholesalers, retailers, service contractors and other business companies; one-third were government agencies including federal, state, and county .**(Table 12, Figure 11** in the appendix: "Native Seed Consumers").

1. Commercial wholesale sector:

As the most important segment of the current native seed market, this consumer group includes a large number of volume users such as general landscapers, nurseries and garden centers, and construction contractors, etc., who serve retail customers and other end-users through direct or service-related sales. They bring the highest sales volumes and have ready access to a growing clientele base. A typical wholesale customer is a business corporation with an interest in native prairie plants who also has the financial ability to pay premium prices for corporate office landscaping through a service contractor.

2. Commercial retail and mail order sector:

Demand for retail sales and mail order has been increasing in the last few years as more homeowners became interested in naturalistic landscaping and started growing wildflowers and native plants in home yards and gardens. This new consumption trend is a result of increased planting of wildflowers and grasses on public land and roadsides and the previous education and promotional efforts by public and private supporters of native prairie plants. Even though retail market and mail order only involve small volume sales, they help achieve the highest product value and profit margin for producers and marketers, and will continue to bring increased market opportunities for the native seed business.

Another popular form of retail is the on-farm sales which serve walk-in customers and farmers from neighboring communities. Most producers have on-farm sale outlets, enabling them to reduce overhead costs through direct marketing.

3. Government sector:

Every year, the State of Minnesota purchases large quantities of native wildflower and grass seeds for highway construction projects, state parks and recreation area planting, wildlife habitat improvement, roadside planting, and other conservation management programs, including RIM (Re-invest in Minnesota). As a forefront promoter and user, the state started purchasing and using native seeds more than a decade ago to help improve the native vegetation and diversity of prairie flowers and grasses along highways and on other state lands. Even though the state purchase fluctuates each year because of budget changes, it has maintained an upward trend since the late 1980's.

Compared to common turf grass and non-native species, native forbs and grasses require less maintenance and chemical use, are highly resistant to drought and better adapted to the soil, water, and natural climate of their particular region of origin. The ecological, economic and aesthetic benefits of native seeds justify the state's efforts and spending that helped bring the visibility and acceptance of Minnesota-origin prairie species, which in the long run will significantly reduce the state's spending in maintenance of roadside and other public utility projects.

Currently, the state also produces and harvests a portion of native seeds it needs for various planting projects as a solution to budget constraints and inadequate supplies. It is unclear, at this point in time, the long-term effect of government production on commercial native seed industry in Minnesota. This topic requires further study and analysis for an in-depth and accurate assessment.

Approximately 15 percent of Minnesota counties, among a total of eighty-seven, are purchasing native wildflower and grass seeds for county highway construction, parks and other public land plantings. The number will increase in the next few years as more counties have expressed interests in using native species or are making plans to do so but may be delayed due to various reasons such as limited funding and seed source.

The U.S. Fish & Wildlife Service of the U.S. Department of Interior is also a long-time user of native seeds. It produces and purchases native species for land improvement projects such as wildlife management and protection.

4. Out-of-state market

Non-Minnesota buyers consist mainly of government users or installation contractors who bid on public planting projects. Among the neighboring mid-western states, government purchases usually hold a 70 percent or more market share, compared to Minnesota's 32 percent. In recent years, many of the mid-western states have increased government plantings, driving up market demand which led to more out-of-state purchases. Minnesota producers stand to gain from seed sales to these states in the next few years, or until seed production in those states catches up with the demand.

E Species in demand

Based on the information obtained from the consumer survey, a species list was compiled to include the current and potential native wildflowers and grasses demanded by Minnesota's market. Some of the high-volume and popular species are listed as follows (in descending order):

Grasses
Side-Oats Grama (*Bouteloua curtipendula*)
Indian Grass (*Sorghastrum nutans*)
Big Bluestem (*Andropogon gerardii*)
Little Bluestem (*Schizachryum scoparium*)
Switch Grass (*Panicum virgatum*)
Blue Grama (*Bouteloua gracilis*)
Green Needle Grass (*Stipa viridula*)
Canada Wild Rye (*Elymus canadensis*)
Western Wheat Grass (*Agropyron smithii*)

Wildflowers
Black-eyed Susan (*Rudbeckia hirta*)
Purple Prairie Clover (*Petalostemum purpureum*)
Purple Coneflower (*Echinacea purpurea*)
Wild Bergamot (*Monarda fistulosa*)
New England Aster (*Aster novae-angliae*)
Dotted Blazing Star (*Liatris punctata*)
Wild Ginger (*Asarum canadense*)
Butterfly Weed (*Asclepias tuberosa*)
Lead Plant (*Amorpha canescens*)
Blue Vervain (*Verbena hastata*)

Table 15 in the appendix provides a list of the common species currently purchased or requested by consumers in the market. However, it does not include all species in demand as many of the consumer survey respondents were unable to supply a complete species list due to quantity purchased and incomplete labeling information for seed mixes.

F. Packaging and marketing requirements

Consumers purchase native wildflower and grass seeds in different packaging forms and mixes. The survey results reported the following statistics:

Purchasing forms	Wildflowers	Grasses
Pure Seed by Pounds	23%	33%

Pure Seed by Ounces	16%	5%
Seed Mix by Pounds	55%	48%
Seed Mix by Ounces	30%	5%
Seedlings	18%	7%
Plants	9%	8%

Consumers also require specific processing standards for the seeds. The following information show different processing categories and the percentage of consumers requesting them:

Cleaned and Conditioned	47%
Tested	43%
Official Seed Certifying Agency Standards	61%

G. Consumer market projections

The 1992 Consumer Survey showed that the survey group is made up of 82 percent current users and 18 percent potential users. From the consumers' point of view, the utilization volume of native seeds can be much higher if the market supply -- quantity, species, and genotypes-types -- can accommodate consumers needs and expectations. In other words, the market-oriented production and supply will help enhance the commercialization and marketing volume of native seeds. In recent years, consumer demand for native wildflowers has been growing at a higher rate than that of the native grasses. This trend will continue in the coming years as the commercial wholesale and retail market expands. The market projection indicates the rate of growth for native grasses will be unlikely to match that of the 1980's because of the maturing CRP acres. The 1990's consumer market demands the diversity of available seed species, easily accessible seed sources, and more genotypes for various geographic locations and regions.

In regard to government purchases, Minnesota's highway-sides and roadsides occupy approximately 260,000 acres of state land, and this figure triples if counties and townships are included. Each year, the Minnesota Department of Transportation seeds approximately 2,000 acres of land after highway construction, of which, about 500 acres are planted with native seed species. Although a portion of such seeds come from internal production, the commercially produced seeds will continue to be a main source of supply. Another state agency, the Minnesota Department of Natural Resources, also plans to expand the planting and use of native seeds for various resources management projects in the coming years. Government purchase and use will remain strong in the future, even though available budgets may limit the rate of increase.

H. Limiting factors to native seed utilization

The majority of consumer survey respondents provided positive feedback to the increased utilization of native species in the state. However, many of them also expressed concerns and dissatisfaction with the current situation in respect to the financial ability to purchase, seed availability and prices, general information and literature, technical assistance, consumer education, market promotion, and labeling. (**Table 12, Figure 12** of the appendix: "Obstacles in Native Seed Utilization").

Twenty-seven percent listed the lack of financial ability to purchase or high seed cost as one of the biggest obstacles facing the consumers. Some of consumers reported that because of the unavailable or limited funds, they had been unable to accomplish the purchase and planting as planned. Twenty-five percent expressed dissatisfaction with the insufficient information and literature on native wildflowers and grasses, as well as the technical references or resources. For the general public or interested consumers, there were no readily available information materials or brochures for reading or learning purposes. Twenty-three percent of respondents identified the inadequate seed supply, limited seed sources and species (such as ecotypes) as another obstacle which prevented consumers from increased seed use. Many consumers are frustrated at finding suppliers and suitable eco-types or species. Fifteen percent also commented on the lack of technical knowledge, skills or available assistance on seeding, planting, management and maintenance of native seeds. There are other prohibiting factors, such as the lack of consumer education and product promotion -- cited by 10 percent of respondents, under-developed markets and lack of consumer interest -- 10 percent, and the time-consuming and difficult process to establish planted fields -- 10 percent.

Conclusion

Minnesota has been a leader in native seed production and utilization in the mid-west region. The past decade witnessed the development of Minnesota's native wildflower and grass seed industry, which has grown from a few hundred pounds annual output to the present production scale of 127,000 pounds. The next few years will bring great challenges as the industry moves toward commercialization where market forces will become increasingly important. Market competition, demand-driven marketing strategies, higher quality requirements, and price competitiveness will affect the production and business decisions for all producers.

However, the market potentials for Minnesota's native seed industry can not be underestimated. Preliminary market research showed that the majority of the general public have very limited information or knowledge about Minnesota's native grasses and wildflowers and their uses or benefits. The 1992 Consumer Survey targeted a selected group of consumers who represented the new market niche, but the scale of the prospective markets exceed the current estimate. Presently, much of the market potentials for native plant species still remain untapped because of the lack of public recognition and awareness. Research findings revealed that a well-informed consumer -- a retailer, wholesaler, or individual -- tends to take a more positive and supportive position in native seed utilization and will most likely become a user. Continued public education and market promotion are essential in reaching a broader spectrum of the general public and potential users.

The commercial market will continue to expand if and when heightened public awareness and interest becomes the driving force in the market development.

There are other challenges facing the Minnesota's native seed industry, such as the competition of imported or non-Minnesota origin wildflowers and grasses, the confusion between "native" and "wild" seed species, and growers' concerns over possible excess-supply. These issues need to be addressed before the market potentials can be fully explored. However, the development of Minnesota's native seed production and utilization holds great promise for a new and viable agricultural industry.

B. 6. Benefits:

1. The market supply and demand will be assessed on state and regional levels providing usable information with which to attract investors and producers to this industry.

2. Estimates of potential market demand will be available for presently unknown areas such as homeowner use of wildflowers in ornamental plantings and farmer use of native grasses for pastures.

C. **Development of methods for testing of seed purity and viability and of standards for maintaining the diversity of individuals in a naturally occurring population of native germplasm when raised for seed.**

C. 1. Narrative: Laboratory testing methods to determine seed purity and viability are not available for many of the Minnesota native grasses and wildflowers. Seed marketed for use in Minnesota and other states must be labeled indicating the purity and viability. For producers to label their seed truthfully, they need test methods which they can rely on. The other part of this objective provides for the writing of cultural and isolation standards which will insure that the native grass and wildflower germplasm does not change when raised in controlled conditions for seed production.

C. 2. Procedures: a). The state seed laboratory in the Minnesota Department of Agriculture will conduct a literature review and propose testing methods which will provide accurate information for labeling purposes. The methods proposed will be adapted from those presently used on closely related species and those which have similar growth habits. The methods will be submitted to the national Association of Official Seed Analysts for peer review. b). The production of native grass and wildflower seed of Minnesota origin must be done in a way that will maintain the diversity of individuals within a naturally occurring population. The Minnesota Crop Improvement Association will use nationally developed seed production standards for these kinds of seed and adapt them to suit our needs.

C. 3. Budget:

Budget:	LCMR Funds
a. Amount Budgeted:	$25,000
b. Balance:	$ 4,100

C. 4. Timeline for Products/Tasks:

	July91	Jan92	July92	Jan93	June93
a. Literature review	X	X	X	X	
b. Potential testing methods identified	X	X	X	X	
c. Testing methods established				X	X
d. Potential certification standards identified			X	X	
e. Certification standards established				X	X

C. 5. Status: After reviewing the available literature for information on standardized testing methods for native grass and wildflower seeds, the state seed laboratory chose ten species to perform germination procedures on in this objective. A literature search for information regarding the testing of native grass and wildflower seeds continued for the duration of the project.

The original goal was to test ten species during the two year project period. However, due to the length of time, the number of replicates, the inability to procure sufficient quantities of pure seed, and the different procedures necessary to thoroughly examine each species, it was not possible to test every one. The list of species that were evaluated in this portion of the project are:

Koeleria macrantha	*Spartina pectinata*
Petalostemum Purpureum	*Verbena stricta*
Liatris pycnostachya	*Sporobolus heterolepis*

Zizia aurea

Due to the constraints listed in the previous paragraph, the following species were not evaluated but testing will continue independent of this project in an effort to work through the germination inhibitors and other problems peculiar to these three species in order to find a uniform testing method:

Petalostemum candidum
Amorpha canescens
Aster oolentangiensis

Inconsistent, variable germination response is typical of many native species and the results of this project are no exception. Individual seed lots can vary considerably in their response to identical test parameters. This situation resulted in the retesting of some species. Never the less, some tentative germination testing standards for a number of the species were achieved. In the short term, these methods will be very useful for in-house testing and in the long term, they hopefully can be used by other laboratories as well.

Testing of the species *Spartina pectinata* and *Koeleria macrantha* under various temperatures and treatments began and was completed prior to July, 1992. Those tests involved subjecting the seed of the two species to nine different prechill and wetting agent methods and each combination was tested at five different temperatures (45 tests involving 18,000 seeds). During this same period, another species, *Petalostemum purpureum*, was initially tested under six different methods and five different temperatures. This species has undergone two additional treatments in the July 1, 1992 to January 1, 1993 period. Physical scarification of the seed greatly improved the germination of the *Petalostemum purpureum* seed.

The germination results have been summarized for the testing done on the seven species tested and they are contained in **Table 16** of the appendix. Each species tested will be discussed individually in the following paragraphs:

<u>Koeleria macrantha (cristata)</u> - Prairie June grass. It grew quite satisfactorily under any regime we exposed it to. We chose one temperature and prechill setting that seems to be optimum. In previous years, we have been unable to initiate any growth without a prechill. This seed lot did not require a prechill to achieve nearly optimum germination.

<u>Spartina pectinata</u> - Prairie cord grass. This species usually grows very well with germination percentages in the 80 to 90 percent range. Evidence of heavy damage from an insect was apparent in this lot. It may also have contained fungal pathogens or had immature caryopses. The reasons for poor performance in these trials was not as important as determining a standard testing technique that would give a reliable result no matter what the condition of the lot. Even with the deficiencies noted,

germination was better under some conditions.

<u>Petalostemum purpureum</u> - Purple prairie clover. This species responded dramatically to physical scarification. This is a logical result since hard seed is a characteristic of the *Fabaceae.*

<u>Verbena stricta</u> - Hoary vervain. Getting a germination response from this species is always a problem due to a inherent high level of dormancy. Nothing we subjected the seed to gave really satisfactory results. The longest prechill period yielded the best response. Perhaps a longer period of prechill might prove to be even better. Quick turn around in testing is an advantage for marketing. Long prechills significantly lengthen the time needed for testing and would delay the marketing.

<u>Liatris pycnostachya</u> - Tall blazing star. Many samples of this species have had damage to the radical end of the seed resulting in abnormal root development. Overzealous harvesting and cleaning may be the cause. Few problems were noted in this lot of seed and it performed much as expected. Trials without gibberellic acid treatment yielded a poorer response than is usually observed.

<u>Sporobolus heterolepis</u> - Prairie dropseed. Initial testing yielded unusable results because the seed lot involved had poor seed quality. Another sample was obtained from a different lot and another series of the same tests were run. Good results were achieved from testing the second lot.

<u>Zizia aurea</u> - Golden alexander. Lower than hoped for germination responses were encountered.

Due to a high degree of innate variability within a species caused by a host of genetic and environmentally induced factors, achieving identical germination responses can be problematic at times. This is why it is necessary to replicate selected optimums many times by as many independent laboratories as possible to insure reproducible results. This is sometimes a difficult task since the cooperation of other laboratories is necessary. Other seed laboratories don't always have the time or the resources to comply with the requests for cooperation. Developing a uniform testing method can sometimes take several years as a result.

The following describes the methodology used in this portion of the project:

1. Every sample was germinated on two standard germination blotting papers and placed in transparent plastic boxes measuring 5.50 X 5.25 inches and 1.0 inch deep. The wetting agents for the blotters were either potassium nitrate (KNO_3), gibberellic acid, or de-ionized water. The blotters were soaked in the wetting agent and excess water was drained off prior to planting according to the Association of Official Seed Ana[illegible] (AOSA) Rules for Testing Seeds. One hundred seeds w[illegible] placed on each

blotter and there were four replicates for each variable tested. The results for each variable tested were derived from averaging the results from the four replicates in each test.

2. The plastic boxes containing the seeds were placed in various germinators set at the prescribed static or alternating temperatures listed in the charts in **Table 16** of the appendix. Each germination chamber was equipped with lights and set to a cycle of 16 hours of light and 8 hours of dark every day. The lighted period coincided with maximum temperature. Temperatures were maintained to within +/-2° Celsius.

3. Seed to be prechilled is placed on blotter paper media in plastic boxes in the same manner as all other replicates and the boxes are placed in a chamber that maintains a constant temperature of 5° Celsius for the prescribed time period.

4. The 24 hour freeze was accomplished by placing the seeds on a moistened substrate (blotter paper media) and put into a freezer. After the 24 hour freeze, the boxes containing the seeds were put into the appropriate germinators.

5. Seed subjected to the hot water treatment was placed in beakers and boiling water was poured over them until they were completely covered. The seed was soaked in this water for 30 minutes, placed on the germination media (blotter paper), and then placed in their appropriate germinators.

6. Scarification was accomplished by placing each one hundred seed replicate to be abraded between stationary and hand held blocks of wood wrapped in sandpaper. Special care was taken to prevent damaging or destroying the seeds by applying too much pressure to the blocks. Periodic examination of the testae under magnification was done to insure that the seeds were being properly scratched.

7. The clipping of the distal end of *Verbena* seeds was done with a surgical scalpel. Care was taken to avoid damaging the cotyledons because abnormalities would then be difficult to spot in the seedlings. Nicking the testa of *Zizia* was done in much the same manner, except that the precise location of the cut on the seed was not a consideration.

8. Acid scarification was accomplished by just covering the tops of seeds placed inside specimen vials with a 1% concentration of hydrochloric acid for a period of one hour. The seed was then rinsed with water and placed on the germination media.

This portion of the project has produced the following proposed test specifications for the seven species on which work was completed:

Koeleria macrantha (cristata)
Temperature: 15-25° Celsius, 5 day prechill.
Potassium nitrate (KNO_3) treatment.

Spartina pectinata
Temperature: 10-30° Celsius, no prechill.
Water treatment.

Petalostemum purpureum
Temperature: 15-25° Celsius.
Scarify physically.
Potassium nitrate (KNO_3) treatment.

Verbena stricta
Temperature: 10-30° Celsius, 28 day prechill.
Gibberellic Acid treatment.

Liatris pycnostachya
Temperature: 20-30° Celsius, 5 day prechill.
Gibberellic Acid treatment.

Sporobolus heterolepis
Temperature: 20-30° Celsius, 14 day prechill.
Water treatment.

Zizia aurea
Temperature: 10-30° Celsius.
Mechanical scarification or a double 5 day prechill with a 7 day warm interval.
Water treatment.

Efforts will continue after the end of this project on the seven species involved and others as time permits to cooperate with the Association of Official Seed Analysts for referee testing of the methods. The methods, once approved by the AOSA, will be available to all seed laboratories for testing to determine the viability of native grass and wildflower seeds.

Work has started on writing certification type standards for the production of native grass and wildflower seeds. Due to the recent illness of one of the project cooperators, Dr. Harley Otto, this part of this objective will not be completed until August 1. Preliminary indications are that many of the species involved are too diverse genetically to fit the commonly accepted definition of a variety. The seed certification program is based upon certifying varietal purity. As a result, a different approach may be used called "source identified" to formulate production standards that will maintain the population diversity desired. This same approach was devised and is currently being used for native production tree seed in Minnesota.

C. 6. Benefits: a). The establishment of seed testing methods for purity and viability will focus industry competition on seed quality through truthful labeling. Consumers will benefit from being able to rely on truthful labeling when choosing seed that will meet their needs. b). The certification of seed produced from commercial native grass and wildflower plantings will provide a means of verifying origin and that the natural diversity of the germplasm is maintained.

IV. Evaluation: During the FY 92-93 biennium, the program can be evaluated based upon whether or not the product timelines are met. Meeting the timelines will indicate that the individual tasks proposed in this report have been completed. At the end of the biennium, the final report will provide the information needed to encourage an increase in native grass and wildflower seed production. The ability of the information provided in the final report to meet this need can be evaluated at that time.

In the longer term, a significant increase in quality and amount of native grass and wildflower seed can be used as an indicator of the success of the program.

V. Context:

A. Little if any work is being done to generate the technical information needed for new growers to produce native grass and wildflower seed in Minnesota. This is not a typical agricultural, vegetable, or flower seed crop which means the normal research and promotion interests are not involved. Most of the native grass and wildflower seed production now taking place is not in Minnesota and Minnesota native germplasm is not being utilized.

B. The work proposed in this program is aimed at providing the information necessary for this segment of the seed industry to attract new investment.

C. The work that has been done to develop the information needed by this segment of the seed industry has been done on too few species and in most cases it has not been done in Minnesota and on Minnesota native germplasm. Individuals and businesses motivated by profit only have sought those species which are easy to raise and which could be sold in many states. Unfortunately many of these species are not even native to Minnesota or North America. There have been no past proposals to the LCMR addressing this need and there are not presently any plans for future ones.

D. Not applicable.

E. Biennial Budget System Program Title and Budget: Not Applicable.

VI. Qualificatic

1. Program Manager:
Charles G. Dale, Supervisor
Seed and Noxious Weed Section
Agronomy Services Division
Minnesota Department of Agriculture

B.S., Agronomy and Soil Science, University of Minnesota, 1971

Mr. Dale has supervised the seed regulatory program for Minnesota since 1978 and in 1983, he played a lead role in the complete revision of the state seed law. He is the immediate past president of the American Association of Seed Control Officials and currently serves as chairman of the associations Planning and Development Committee. Mr. Dale's primary role will be as program manager and to oversee work conducted under part of Objective C.

2. Major Cooperators:

A. Dr. Anne M. Hanchek
Assistant Professor, Department of Horticultural Science
Extension Environmental Horticulturist, Minnesota Extension Service University of Minnesota

Ph.D., Horticulture, Michigan State University, 1989
M.S., Botany/Plant Ecology, University of North Carolina, 1984
B.A., Biology/Botany, Northern Michigan University, 1980

Dr. Hanchek specializes in environmental horticulture for consumers and in herbaceous plants. Her doctoral research focused on techniques and problems in commercial production of herbaceous perennials. Her master's work assessed the effect of microclimate on distribution of Michigan wildflowers. In Minnesota, she acts as a leader in home horticulture programming for the Extension Service and State Coordinator for the Master Gardener program. Her primary role will be to participate in objective A.

B. Sue Ye
Agricultural Marketing Specialist
Marketing Division
Minnesota Department of Agriculture

M.S., Agricultural Economics, University of Minnesota, 1987

As a trained agricultural economist, Ms. Ye administers market research programs for the Marketing Division, Department of Agriculture. Her background includes working for the Chinese government and the United Nations with duties ranging from policy ar 'onomic analysis to market research for primary agricult commodities. She joined the Department of Agriculture in 1987 and has since conducted various market research projects for Minnesota's agricultural and food products. Ms. Ye is a member of the American Association of Agricultural Economists. Her primary role will be to perform the tasks in Objective B.

C. Dr. Mark Strefeler
Assistant Professor, Department of Horticultural Science, University of Minnesota

Ph.D., Pomology (Breeding & Genetics), Cornell University, 1989
M.S., Horticultural Science, North Carolina State University, 1985

Dr. Strefeler has refereed publication and has conducted research in the areas of population and quantitative genetics, molecular biology and genetics using both cultivated plant species and wild germplasm.

Current projects include the genetic characterization of invasion purple loosestrife populations in Minnesota and possible insights on how they may be controlled, the genetics of fuchsia and rose, and the use of molecular markers to study the genetic structure of plant species. Besides research, he has experience in horticulture production and the use of plants in interior and exterior landscaping. Dr. Strefeler's primary role will be to characterize the genetic diversity of wild germplasm and to develop cultural management practices which will maintain this diversity in the foundation seed plantings used to provide commercial wildflower seed in Minnesota. These tasks are in Objectives A and C.

D. Other Contributors

1. Dr. Harley J. Otto
   Executive Vice President
   Minnesota Crop Improvement Association

2. Chris Hanson
   Administrator
   Center For Alternative Plant and Animal Products
   University of Minnesota, St. Paul Campus

3. Peter Buesseler
   State Prairie Biologist
   Scientific and Natural Areas Program

4. Sarlyn Ziegler
   Seed Analyst Senior-Purity
   State Seed Laboratory
   Laboratory Services Division
   Minnesota Department of Agriculture

5. Michael Muggli
   Supervisor State Seed Laboratory
   Laboratory Services Division
   Minnesota Department of Agriculture

6. Bonnie Harper-Lore
   Program Coordinator
   National Wildflower Research Center -Midwest

VII. <u>Reporting Requirements</u>

Semiannual reports will be submitted not later than January 1, 1992, July 1, 1992, January 1, 1993 and a final status report by June 30, 1993.

July 1, 1993 Final Status Report

DATE OF REPORT: LY 1, 1993

LCMR Final Status Report - Summary Version - Research

I. Native Grass and Wildflower Seed

Program Manager: Charles G. Dale (612) 296-6123
Minnesota Department of Agriculture
Agronomy Services Division

A. Legal Citation M.L. 1991 Chapter 254, Article 1, Section 14, Subdivision 6(e).

Appropriation $130,000
Balance $ 4,100

Native grass and wildflower seed. This appropriation is to the Commissioner of Agriculture in cooperation with the Commissioner of Natural Resources to develop the varietal, cultural, and market information necessary to encourage expanded commercial production of Minnesota origin native wildflower and grass seed.

B. Compatible Data: The information collected during the biennium ending June 30, 1993, from projects funded under this section that have common value for natural resource planning and management and for various agricultural production systems will be in a format that can be adapted for use by other public agencies, private organizations, and individuals. The expense of integrating the information into other data management systems will be the responsibility of the agency, organization, or individual receiving the information.

II. Narrative

This program is designed to develop germplasm, cultural, and market information needed to promote an increase in production of native grass and wildflower seed. Current demand for these kinds of seed far exceeds supply in both the quality and the number of species available for public and private use. Technical information on how to produce seed from selected species and market information are needed in order for potential growers to decide whether or not they should invest in the production of these kinds of seed.

III. Objectives

A. **Development of germplasm and cultural information.**

A. 1. Narrative: Developing methods which can be used to produce seed from native grasses and wildflowers along with methods by which the diversity of individuals in a naturally occurring population can be maintained are problems to be solved in this part of the project. The Center for Alternative Plant and Animal Products will review and evaluate new and existing information and methods in order to develop guidelines for growers to produce and maintain diversity in

native grass and wildflower seeds. The information resulting from this objective will also be presented at scientific meetings and in professional journal papers.

A. 2. Procedures: Existing information on commercial production of approximately 25 species of native grass and wildflower seed will be reviewed and current practices evaluated under controlled conditions. Native germplasm will be collected and evaluated for several genera. Germplasm diversity of a model grass and model wildflower will be assessed between and within regions of the state and compared to commercially available seed. The results will be summarized in guidelines to commercial producers, addressing production techniques, seed and seedling identification, and maintenance of germplasm diversity. The systems developed in this objective will act as models for future research.

A. 3. Budget: LCMR Funds
a. Amount Budgeted: $70,000
b. Balance: $ 0

A 4. Timeline for Products/Tasks:

	July91	Jan92	June92	Jan93	June93
a. Literature review		X	X	X	X
b. Establish species list	X	X			
c. Identify production practices	X	X	X		
d. Characterize populations	X	X	X	X	
e. Evaluate production practices	X	X	X	X	X
f. Develop production guidelines					X
g. Prepare seed identification materials		X	X	X	X
h. Collect germplasm	X	X	X	X	X

A. 5. Status: Two graduate students joined the project under the guidance of Drs.Hanchek and Strefeler. They have made many trips to collect seeds and visits to producers, and will continue to do so. Seeds of over 28 species and/or varieties from 50 sites have been collected for use in preliminary propagation trials, detailed studies, and genetic research. Each collection is labelled to keep populations distinct. Not all species collected are included in the detailed research. The students have also attended conferences on native plants (one gave a paper at the 1992 North American Prairie Conference) and participated in the development of a growers group. This group formed after discussion between Dr. Hanchek and Jack Johnson of AURI.

Literature Review

The task of reviewing the literature began in August 1991, well ahead of schedule, and has continued throughout the project. Insufficient documentation of production methods exists in the scientific literature, despite many popular press articles, and what does exist is scattered widely throughout journals, conference proceedings, and monographs. In June of 1992, another graduate student, Eleanor Congdon, was engaged as hourly help, primarily for the literature review. Since her background is history, and thus library research, her help has greatly increased our ability to gather information.

The current bibliography has over 1085 entries entered into a commercial bibliographical database called Papyrus 7.0, created by Dave Goldman for Research Software Design of Portland Oregon. Citations include articles, books, conference proceedings, theses, and pamphlets. Each entry lists pertinent information such as year, author, title, publisher, etc. Where applicable, the call numbers assigned by the University of Minnesota Library system are included so that the citation may be reviewed by interested readers.

The bibliography's function is not only to find as many citations as possible concerning native plants and growth practices relating to them, but also to extract that information as needed. One third of the citations have appended abstracts, and 250 have more detailed notecards that give specific information concerning production procedures or requirements for plants native to Minnesota. The full bibliography will be available through the Center for Alternative Plant and Animal Products, and may be published in a format yet to be determined.

Species List

There are actually several different lists, each based on different criteria. Unfortunately, not many plants can be used to study a genetic problem and a specific production problem and at the same time be the commercially most attractive and environmentally most interesting. For the production portion of the research, the species list has been developed through input from two sources. In collaboration with the bibliography, a species list was created by indexing Ownbey and Morley's Vascular Plants of Minnesota according to scientific name, but excluding ferns, woody plants, and introduced species, while including information on each plant's status on the State Noxious Weeds List, the State Endangered Plants List, and the State Protected Plants List. In addition, suggestions were solicited from producers by Julia Bohnen.

Development of recommended production practices has included both the results of our experimental research and material found during the literature review. Details on specific plants are being collated into a computerized database and can be accessed as a Lotus 123 spreadsheet. As a result, 1303 plants will be listed, for which available information is given on topics such as fruiting structure, time of harvest, seed storage requirements, seed treatments, asexual propagation methods, production treatments for established plants, a plant's preferences for soil, moisture, a[illegible]ght, root structure, and genetic information. All details in [illegible]spreadsheet are

accompanied by a reference number which refers to the source of the information in the bibliography. A total of 44 columns for different types of information, and for references, have been set up in the spreadsheet. This database also shows that much information is lacking for many of Minnesota's native plants. The spreadsheet will be available to the public through the Center for Alternate Plant and Animal Products, and it may be published through them in a format yet to be determined.

Seed and Seedling Identification

Seed and seedling identification guide materials are being prepared. Development of this resource has continued to the end of the grant period. Several sets of slides will be available from the University of Minnesota Extension Service Distribution Center.

Production Practices

To identify successful production practices, site visits were made to several Minnesota producers. Generally it was observed that successful producers are innovative individuals with the ability to apply agricultural and horticultural skills and techniques to the diverse palette of native plants. Some specialization has occurred, with some of the producers focusing on production of grasses, while others may produce only native wildflowers. Agricultural engineering skills also prove useful as the diverse plant forms and growth habit make seed harvesting and processing a challenge. A detailed survey summarized in February 1992 compiled information about production facilities and products being marketed.

As part of the evaluation process for production standards, growers were consulted. We learned that standard horticultural techniques can be used successfully with the majority of our native plants. Greenhouse trials have been underway since August 1991, and formal trials examining the effects of stratification, scarification, and after-ripening are ongoing. Special emphasis is being placed on *Spartina pectinata, Lilium philadelphicum, and Phlox pilosa* (one grass, one non-grass monocot, and one dicot). The effect of gibberellic acid (GA) in enhancing rate and uniformity of germination has also been examined. We have found that all of these treatments can be effective on native plants, but the application is highly species dependent. Our results, obtained under conditions similar to those of some producers, are very encouraging.

The often impervious seed coat of legumes usually needs to be damaged or worn in some way to allow gases and water to enter or to reduce the mechanical pressure on the embryo so that germination can proceed. In trials comparing scarified versus not scarified seed, physical scarification of several leguminous species has resulted in 22 - 83 percent germination. Non-scarified seed had from less than one to 63 percent germination.

For some species, grasses in particular, a period of after-ripening is required. During the after-ripening period, physiological processes occur bringing the seed nearer a state in which it is able to germinate [illegible] length of the after-ripening period varies for different s[illegible]s, but usually involves storage for two months or longer after harvest.

Many of our native species require a cold moist period to promote germination. Several approaches can be used to accomplish chilling treatment. Some producers sow their seed outdoors and allow nature to take its course. Refrigeration can simulate winter under more controlled conditions. Stratification treatments consisted of 4 to 12 weeks on moist blotter paper in petri dishes in the 1992 trials or in moistened germination medium for the 1993 trials. Germination can be adversely affected, however, by too much cold moist stratification as well as too little.

Gibberellic acid may be effective in circumventing other more time-consuming treatments, and can substitute for cold moist stratification in many instances. However, over-exposure to GA can cause plant growth abnormalities such as excessive elongation which could potentially affect the salability of the plant or its establishment upon transplanting. Appropriate GA concentrations and treatment lengths were examined for several species.

For many species, it is unlikely and probably biologically undesirable that 100 percent germination occurs in a very short period of time. Due to variability within a population, seed will germinate over a sometimes much extended time frame. Uniformity of germination is important in plug production from seed. Increased uniformity occurs when more seeds germinate in a shorter time frame. Optimum uniformity can be achieved by applying the appropriate treatment to the seed. However, germination results for two populations of a species may vary depending upon inherent physiological differences and upon environmental conditions prevailing at the site of origin. Results from the germination trials will be available after the data has been analyzed and summarized.

In some instances, seed germination may not be the factor most limiting to native plant production. Many growers commented in the surveys on small quantities of seed produced by different species. Can cultivation improve quantity and quality of seed yield? Is insect predation on seeds a major problem? Can we document and examine seed production? Field plots established at the Minnesota Landscape Arboretum are addressing these questions. Individual plants of *Spartina pectinata, Tradescantia ohiensis, and Petalostemum purpureum* (one grass, one non-grass monocot, and one dicot) are being monitored for seed yield and factors affecting it. At the same time, transplants from the prairie are being monitored similarly while growing in cultivated field conditions near the prairie.

Preliminary data suggest that simple field cultivation can increase seed yield and/or vegetative growth in certain native species. Seed yield in *T. ohiensis* was increased dramatically in cultivation within the first season of transplanting. *S. pectinata* did not flower in either the prairie or the cultivated plot, probably due in part to the unseasonably cool weather during the 1992 growing season. *P. purpureum* flowered in both treatments; however, flowering occurred too late in the cultivated plot for seed to fully develop before the growing season was interrupted by a hard frost. In both the cultivated *P. purpureum* and *S. pectinata*, substantial vegetative growth was realized in the first growing season. This study will, of necessity, continue through the 1993 growing season to allow a second year of data to be collected. The work described here forms Julia Bohnen's master's thesis and will be presented in detail with full analysis and peer review in her thesis manuscript and defense, planned for late fall of 1993.

Characterize Populations

Seeds of the species for genetic diversity research were collected in 1991 and 1992 and germinated in the greenhouse. The goal is to obtain at least 25-30 plants of each of the collected populations. The populations are then characterized in three ways:

1. Seedling tissue and leaf tissue is analyzed using isozyme analysis. The resulting banding patterns show if there are genetic differences within and between populations. Some of the isozymes used were: ACP, ADH, EST, G6PDH, GDH, GOT, IDH, MDH, PRX, PGI, PGD, and PGM.

2. Morphological differences within and between populations grown in the greenhouse were observed. These include number of flowers, number of leaves, height, number of stems (grasses only), and time of flowering.

3. Morphological differences within and between populations grown in the greenhouse and later transplanted into the field were also observed.

Genetic Diversity Research

Grasses

Andropogon gerardii

1) Morphological Differences.
Several populations were grown in the field in the summer of 1992 and the following characteristics were observed and recorded; plant height, number of stems and number of inflorescences. Within populations, there was variability observed in all characteristics studied. The highest variability was observed in plant height, followed by both the number of stems and inflorescences. Between populations, there was little or no difference in the means observed for both shoot and inflorescence number. It was also noted that the time of anthesis and senescence (stem discoloration) varied within populations.

2) Isozyme Analysis.
Preliminary results of starch gel electrophoresis indicate that there is little genetic variation within the populations. Isozyme analysis will be completed this summer.

Schizachyrium scoparium

1) Morphological Differences.
The same characteristics were observed and recorded as in *Andropogon gerardii*. Within populations, there was variability in all characteristics. Inflorescence number showed the most variability and the least variability was observed for plant height. Between populations, there was variation in mean shoot and inflorescence number and very little variation in mean plant height. There was also variation in time of anthesis.

2) Isozyme Analysis.
Starch gel electrophoresis indicates so far that there is little genetic variation within the populations.

<u>Forbs</u>

Monarda fistulosa.

1) Morphological Differences
Despite several germination attempts, plants died in the greenhouse and no field data could be collected. However, this summer several populations will be grown again in the field.

2) Isozyme Analysis.
Because of difficulties during laboratory procedures, the results are still inconclusive.

Liatris spp.

1) Morphological Differences.
Several populations of *Liatris aspera*, *Liatris ligulistylis*, *Liatris punctata*, and *Liatris pycnostachya* were grown in the field and the following characteristics were observed and recorded; number of leaves, leaf length, leaf width, and dry weight of the aboveground plant parts. There was variation within the populations for all characteristics with the most variability observed for leaf number. Little variation was observed between populations in number of leaves, length, width and dry weight.

Floral traits will be evaluated this summer and fall, the first season of flowering for these seedling populations.

2) Isozyme Analysis.
Isozyme polymorphisms in *Liatris* was observed for the following isozymes: Acid phosphatase (ACP), Alcohol de 'rogenase (ADH),

Aspartate aminotransferase (AAT), and Phosphoglucomutase (PGM). This indicates that isozyme diversity exists with populations of *Liatris* and hence, genetic diversity for these enzymes in these populations.

Continuation of Genetic Diversity Research

1) Morphological Differences.
About 30 individuals from each population will be grown again in two field locations (St. Paul and Morris, MN) for this summer. Additional populations will be grown from seed collected not only in Minnesota, but also from neighboring states. Similar characteristics will be observed and recorded by late September to early October. At the end of the growing season plants will be removed from the field and overall dry weight will be recorded. The St. Paul field will be used to obtain a two-year data (1992 and 1993) while the Morris location will just provide one-year data (1993 only).

2) Isozyme Analysis.
Starch gel electrophoresis will continue through this summer. Leaf tissue will be collected from both locations, St. Paul and Morris, for the analysis.

Cultural management practices for maintaining genetic diversity

As soon as all the data from the field observations and the isozyme analysis are completed more detailed recommendations on management of seed production practices will be forthcoming.

General Conclusions for all species in this study

The preliminary results show that genetic diversity is greater within local populations than between populations. This is common in many natural populations of plants and animals. The significance of these results is that seed from fairly large geographical areas (> 200 mile radius) can be intermixed or planted throughout a region without significantly or permanently altering the genetic integrity of natural populations in that region. It may even be possible to plant seeds from the species examined in this study anywhere in the state regardless of its point of origin, without any negative impact on natural populations.

Management of genetic diversity in seeds will best be achieved by collecting seeds from several populations in distinct areas within a given region and using these as the foundation plantings for seed production. This approach will maximize genetic diversity in the source population and reduce genetic drift. Limiting seed collection and distribution to a small geographical area would increase the effects of genetic drift and dec' ; the genetic diversity in the seed produced. The resultan ntings may then have a negative impact on natural populations in the vicinity.

These recommendations are based on a limited amount of genetic information and are only preliminary in nature. Upon completion of this study we will have a good base to make recommendations but more work on the genetics of these and other species are needed to insure that proper methods of collection, production and distribution are used to minimize the impact of future plantings on natural populations.

Finally, we feel it is vital that a practical and objective set of guidelines are developed. These should be sound for the environment and economically feasible for the producers; otherwise any effort in this area will prove futile. The State of Minnesota needs to find ways to promote production of native plants in a commercial setting. The alternative and current practice of collecting seeds from the wild will ultimately result in adverse affects on natural populations and increase their vulnerability to the loss of species in the future.

Kerstin Concibido's master thesis will deal with the population genetics of *Liatris* spp. in Minnesota.

A. 6. Benefits:

a. The information developed by this objective can be used by anyone who is interested in producing Minnesota origin native grass and wildflower seed resulting in a supply which is closer to meeting demand.

b. Existing stands of native grasses and wildflowers will suffer less unregulated seed harvest because supplies will be commercially available.

c. The quality of plantings of native species along roadside and on other public lands will increase significantly if these seeds are more rapidly available.

d. Models developed in this objective will be applicable to other research into native grasses and wildflowers.

B. **Assess present supply and demand of native grass and wildflower seed, analyze the scale potential of Minnesota's native origin seed industry and future market demand.**

B. 1. Narrative: An inventory of present supply and demand of native grass and wildflower seed must be ascertained to encourage appropriate levels of public and private investment. The focus of this objective is to collect and examine primary information and data on the native grass and wildflower seed industry, and make them available for use by the interested public including present and potential producers, consumers, and investors.

B. 2. Procedures: Producer and consumer surveys will be conducted to: 1) determine the current production and consumption level and geographic distribution of seed source and destination, and 2) identify present and prospective producers and consumers. Market information and data will be collected through telephone and/or in-person interviews and mail responses. A customized database will be developed and maintained to better manage the available industry data. Results of the survey will be entered into the database for processing and analysis.

B. 3. Budget

Budget	LCMR Funds
a. Amount Budgeted:	$35,000
b. Balance:	$ 0

B. 4. Timeline for Products/Tasks:

	July91	Jan92	June92	Jan93	June93
a. Producer and Consumer Survey	X	X	X	X	
b. Prepare collected data and establish database	X	X	X	X	
c. Review and analyze results			X	X	
d. Final report				X	X

B. 5. Status: The native grass and wildflower seed producer and consumer surveys have been completed and the survey data was analyzed and summarized by research staff. A computer database was also set up through the Marketing Division's Agri-Source network to list all native seed producers in Minnesota and relevant production information including location, species, seed production catalogs, etc.

The producer and consumer surveys provided major research findings in regard to Minnesota's current and potential native seed market. Detailed information is outlined in the research report entitled "A Market Assessment of Minnesota's Native Wildflower and Grass Seed Industry". The highlights of the research can be summarized as follows:

Production and Supply

Minnesota's native seed industry has been growing at an annual rate of 20-30% during the last few years and provides approximately $10 million in sales revenues per year to the state's overall economy. This figure includes sales of seeds, seedlings and plants, and earnings from service contracts for seeding, planting, land preparations and related consultation work. Currently, Minnesota's native wildflower and grass seed production are estimated at 127,000 pounds a year, of which 96% were grass seeds and 4% were wildflower seeds. The production is composed of two types: cultivated production and wild collection. More than one half of the commercially available seeds come from cultivated productions while the rest is made up by wild collection.

About one-third of producers devote full time to native seed production, 55% devote part time, and 10% are hobby farms. The majority of producers have been in native seed production for less than five years and have small size operations involving 30 acres or less of production land.

Commercial production of native seeds takes place in 25 counties across the state, with an estimated 2,000 plus acres of production fields and wild collection sites. Production is concentrated in the southern part of the state.

Over 300 native seed species are currently available in the market. The best selling grass species include (in descending order): Switchgrass (*Panicum virgatum*), Big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), Side-oats grama (*Bouteloua curtipendula*). The best selling wildflowers are Purple prairie clover (*Petalostemum purpureum*), Maximillian sunflower (*Helianthus Maximiliani*), Leadplant (*Amorpha canescens*), and Yellow coneflower (*Rudbeckia hirta*).

Production costs are significantly different from producer to producer, ranging from $300 to $1,000 per acre for grasses and $1,000 to $10,000 per acre for wildflowers. This depends on many variables such as land conditions, species grown, cultivation methods, intensity of labor, as well as the grower's experience and expertise in native seed production.

Minnesota's native seed market consists of wholesale, retail, government purchase, growers' in-house use, and out-of-state sales. Sixty-eight percent of Minnesota-grown native seeds are sold within the state, while 32% are exported to Iowa, North and South Dakota, Wisconsin, Illinois and Canada. In the Minnesota market, wholesale holds a 31% market share, retail - 27%, government purchase - 32%, and growers' in-house use - 10%. Fifty-one percent of seed production is marketed within 100 mile radius of origin, while only 17% of seeds are sold beyond a 200 mile radius.

Native grass and wildflower seeds carry an extremely broad price range because of the various pricing factors for each specific species, such as production cost, quantity produced in a particular year, and consumer demand. The medium price comes to $10.00 per pound for all grasses and $110 per pound for all wildflowers.
Producers identified some major obstacles to native seed production expansion: lack of financial resources or production loans, unavailable technical assistance, market constraints (such as lack of market information, undefined consumer needs, market fluctuations, and uncertainty about the future's market), consumer education, and state pol nitiatives.

Consumption and Demand

Minnesota currently consumes 97,000 pounds of native wildflower and grass seeds per year, of which 72% are grasses and 28% are wildflowers. In comparison, Minnesota's native seed production has a 96% grasses and 4% wildflowers ratio mix. There is a discrepancy between market supply and demand, which may be the cause of confusion in the marketplace due to different expectations of producers and consumers. Minnesota also supplies approximately 40,640 pounds of native seeds to non-Minnesota buyers each year.

Native seed utilization in Minnesota has five main categories: 1) residential and commercial landscaping - 47%; 2) parks and recreation projects - 13%; 3)roadside and highway construction - 11%; 4) land improvement and set-aside acres - 10%; and 5) seed production and miscellaneous uses such as resale - 19%.

An estimated two-thirds of native seed users are geographically concentrated in central Minnesota, especially around the seven-county metro area. The remainder are located in southern Minnesota (19%), and northern Minnesota (15%).

The survey reported that Minnesota consumers prefer to use 100% locally grown species. But due to various reasons such as seed availability and prices, they may also purchase non-native species from other states. In the marketplace, Minnesota's growers supply over two thirds of all wildflower seeds purchased, while the rest comes from non-Minnesota sources. However, local growers provide a larger share of native grass seeds in the market, 90% compared to 10% of non-Minnesota grass seeds. Almost 80% of users purchase seeds from sources within a 100 mile radius; among them, half of the users buy seeds from within a 50 mile radius. Only 2% go beyond a 200 mile radius to purchase seeds.

Among non-Minnesota suppliers, Wisconsin ranks No. 1 with a 15% market share of non-Minnesota seeds, followed by, in descending order, North Dakota - 10%, Iowa -8%, Colorado - 8%, South Dakota - 5%, and Nebraska - 5%. Other suppliers also include Idaho, Indiana, Kansas, Michigan, Missouri, New Hampshire, New Jersey, Pennsylvania, and Vermont.

Within the user group, two thirds represented the commercial sector that is composed of wholesalers, retailers, service contractors and other business companies; one third were government agencies including federal, state, and county offices.

Traditionally, state and federal government agencies were predominant buyers and users of native prairie seed. However, commercial wholesale has become the most important segment of the native seed market because of the increased commercialization since the late)'s. The wholesale market includes a large number of vo. ; users such as general landscapers, nurseries and garden centers, and construction contractors, etc., who serve retail customers and other end-users through direct or service-related sales. They bring the highest sales volumes and have ready access to a growing clientele base. A typical wholesale customer is a business corporation with an interest in native prairie plants who also has the financial ability to pay premium prices for corporate office landscaping through a service contractor.

Commercial retail and mail order is another rapidly growing sector as more homeowners became interested in naturalistic landscaping and started growing wildflowers and native plants in home yards and gardens. This new consumption trend is a result of increased planting of wildflowers and grasses on public land and roadside and the previous education and promotional efforts by public and private supporters of native prairie plants. Even though retail market and mail order only involve small volume sales, they help achieve the highest product value and profit margin for producers and marketers, and will continue to bring increased market opportunities for native seed business.

Another popular form of retail is the on-farm sales that serve walk-in customers and farmers from neighboring communities. Most producers have on-farm sale outlets, enabling them to reduce overhead costs through direct marketing.

Government purchase ranks No. 3 in market share. Every year, the State of Minnesota purchases large quantities of native wildflower and grass seeds for highway construction projects, state parks and recreation area planting, wildlife habitat improvement, roadside planting, and other conservation management programs, such as RIM (Re-Invest in Minnesota). Even though the state purchases fluctuate each year because of budget changes, it has maintained an upward trend since the late 1980's.

Currently, the state also produces and harvests a portion of the native seeds it needs for various planting projects as a solution to budget constraints and inadequate supplies. It is unclear, at this point of time, what the long-term effect of government production will have on the commercial native seed in Minnesota. This topic requires further study and analysis for an in-depth and accurate assessment.

Approximately 15% of Minnesota counties, among a total of 87, are currently purchasing native wildflower and grass seeds for county highway construction, parks and other public land plantings. The number will increase in the next few years as more counties have expressed interest in using native species or are making plans to do so. But the process may be delayed due to various reasons such as limited funding and seed source.

The U.S. Fish & Wildlife Service of the U.S. Department of the Interior is also a long time user of native seeds. It produces and purchases native species for land

improvement projects for wildlife management and protection.

A species list has been compiled from the survey indicating all native species in demand in the market.

Consumers purchase native wildflower and grass seeds in different packaging forms and mixes. The survey results reported the following statistics:

Purchasing forms	Wildflowers	Grasses
Pure Seed by Pounds	23%	33%
Pure Seed by Ounces	16%	5%
Seed Mix by Pounds	55%	48%
Seed Mix by Ounces	30%	5%
Seedlings	18%	7%
Plants	9%	8%

Consumers also require specific processing standards for seeds. The following information shows different processing categories and the percentage of consumers requesting them:

Cleaned and Conditioned	47%
Tested	43%
Official Seed Certifying Agency Standards	61%

From the consumers' point of view, the utilization volume of native seeds can be much higher if the market supply can accommodate consumers' needs and expectations. The commercial market will continue to expand while heightened public awareness of the benefits of native seeds will be the driving force for the market development.

Minnesota roadsides occupy approximately 260,000 acres of state land, and this figure triples if counties and townships are included. Government purchase and use will remain strong in the future, even though available budgets may limit the rate of increase.

One noticeable development in the native seed industry was the service-related sales or the new value-added component of the native seed business. This includes the production of seedlings and plants, seeded sod, service contracts for seeding, planting, land preparations, post-installation management and consultation work. The value methods to determine seed purity and viability are not available for many of the Minnesota native grasses and wildflowers. Seed marketed for use in Minnesota and other states must be labeled indicating the purity and viability. For producers to label their seed truthfully, they need test methods which they can rely on. The other part of this objective provides for the writing of cultural and isolation standards which will insure that the native grass and wildflower germplasm does not change when raised in controlled conditions for seed production.

B. 6. Benefits:
1. The market supply and demand will be assessed on state and regional levels providing useable information with which to attract investors and producers to this industry.

2. Estimates of potential market demand will be available for presently unknown areas such as homeowner use of wildflowers in ornamental plantings and farmer use of native grasses for pastures.

C. Development of methods for testing of seed purity and viability and of standards for maintaining the diversity of individuals in a naturally occurring population of native germplasm when raised for seed.

C. 1. Narrative: Laboratory testing methods to determine seed purity and viability are not available for many of the Minnesota native grasses and wildflowers. Seed marketed for use in Minnesota and other states must be labeled indicating the purity and viability. For producers to label their seed truthfully, they need test methods which they can rely on. The other part of this objective provides for the writing of cultural and isolation standards which will insure that the native grass and wildflower germplasm does not change when raised in controlled conditions for seed production.

C. 2. Procedures: a). The state seed laboratory in the Minnesota Department of Agriculture will conduct a literature review and propose testing methods which will provide accurate information for labeling purposes. The methods proposed will be adapted from those presently used on closely related species and those which have similar growth habits. The methods will be submitted to the national Association of Official Seed Analysts for peer review. b). The production of native grass and wildflower seed of Minnesota origin must be done in a way that will maintain the diversity of individuals within a naturally occurring population. The Minnesota Crop Improvement Association will use nationally developed seed production standards for these kinds of seed and adapt them to suit our needs.

C. 3. Budget:

Budget:	LCMR Funds
a. Amount Budgeted:	$25,000
b. Balance:	$ 4,100

C. 4. Timeline for Products/Tasks:

	July91	Jan92	July92	Jan93	June93
a. Literature review	X	X	X	X	

b. Potential testing methods identified	X	X	X	X	
c. Testing methods established				X	X
d. Potential certification standards identified			X	X	
e. Certification standards established				X	X

C. 5. Status: After reviewing the available literature for information on standardized testing methods for native grass and wildflower seeds, the state seed laboratory chose ten species to perform germination procedures on in this objective. A literature search for information regarding the testing of native grass and wildflower seeds continued for the duration of the project.

The original goal was to test ten species during the two year project period. However, due to the length of time, the number of replicates, the inability to procure sufficient quantities of pure seed, and the different procedures necessary to thoroughly examine each species, it was not possible to test every one. The list of species that were evaluated in this portion of the project are:

Koeleria macrantha	*Spartina pectinata*
Petalostemum Purpureum	*Verbena stricta*
Liatris pycnostachya	*Sporobolus heterolepis*
Zizia aurea	

Due to the constraints listed in the previous paragraph, the following species were not evaluated but testing will continue independent of this project in an effort to work through the germination inhibitors and other problems peculiar to these three species in order to find a uniform testing method:

Petalostemum candidum
Amorpha canescens
Aster oolentangiensis

Inconsistent, variable germination response is typical of many native species and the results of this project are no exception. Individual seed lots can vary considerably in their response to identical test parameters. This situation resulted in the retesting of some species. Never the less, some tentative germination testing standards for a number of the species were achieved. In the short term, these methods will be very useful for in-house testing and in the long term, they hopefully can be used by other laboratories as well.

Testing of th :cies *Spartina pectinata* and *Koeleria macrantha* under \ us temperatures and treatments began and was completed prior to July, 1992. Those tests involved subjecting the seed of the two species to nine different prechill and wetting agent methods and each combination was tested at five different temperatures (45 tests involving 18,000 seeds). During this same period, another species, *Petalostemum purpureum*, was initially tested under six different methods and five different temperatures. This species has undergone two additional treatments in the July 1, 1992 to January 1, 1993 period. Physical scarification of the seed greatly improved the germination of the *Petalostemum purpureum* seed.

The germination results have been summarized for the testing done on the seven species tested. Each species tested will be discussed individually in the following paragraphs:

Koeleria macrantha (cristata) - Prairie June grass. It grew quite satisfactorily under any regime we exposed it to. We chose one temperature and prechill setting that seems to be optimum. In previous years, we have been unable to initiate any growth without a prechill. This seed lot did not require a prechill to achieve nearly optimum germination.

Spartina pectinata - Prairie cord grass. This species usually grows very well with germination percentages in the 80 to 90 percent range. Evidence of heavy damage from an insect was apparent in this lot. It may also have contained fungal pathogens or had immature caryopses. The reasons for poor performance in these trials was not as important as determining a standard testing technique that would give a reliable result no matter what the condition of the lot. Even with the deficiencies noted, germination was better under some conditions.

Petalostemum purpureum - Purple prairie clover. This species responded dramatically to physical scarification. This is a logical result since hard seed is a characteristic of the *Fabaceae.*

Verbena stricta - Hoary vervain. Getting a germination response from this species is always a problem due to an inherent high level of dormancy. Nothing we subjected the seed to gave really satisfactory results. The longest prechill period yielded the best response. Perhaps a longer period of prechill might prove to be even better. Quick turn around in testing is an advantage for marketing. Long prechills significantly lengthen the time needed for testing and would delay the marketing.

Liatris pycnostachya - Tall blazing star. Many samples of this species have had damage to the radical end of the seed resulting in abnormal root development. Overzealous harvesting and cleaning may be the cause. Few problems were noted in this lot of seed and it performed much as expected. Trials without gibberellic acid treatment yielded a poorer response than is usually observed.

Sporobolus heterolepis - Prairie dropseed. Initial testing yielded unusable results because the seed lot involved had poor seed quality. Another sample was obtained from

a different lot and another series of the same tests were run. Good results were achieved from testing the second lot.

Zizia aurea - Golden alexander. Lower than hoped for germination responses were encountered.

Due to a high degree of innate variability within a species caused by a host of genetic and environmentally induced factors, achieving identical germination responses can be problematic at times. This is why it is necessary to replicate selected optimums many times by as many independent laboratories as possible to insure reproducible results. This is sometimes a difficult task since the cooperation of other laboratories is necessary. Other seed laboratories don't always have the time or the resources to comply with the requests for cooperation. Developing a uniform testing method can sometimes take several years as a result.

The following describes the methodology used in this portion of the project:

1. Every sample was germinated on two standard germination blotting papers and placed in transparent plastic boxes measuring 5.50 X 5.25 inches and 1.0 inch deep. The wetting agents for the blotters were either potassium nitrate (KNO_3), gibberellic acid, or de-ionized water. The blotters were soaked in the wetting agent and excess water was drained off prior to planting according to the Association of Official Seed Analysts (AOSA) Rules for Testing Seeds. One hundred seeds were placed on each blotter and there were four replicates for each variable tested. The results for each variable tested were derived from averaging the results from the four replicates in each test.

2. The plastic boxes containing the seeds were placed in various germinators set at the prescribed static or alternating temperatures. Each germination chamber was equipped with lights and set to a cycle of 16 hours of light and 8 hours of dark every day. The lighted period coincided with maximum temperature. Temperatures were maintained to within +/-2° Celsius.

3. Seed to be prechilled is placed on blotter paper media in plastic boxes in the same manner as all other replicates and the boxes are placed in a chamber that maintains a constant temperature of 5° Celsius for the prescribed time period.

4. The 24 hour freeze was accomplished by placing the seeds on a moistened substrate (blotter paper media) and put into a freezer. After the 24 hour freeze, the boxes containing the seeds were put into the appropriate germinators.

5. Seed subjected to the hot water treatment was placed in beakers and boiling water was poured over them until they were completely covered. The seed was soaked in this water for 30 minutes, placed on the germination media (blotter paper), and then

placed in their appropriate germinators.

6. Scarification was accomplished by placing each one hundred seed replicate to be abraded between stationary and hand held blocks of wood wrapped in sandpaper. Special care was taken to prevent damaging or destroying the seeds by applying too much pressure to the blocks. Periodic examination of the testae under magnification was done to insure that the seeds were being properly scratched.

7. The clipping of the distal end of *Verbena* seeds was done with a surgical scalpel. Care was taken to avoid damaging the cotyledons because abnormalities would then be difficult to spot in the seedlings. Nicking the testa of *Zizia* was done in much the same manner, except that the precise location of the cut on the seed was not a consideration.

8. Acid scarification was accomplished by just covering the tops of seeds placed inside specimen vials with a 1% concentration of hydrochloric acid for a period of one hour. The seed was then rinsed with water and placed on the germination media.

This portion of the project has produced the following proposed test specifications for the seven species on which work was completed:

Koeleria macrantha (cristata)
Temperature: 15-25° Celsius, 5 day prechill.
Potassium nitrate (KNO_3) treatment.

Spartina pectinata
Temperature: 10-30° Celsius, no prechill.
Water treatment.

Petalostemum purpureum
Temperature: 15-25° Celsius.
Scarify physically.
Potassium nitrate (KNO_3) treatment.

Verbena stricta
Temperature: 10-30° Celsius, 28 day prechill.
Gibberellic Acid treatment.

Liatris pycnostachya
Temperature: 20-30° Celsius, 5 day prechill.
Gibberellic Acid treatment.

Sporobolus heterolepis

Temperature: 20-30° Celsius, 14 day prechill.
Water treatment.

Zizia aurea
Temperature: 10-30° Celsius.
Mechanical scarification or a double 5 day prechill with a 7 day warm interval.
Water treatment.

Efforts will continue after the end of this project on the seven species involved and others as time permits to cooperate with the Association of Official Seed Analysts for referee testing of the methods. The methods, once approved by the AOSA, will be available to all seed laboratories for testing to determine the viability of native grass and wildflower seeds.

Work has started on writing certification type standards for the production of native grass and wildflower seeds. Due to the recent illness of one of the project cooperators, Dr. Harley Otto, this part of this objective will not be completed until August 1. Preliminary indications are that many of the species involved are too diverse genetically to fit the commonly accepted definition of a variety. The seed certification program is based upon certifying varietal purity. As a result, a different approach may be used called "source identified" to formulate production standards that will maintain the population diversity desired. This same approach was devised and is currently being used for native production tree seed in Minnesota.

C. 6. Benefits: a). The establishment of seed testing methods for purity and viability will focus industry competition on seed quality through truthful labeling. Consumers will benefit from being able to rely on truthful labeling when choosing seed that will meet their needs. b). The certification of seed produced from commercial native grass and wildflower plantings will provide a means of verifying origin and that the natural diversity of the germplasm is maintained.

IV. Evaluation: During the FY 92-93 biennium, the program can be evaluated based upon whether or not the product timelines are met. Meeting the timelines will indicate that the individual tasks proposed in this report have been completed. At the end of the biennium, the final report will provide the information needed to encourage an increase in native grass and wildflower seed production. The ability of the information provided in the final report to meet this need can be evaluated at that time.

In the longer term, a significant increase in quality and amount of native grass and wildflower seed can be used as an indicator of the success of the program.

V. Context:

A. Little if any work is being done to generate the technical information needed for new growers to produce n[illegible] grass and wildflower seed in Minnesota. This is not a ty[illegible] agricultural, vegetable, or flower seed crop which means the normal research and promotion interests are not involved. Most of the native grass and wildflower seed production now taking place is not in Minnesota and Minnesota native germplasm is not being utilized.

B. The work proposed in this program is aimed at providing the information necessary for this segment of the seed industry to attract new investment.

C. The work that has been done to develop the information needed by this segment of the seed industry has been done on too few species and in most cases it has not been done in Minnesota and on Minnesota native germplasm. Individuals and businesses motivated by profit only have sought those species which are easy to raise and which could be sold in many states. Unfortunately many of these species are not even native to Minnesota or North America. There have been no past proposals to the LCMR addressing this need and there are not presently any plans for future ones.

D. Not applicable.

E. Biennial Budget System Program Title and Budget: Not Applicable.

VI. Qualifications:

1. Program Manager:
Charles G. Dale, Supervisor
Seed and Noxious Weed Section
Agronomy Services Division
Minnesota Department of Agriculture

B.S., Agronomy and Soil Science, University of Minnesota, 1971

Mr. Dale has supervised the seed regulatory program for Minnesota since 1978 and in 1983, he played a lead role in the complete revision of the state seed law. He is the immediate past president of the American Association of Seed Control Officials and currently serves as chairman of the associations Planning and Development Committee. Mr. Dale's primary role will be as program manager and to oversee work conducted under part of Objective C.

2. Major Cooperators:

A. Dr. Anne M. Hanchek
Assistant Professor, Department of Horticultural Science
Extension Environmental Horticulturist, Minnesota Extension Service University of Minnesota

Ph.D., Horticulture, Michigan State University, 1989
M.S., Botany/Plant Ecology, University of North Carolina, 1984

B.A., Biology/Botany, Northern Michigan University, 1980

Dr. Hanchek specializes in environmental horticulture for consumers and in herbaceous plants. Her doctoral research focused on techniques and problems in commercial production of herbaceous perennials. Her master's work assessed the effect of microclimate on distribution of Michigan wildflowers. In Minnesota, she acts as a leader in home horticulture programming for the Extension Service and State Coordinator for the Master Gardener program. Her primary role will be to participate in objective A.

B. Sue Ye
Agricultural Marketing Specialist
Marketing Division
Minnesota Department of Agriculture

M.S., Agricultural Economics, University of Minnesota, 1987

As a trained agricultural economist, Ms. Ye administers market research programs for the Marketing Division, Department of Agriculture. Her background includes working for the Chinese government and the United Nations with duties ranging from policy and economic analysis to market research for primary agricultural commodities. She joined the Department of Agriculture in 1987 and has since conducted various market research projects for Minnesota's agricultural and food products. Ms. Ye is a member of the American Association of Agricultural Economists. Her primary role will be to perform the tasks in Objective B.

C. Dr. Mark Strefeler
Assistant Professor, Department of Horticultural Science, University of Minnesota

Ph.D., Pomology (Breeding & Genetics), Cornell University, 1989
M.S., Horticultural Science, North Carolina State University, 1985
Dr. Strefeler has refereed publication and has conducted research in the areas of population and quantitative genetics, molecular biology and genetics using both cultivated plant species and wild germplasm.

Current projects include the genetic characterization of invasion purple loosestrife populations in Minnesota and possible insights on how they may be controlled, the genetics of fuchsia and rose, and the use of molecular markers to study the genetic structure of plant species. Besides research, he has experience in horticulture production and the use of plants in interior and exterior landscaping. Dr. Strefeler's primary role will be to characterize the genetic diversity of wild germplasm and to develop cultural management practices which will maintain this diversity in the foundation seed plantings used to provide commercial wildflower seed in Minnesota.

These tasks are in Objectives A and C.

D. Other Contributors

1. Dr. Harley J. Otto
   Executive Vice President
   Minnesota Crop Improvement Association

2. Chris Hanson
   Administrator
   Center For Alternative Plant and Animal
   Products
   University of Minnesota, St. Paul Campus

3. Peter Buesseler
   State Prairie Biologist
   Scientific and Natural Areas Program

4. Sarlyn Ziegler
   Seed Analyst Senior-Purity

   State Seed Laboratory
   Laboratory Services Division
   Minnesota Department of Agriculture

5. Michael Muggli
   Supervisor State Seed Laboratory
   Laboratory Services Division
   Minnesota Department of Agriculture

6. Bonnie Harper-Lore
   Program Coordinator
   National Wildflower Research Center -Midwest

VII. Reporting Requirements

Semiannual reports will be submitted not later than January 1, 1992, July 1, 1992, January 1, 1993 and a final status report by June 30, 1993.

July 1, 1993 Final Status Report

TABLE 1: BIBLIOGRAPHY- NATIVE GRASS AND WILDFLOWER RESEARCH PUBLICATIONS

The following is the reference list prepared by Eleanor Congdon as a part of the LCMR project "Native Grass and Wildflower Seed." Also included on the last page is an example of an abstract and a notecard that can be generated from one of the listed references. The references are grouped according to their primary topics.

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Example of Bibliography with Abstract and Notecard

Abstract:

10. Albrecht, Mary Lewes (1991): Daylength, Cold Storage, and Plant Production Method Influence Growth and Flowering of *Asclepias tuberosa*. Journal American Society of Hort. Science 26(2), 120-121.
<Forcing plants for the florists trade, optimum photoperiod, temp., etc. to bring flowers to bloom.>
[PRODUCTION TREATMENTS; SPECIFIC PLANT]

* Reference has 1 notecard *

Notecard:

Asclepias tuberosa
(10. Albrecht 1991)
Plants grown in the greenhouse produced more flowers than those produced in the field. 9 hr day-length forced plants to produce flower stalks that aborted without blooming. 13 hr day-length reduced production of flower heads on 18 month old plants from 71 to 61 days. 17 hr day-length delayed field-produced plants flowering by 15 days in comparison to the 13 hr. plants. For greenhouse produced plants, best to store plants in cold storage 4C for 12-14 weeks, plants never sprouted if held at 10C for a period.
[SPECIFIC PLANT]

The following list is from the book entitled VASCULAR PLANTS OF MINNESOTA: A CHECKLIST AND ATLAS by Gerald Ownbey and Thomas Morley, Minneapolis: University of Minnesota, 1991.

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Arethusa bulbosa	Orchidaceae	1352	236	Threatened, Protected
Arisaema dracontium	Araceae	155	103	
Arisaema triphyllum	Araceae	156	103	
Aristida basiramea	Gramineae	907	186	
Aristida dichotoma v. curtissii	Gramineae	908	186	
Aristida oligantha	Gramineae	909	186	
Aristida purpurea v. longiseta	Gramineae	910	187	Special Concern
Aristida tuberculosa	Gramineae	911	187	Special Concern
Arnica lonchophylla (A. chionopappa)	Compositae	345	124	Threatened
Arrhenatherum elatius	Gramineae	912	187	
Artemisia campestris	Compositae	348	124	
Artemisia dracunculus	Compositae	349	124	
Artemisia frigida	Compositae	350	124	
Artemisia ludoviciana	Compositae	351	124	
Artemisia serrata	Compositae	352	125	
Asarum canadense	Aristolochiaceae	164	104	
Asclepias amplexicaulis	Asclepiadaceae	165	104	Special Concern
Asclepias exaltata	Asclepiadaceae	166	104	

Asclepias hirtella	Asclepiadaceae	167	104	Threatened
Asclepias incarnata	Asclepiadaceae	168	104	
Asclepias lanuginosa	Asclepiadaceae	169	104	
Asclepias ovalifolia	Asclepiadaceae	170	104	
Asclepias speciosa	Asclepiadaceae	171	104	
Asclepias stenophylla	Asclepiadaceae	172	105	Endangered
Asclepias sullivantii	Asclepiadaceae	173	105	Threatened
Asclepias syriaca	Asclepiadaceae	174	105	Secondary Noxious Weed
Asclepias tuberosa	Asclepiadaceae	175	105	
Asclepias verticillata	Asclepiadaceae	176	105	
Asclepias viridiflora	Asclepiadaceae	177	105	
Aster borealis	Compositae	353	125	
Aster brachyactis	Compositae	354	125	
Aster ciliolatus	Compositae	355	125	
Aster cordifolius	Compositae	356	125	
Aster drummondii	Compositae	358	125	
Aster ericoides	Compositae	359	125	
Aster falcatus ssp. commutatus	Compositae	360	126	
Aster hesperius	Compositae	361	126	
Aster laevis	Compositae	362	126	
Aster lanceolatus	Compositae	363	126	
Aster lateriflorus	Compositae	364	126	
Aster macrophyllus	Compositae	366	126	
Aster modestus	Compositae	367	126	
Aster novae-angliae	Compositae	368	126	
Aster oblongifolius	Compositae	369	126	
Aster ontarionis	Compositae	370	127	
Aster oolentangiensis	Compositae	371	127	
Aster pilosus	Compositae	372	127	
Aster prenanthoides	Compositae	373	127	
Aster puniceus ssp. firmus	Compositae	374	127	
Aster puniceus ssp. puniceus	Compositae	375	127	
Aster sericeus	Compositae	376	127	
Aster shortii	Compositae	377	127	Special Concern
Aster umbellatus	Compositae	378	127	
Aster urophyllus	Compositae	357	125	
Aster x longulus	Compositae	365	126	
Astragalus adsurgens v. robustior	Leguminosae	1169	215	
Astragalus agrestis	Leguminosae	1170	215	
Astragalus canadensis	Leguminosae	1171	216	
Astragalus crassicarpus	Leguminosae	1172	216	
Astragalus flexuosus	Leguminosae	1173	216	ecial Concern

Astragalus lotiflorus	Leguminosae	1174	216	
Astragalus missouriensis	Leguminosae	1175	216	Special Concern
Astragalus neglectus	Leguminosae	1176	216	Special Concern
Astragalus racemosus	Leguminosae	1177	216	
Astragalus tenellus	Leguminosae	1178	216	
Aureolaria grandiflora v. pulchra	Scrophulariaceae	1745	279	
Aureolaria pedicularia	Scrophulariaceae	1746	279	
Bacopa rotundifolia	Scrophulariaceae	1747	280	Special Concern
Baptisia alba v. macrophylla	Leguminosae	1179	216	
Baptisia bracteata v. glabrescens	Leguminosae	1180	217	Special Concern
Barbarea orthoceras	Cruciferae	564	148	
Bartonia virginica	Gentianaceae	875	183	Endangered
Beckmannia syzigachne v. baicalensis	Gramineae	915	187	
Berula pusilla	Umbelliferae	1812	287	
Besseya bullii	Scrophulariaceae	1748	280	Endangered
Bidens cernua	Compositae	380	128	
Bidens comosa	Compositae	381	128	
Bidens connata	Compositae	382	128	
Bidens coronata	Compositae	383	128	
Bidens discoidea	Compositae	384	128	
Bidens frondosa	Compositae	385	128	
Bidens vulgata	Compositae	386	128	
Blephila hirsuta	Labiatae	1135	212	
Boehmeria cylindrica	Urticaceae	1839	290	
Boltonia asteroides v. recognita	Compositae	387	128	
Bouteloua curtipendula	Gramineae	916	187	
Bouteloua gracilis	Gramineae	917	187	
Bouteloua hirsuta	Gramineae	918	187	
Brachyelytrum erectum	Gramineae	919	188	
Brasenia schreberi	Nymphaeaceae	1317	232	
Bromus ciliatus	Gramineae	920	188	
Bromus kalmii	Gramineae	923	188	
Bromus latiglumis	Gramineae	924	188	
Bromus pubescens	Gramineae	925	188	
Buchloë dactyloides	Gramineae	928	189	Special Concern
Bulbostylis capillaris	Cyperaceae	606	153	
Cacalia muhlenbergii	Compositae	388	129	
Cacalia plantaginea	Compositae	389	129	Threatened
Cacalia suaveolens	Compositae	390	129	Endangered
Calamagrostis canadensis	Gramineae	929	189	
Calamagrostis inexpansa v. brevior	Gramineae	930	189	

Calamagrostis lacustris	Gramineae	931	189	Endangered
Calamagrostis montanensis	Gramineae	932	189	
Calamagrostis neglecta	Gramineae	933	189	
Calamagrostis purpurascens	Gramineae	934	189	Endangered
Calamovilfa longifolia	Gramineae	935	189	
Calla palustris	Araceae	157	103	
Callitriche hermaphroditica	Callitrichaceae	222	110	
Callitriche heterophylla	Callitrichaceae	223	110	
Callitriche verna	Callitrichaceae	224	110	
Calopogon tuberosus	Orchidaceae	1353	236	Protected
Caltha natans	Ranunculaceae	1536	256	Endangered
Caltha palustris	Ranunculaceae	1537	256	
Calylophus serrulata	Onagraceae	1327	233	
Calypso bulbosa v. americana	Orchidaceae	1354	236	Protected
Campanula americana	Campanulaceae	225	110	
Campanula aparinoides	Campanulaceae	226	111	
Campanula rotundifolia	Campanulaceae	228	111	
Cardamine bulbosa	Cruciferae	573	149	
Cardamine parviflora v. arenicola	Cruciferae	574	149	
Cardamine pensylvanica	Cruciferae	575	149	
Cardamine pratensis v. palustris	Cruciferae	576	149	
Carex abdita	Cyperaceae	607	153	
Carex adusta	Cyperaceae	608	153	
Carex aenea	Cyperaceae	609	153	
Carex albursina	Cyperaceae	610	153	
Carex alopecoidea	Cyperaceae	611	153	
Carex amphibola v. turgida	Cyperaceae	612	153	
Carex angustior	Cyperaceae	613	154	
Carex annectens	Cyperaceae	614	154	Special Concern
Carex aquatilis	Cyperaceae	615	154	
Carex arcta	Cyperaceae	616	154	
Carex arctata	Cyperaceae	617	154	
Carex assiniboinensis	Cyperaceae	618	154	
Carex atherodes	Cyperaceae	619	154	
Carex aurea	Cyperaceae	620	154	
Carex backii	Cyperaceae	621	154	
Carex bebbii	Cyperaceae	622	155	
Carex bicknellii	Cyperaceae	623	155	
Carex blanda	Cyperaceae	624	155	
Carex brevior	Cyperaceae	625	155	
Carex bromoides	Cyperaceae	626	155	
Carex brunnescens v. sphaerostachya	Cyperaceae	627	155	

Carex buxbaumii	Cyperaceae	628	155	
Carex canescens	Cyperaceae	629	155	
Carex capillaris v. major	Cyperaceae	630	155	
Carex castanea	Cyperaceae	631	156	
Carex cephalantha	Cyperaceae	632	156	
Carex cephaloidea	Cyperaceae	633	156	
Carex cephalophora	Cyperaceae	634	156	
Carex chordorrhiza	Cyperaceae	635	156	
Carex communis	Cyperaceae	636	156	
Carex comosa	Cyperaceae	637	156	
Carex conjuncta	Cyperaceae	638	156	Threatened
Carex conoidea	Cyperaceae	639	156	
Carex convoluta	Cyperaceae	640	157	
Carex crawei	Cyperaceae	641	157	
Carex crawfordii	Cyperaceae	642	157	
Carex crinita	Cyperaceae	643	157	
Carex cristatella	Cyperaceae	644	157	
Carex crus-corvi	Cyperaceae	645	157	Endangered
Carex cryptolepis	Cyperaceae	646	157	
Carex davisii	Cyperaceae	647	157	Threatened
Carex debilis v. rudgei	Cyperaceae	648	157	
Carex deflexa	Cyperaceae	649	158	
Carex deweyana	Cyperaceae	650	158	
Carex diandra	Cyperaceae	651	158	
Carex disperma	Cyperaceae	652	158	
Carex eburnea	Cyperaceae	653	158	
Carex eleocharis	Cyperaceae	654	158	
Carex emoryi	Cyperaceae	655	158	
Carex exilis	Cyperaceae	656	158	Special Concern
Carex festucacea	Cyperaceae	657	158	
Carex filifolia	Cyperaceae	658	159	
Carex flava	Cyperaceae	659	159	
Carex foenea	Cyperaceae	660	159	
Carex formosa	Cyperaceae	661	159	Endangered
Carex garberi	Cyperaceae	662	159	Endangered
Carex gracillima	Cyperaceae	663	159	
Carex granularis v. haleana	Cyperaceae	664	159	
Carex gravida	Cyperaceae	665	159	
Carex grayi	Cyperaceae	666	159	
Carex gynandra	Cyperaceae	667	160	
Carex gynocrates	Cyperaceae	668	160	
Carex hallii	Cyperaceae	669	160	Threatened
Carex haydenii	Cyperaceae	670	160	

Carex heliophila	Cyperaceae	671	160	
Carex hirtifolia	Cyperaceae	672	160	
Carex hitchcockiana	Cyperaceae	673	160	
Carex houghtoniana	Cyperaceae	674	160	
Carex hystericina	Cyperaceae	675	160	
Carex interior	Cyperaceae	676	161	
Carex intumescens v. fernaldii	Cyperaceae	677	161	
Carex jamesii	Cyperaceae	678	161	
Carex katahdinensis	Cyperaceae	679	161	Endangered
Carex lacustris	Cyperaceae	680	161	
Carex laeviconica	Cyperaceae	681	161	
Carex laevivaginata	Cyperaceae	682	161	Special Concern
Carex lanuginosa	Cyperaceae	683	161	
Carex lasiocarpa v. americana	Cyperaceae	684	161	
Carex laxiculmis v. copulata	Cyperaceae	685	162	Special Concern
Carex lenticularis	Cyperaceae	686	162	
Carex leptalea	Cyperaceae	687	162	
Carex leptonervia	Cyperaceae	688	162	
Carex limosa	Cyperaceae	689	162	
Carex livida v. radicaulis	Cyperaceae	690	162	
Carex lupulina	Cyperaceae	691	162	
Carex lurida	Cyperaceae	692	162	
Carex meadii	Cyperaceae	693	162	
Carex media	Cyperaceae	694	163	
Carex merritt-fernaldii	Cyperaceae	695	163	
Carex michauxiana	Cyperaceae	696	163	Threatened
Carex molesta	Cyperaceae	697	163	
Carex muhlenbergii	Cyperaceae	698	163	
Carex muskingumensis	Cyperaceae	699	163	
Carex normalis	Cyperaceae	700	163	
Carex obtusata	Cyperaceae	701	163	Special Concern
Carex oligocarpa	Cyperaceae	702	163	
Carex oligosperma	Cyperaceae	703	164	
Carex ormostachya	Cyperaceae	704	164	
Carex pallescens v. neogaea	Cyperaceae	705	164	Endangered
Carex pauciflora	Cyperaceae	706	164	
Carex paupercula	Cyperaceae	707	164	
Carex peckii	Cyperaceae	708	164	
Carex pedunculata	Cyperaceae	709	164	
Carex pensylvanica	Cyperaceae	710	164	
Carex plantaginea	Cyperaceae	711	164	Threatened
Carex praegracilis	Cyperaceae	712	165	
Carex prairea	Cyperaceae	713	165	

CareX praticola	Cyperaceae	714	165	Threatened
Carex projecta	Cyperaceae	715	165	
Carex pseudocyperus	Cyperaceae	716	165	
Carex retrorsa	Cyperaceae	717	165	
Carex richardsonii	Cyperaceae	718	165	
Carex rosea	Cyperaceae	719	165	
Carex rossii	Cyperaceae	720	165	Endangered
Carex rostrata v. utriculata	Cyperaceae	721	166	
Carex sartwellii	Cyperaceae	722	166	
Carex saximontana	Cyperaceae	723	166	
Carex scirpiformis	Cyperaceae	724	166	Special Concern
Carex scoparia	Cyperaceae	725	166	
Carex sparganioides	Cyperaceae	726	166	
Carex sprengelii	Cyperaceae	727	166	
Carex sterilis	Cyperaceae	728	166	Threatened
Carex stipata	Cyperaceae	729	166	
Carex stricta	Cyperaceae	730	167	
Carex supina v. spaniocarpa	Cyperaceae	731	167	Endangered
Carex sychnocephala	Cyperaceae	732	167	
Carex tenera	Cyperaceae	733	167	
Carex tenuiflora	Cyperaceae	734	167	
Carex tetanica	Cyperaceae	735	167	
Carex tonsa	Cyperaceae	736	167	
Carex torreyi	Cyperaceae	737	167	
Carex tribuloides	Cyperaceae	738	167	
Carex trichocarpa	Cyperaceae	739	168	
Carex trisperma	Cyperaceae	740	168	
Carex tuckermanii	Cyperaceae	741	168	
Carex typhina	Cyperaceae	742	168	
Carex umbellata	Cyperaceae	743	168	
Carex vaginata	Cyperaceae	744	168	
Carex vesicaria	Cyperaceae	745	168	
Carex viridula	Cyperaceae	746	168	
Carex vulpinoidea	Cyperaceae	747	168	
Carex woodii	Cyperaceae	748	169	Special Concern
Carex xerantica	Cyperaceae	749	169	Endangered
Castilleja coccinea	Scrophulariaceae	1749	280	
Castilleja septentrionalis	Scrophulariaceae	1750	280	
Castilleja sessiliflora	Scrophulariaceae	1751	280	
Caulophyllum thalictroides	Berberidaceae	181	106	
Cenchrus longispinus	Gramineae	936	189	
Cerastium arvense	Caryophyllaceae	262	115	
Cerastium brachypodum	Caryophyllaceae	263	115	

Cerastium nutans	Caryophyllaceae	265	115	
Ceratophyllum demersum	Ceratophyllaceae	295	118	
Ceratophyllum echinatum	Ceratophyllaceae	296	118	
Chamaecrista fasciculata	Leguminosae	1181	217	
Chamaedaphne calyculata v. angustifolia	Ericaceae	834	178	
Chamaesaracha grandiflora	Solanaceae	1786	284	
Chelone glabra	Scrophulariaceae	1753	280	
Chenopodium capitatum	Chenopodiaceae	300	119	
Chenopodium desiccatum	Chenopodiaceae	301	119	
Chenopodium rubrum	Chenopodiaceae	303	119	
Chenopodium simplex	Chenopodiaceae	304	119	
Chenopodium standleyanum	Chenopodiaceae	305	119	
Chimaphila umbellata v. cisatlantica	Pyrolaceae	1515	254	
Chrysosplenium americanum	Saxifragaceae	1714	276	
Chrysosplenium iowense	Saxifragaceae	1715	276	Endangered
Cicuta bulbifera	Umbelliferae	1814	287	
Cicuta maculata	Umbelliferae	1815	287	
Cinna arundinacea	Gramineae	937	190	
Cinna latifolia	Gramineae	938	190	
Circaea alpina	Onagraceae	1328	233	
Circaea lutetiana ssp. canadensis	Onagraceae	1329	233	
Cirsium altissimum	Compositae	398	130	
Cirsium discolor	Compositae	400	130	
Cirsium flodmanii	Compositae	401	130	
Cirsium hillii	Compositae	402	130	Special Concern
Cirsium muticum	Compositae	403	130	
Cladium mariscoides	Cyperaceae	750	169	Special Concern
Claytonia caroliniana	Portulacaceae	1469	249	Special Concern
Claytonia virginica	Portulacaceae	1470	249	
Clematis occidentalis	Ranunculaceae	1538	256	
Clematis virginiana	Ranunculaceae	1539	256	
Clintonia borealis	Liliaceae	1254	225	
Coeloglossum viride v. virescens	Orchidaceae	1355	236	Protected
Collomia linearis	Polemoniaceae	1412	242	
Comandra umbellata	Santalaceae	1711	276	
Commelina erecta	Commelinaceae	323	121	
Convolvulus sepium	Convolvulaceae	532	145	
Convolvulus spithamaeus	Convolvulaceae	533	145	
Conyza canadensis	Compositae	405	130	
Conyza ramosissima	Compositae	406	131	
Coptis groenlandica	Ranunculaceae	1540	257	

Corallorhiza maculata	Orchidaceae	1356	236	Protected
Corallorhiza odontorhiza	Orchidaceae	1357	236	Protected
Corallorhiza striata	Orchidaceae	1358	236	Protected
Corallorhiza trifida	Orchidaceae	1359	236	Protected
Coreopsis palmata	Compositae	408	131	
Cornus canadensis	Cornaceae	545	146	
Corydalis aurea	Fumariaceae	870	182	
Corydalis micrantha	Fumariaceae	871	182	
Corydalis sempervirens	Fumariaceae	872	182	
Coryphantha vivipara	Cactaceae	219	110	Threatened
Crepis runcinata	Compositae	410	131	
Crotalaria sagittalis	Leguminosae	1183	217	
Cryptotaenia canadensis	Umbelliferae	1816	287	
Cuscuta gronovii	Convolvulaceae	538	145	
Cuscuta campestris	Convolvulaceae	534	145	
Cuscuta cephalanthi	Convolvulaceae	535	145	
Cuscuta coryli	Convolvulaceae	536	145	
Cuscuta glomerata	Convolvulaceae	537	145	
Cuscuta obtusiflora v. glandulosa	Convolvulaceae	539	145	
Cuscuta pentagona	Convolvulaceae	540	145	
Cuscuta polygonorum	Convolvulaceae	541	146	
Cuscuta umbrosa	Convolvulaceae	542	146	
Cycloloma atriplicifolium	Chenopodiaceae	309	120	
Cymopteris acaulis	Umbelliferae	1817	287	Special Concern
Cynoglossum boreale	Boraginaceae	198	107	
Cyperus acuminatus	Cyperaceae	751	169	Special Concern
Cyperus aristatus	Cyperaceae	752	169	
Cyperus diandrus	Cyperaceae	753	169	
Cyperus engelmannii	Cyperaceae	754	169	
Cyperus erythrorhizos	Cyperaceae	755	169	
Cyperus houghtonii	Cyperaceae	757	170	
Cyperus lupulinus	Cyperaceae	758	170	
Cyperus lupulinus x C. schweinitzii	Cyperaceae	759	170	
Cyperus odoratus	Cyperaceae	760	170	
Cyperus rivularis	Cyperaceae	761	170	
Cyperus schweinitzii	Cyperaceae	763	170	
Cyperus strigosus	Cyperaceae	764	170	
Cypripedium acaule	Orchidaceae	1360	237	Protected
Cypripedium arietinum	Orchidaceae	1361	237	Endangered, Protected
Cypripedium calceolus v. parviflor	Orchidaceae	1362	237	-otected

Cypripedium calceolus v. pubescens	Orchidaceae	1363	237	Protected
Cypripedium candidum	Orchidaceae	1364	237	Protected
Cypripedium reginae	Orchidaceae	1365	237	Special Concern, Protected
Dalea leporina	Leguminosae	1184	217	
Danthonia spicata	Gramineae	940	190	
Decodon verticillatus v. laevigatus	Lythraceae	1290	229	Special Concern
Delphinium virescens	Ranunculaceae	1541	257	
Dentaria laciniata	Cruciferae	577	150	
Deschampsia cespitosa v. glauca	Gramineae	941	190	
Deschampsia flexuosa	Gramineae	942	190	Special Concern
Descurainia pinnata v. brachycarpa	Cruciferae	578	150	
Descurainia richardsonii	Cruciferae	579	150	
Desmanthus illinoensis	Leguminosae	1185	217	Special Concern
Desmodium canadense	Leguminosae	1186	217	
Desmodium cuspidatum v. longifolium	Leguminosae	1187	217	Special Concern
Desmodium glutinosum	Leguminosae	1188	217	
Desmodium illinoense	Leguminosae	1189	218	Threatened
Desmodium nudiflorum	Leguminosae	1190	218	Special Concern
Dicentra canadensis	Fumariaceae	873	182	Special Concern
Dicentra cucullaria	Fumariaceae	874	183	
Didiplis diandra	Lythraceae	1291	229	
Dioscorea villosa	Dioscoreaceae	818	176	
Diplachne fascicularis	Gramineae	945	190	
Distichlis stricta	Gramineae	946	191	
Dodecatheon amethystinum (D. pulchellum)	Primulaceae	1503	252	Special Concern
Dodecatheon meadia	Primulaceae	1504	253	Special Concern
Draba arabisans	Cruciferae	581	150	Special Concern
Draba nemorosa	Cruciferae	582	150	
Draba norvegica	Cruciferae	583	150	Endangered
Draba reptans	Cruciferae	584	150	
Dracocephalum parviflorum	Labiatae	1136	212	
Drosera anglica	Droseraceae	820	177	Threatened
Drosera intermedia	Droseraceae	821	177	
Drosera linearis	Droseraceae	822	177	Threatened
Drosera rotundifolia	Droseraceae	823	177	
Dulichium arundinaceum	Cyperaceae	765	170	
Echinacea angustifolia	Compositae	413	131	
Echinochloa muricata	Gramineae	948	191	

Echinochloa walteri	Gramineae	949	191	Special Concern
Echinocystis lobata	Cucurbitaceae	604	153	
Elatine minima	Elatinaceae	828	177	
Elatine triandra	Elatinaceae	829	178	
Eleocharis acicularis	Cyperaceae	766	171	
Eleocharis compressa	Cyperaceae	767	171	
Eleocharis elliptica	Cyperaceae	768	171	
Eleocharis engelmannii	Cyperaceae	769	171	
Eleocharis erythropoda	Cyperaceae	770	171	
Eleocharis intermedia	Cyperaceae	771	171	
Eleocharis macrostachya	Cyperaceae	772	171	
Eleocharis nitida	Cyperaceae	773	171	Threatened
Eleocharis obtusa	Cyperaceae	774	171	
Eleocharis olivacea	Cyperaceae	775	172	Threatened
Eleocharis ovata	Cyperaceae	776	172	
Eleocharis parvula v. anachaeta	Cyperaceae	777	172	Threatened
Eleocharis pauciflora v. fernaldii	Cyperaceae	778	172	Special Concern
Eleocharis rostellata	Cyperaceae	779	172	Threatened
Eleocharis smallii	Cyperaceae	780	172	
Eleocharis wolfii	Cyperaceae	781	172	Endangered
Ellisia nyctelea	Hydrophyllaceae	1082	206	
Elymus canadensis	Gramineae	950	191	
Elymus diversiglumis	Gramineae	951	191	
Elymus hystrix	Gramineae	952	191	
Elymus villosus	Gramineae	955	192	
Elymus virginicus	Gramineae	956	192	
Elymus wiegandii	Gramineae	957	192	
Empetrum atropurpureum	Empetraceae	830	178	Endangered
Empetrum nigrum	Empetraceae	831	178	Endangered
Epigaea repens v. glabrifolia	Ericaceae	835	178	Protected
Epilobium angustifolium	Onagraceae	1330	233	
Epilobium ciliatum	Onagraceae	1331	233	
Epilobium coloratum	Onagraceae	1332	233	
Epilobium glandulosum	Onagraceae	1333	234	
Epilobium leptophyllum	Onagraceae	1334	234	
Epilobium palustre	Onagraceae	1335	234	
Epilobium strictum	Onagraceae	1336	234	
Eragrostis frankii	Gramineae	959	192	
Eragrostis hypnoides	Gramineae	960	192	
Eragrostis pectinacea	Gramineae	961	192	
Eragrostis spectabilis	Gramineae	962	192	
Erechtites heiracifolia	Compositae	415	132	
Erigeron acris v. asteroides	Compositae	416	132	Special Concern

Erigeron annuus	Compositae	417	132	
Erigeron glabellus v. pubescens	Compositae	418	132	
Erigeron lonchophyllus	Compositae	419	132	
Erigeron philadelphicus	Compositae	420	132	
Erigeron pulchellus	Compositae	421	132	
Erigeron strigosus	Compositae	422	132	
Eriocaulon septangulare	Eriocaulaceae	848	180	
Eriophorum angustifolium	Cyperaceae	782	172	
Eriophorum chamissonis	Cyperaceae	783	172	
Eriophorum gracile	Cyperaceae	784	173	
Eriophorum spissum	Cyperaceae	785	173	
Eriophorum tenellum	Cyperaceae	786	173	
Eriophorum virginicum	Cyperaceae	787	173	
Eriophorum viridi-carinatum	Cyperaceae	788	173	
Eryngium yuccifolium	Umbelliferae	1819	288	Special Concern
Erysimum asperum	Cruciferae	586	151	
Erysimum inconspicuum	Cruciferae	588	151	
Erythronium albidum	Liliaceae	1255	225	
Erythronium americanum	Liliaceae	1256	225	
Erythronium propullans	Liliaceae	1257	225	Endangered
Eupatorium altissimum	Compositae	423	132	
Eupatorium maculatum	Compositae	424	133	
Eupatorium perfoliatum	Compositae	425	133	
Eupatorium purpureum	Compositae	426	133	
Eupatorium rugosum	Compositae	427	133	
Eupatorium sessilifolium	Compositae	428	133	Threatened
Euphorbia corollata	Euphorbiaceae	850	180	
Euphorbia cyathophora	Euphorbiaceae	851	180	
Euphorbia dentata	Euphorbiaceae	853	180	
Euphorbia geyeri	Euphorbiaceae	854	180	
Euphorbia glyptosperma	Euphorbiaceae	855	180	
Euphorbia maculata	Euphorbiaceae	856	181	
Euphorbia marginata	Euphorbiaceae	857	181	
Euphorbia nutans	Euphorbiaceae	858	181	
Euphorbia serpyllifolia	Euphorbiaceae	860	181	
Euphorbia spathulata	Euphorbiaceae	861	181	
Euphrasia hudsoniana v. ramosior	Scrophulariaceae	1755	280	Special Concern
Euthamia graminifolia	Compositae	429	133	
Euthamia gymnospermoides	Compositae	430	133	
Festuca obtusa	Gramineae	966	193	
Festuca rubra	Gramineae	969	193	
Festuca saximontana	Gramineae	967	193	
Fimbristylis autumnalis	Cyperaceae	789	173	

Fimbristylis puberula v. interior	Cyperaceae	790	173	
Floerkea proserpinacoides	Limnanthaceae	1283	228	Special Concern
Fragaria vesca ssp. americana	Rosaceae	1607	264	
Fragaria virginiana	Rosaceae	1608	264	
Froelichia floridana v. campestris	Amaranthaceae	139	101	
Gaillardia aristata	Compositae	431	133	
Galearis spectabilis	Orchidaceae	1366	237	Protected
Galium aparine	Rubiaceae	1674	271	
Galium asprellum	Rubiaceae	1675	272	
Galium boreale ssp. septentrionale	Rubiaceae	1676	272	
Galium brevipes	Rubiaceae	1677	272	
Galium concinnum	Rubiaceae	1678	272	
Galium labradoricum	Rubiaceae	1679	272	
Galium obtusum	Rubiaceae	1680	272	
Galium tinctorium	Rubiaceae	1681	272	
Galium trifidum	Rubiaceae	1682	272	
Galium triflorum	Rubiaceae	1683	272	
Gaultheria hispidula	Ericaceae	836	178	
Gaultheria procumbens	Ericaceae	837	178	
Gaura biennis	Onagraceae	1337	234	Special Concern
Gaura coccinea	Onagraceae	1338	234	
Gentiana affinis	Gentianaceae	877	183	Special Concern, Protected
Gentiana alba	Gentianaceae	878	183	Protected
entiana andrewsii	Gentianaceae	879	183	Protected
Gentiana puberulenta	Gentianaceae	880	183	Protected
Gentiana rubricaulis	Gentianaceae	881	183	Protected
Gentianella amarella ssp. acuta	Gentianaceae	882	183	Special Concern, Protected
Gentianella quinquefolia ssp occidentalis	Gentianaceae	883	184	Protected
Gentianopsis crinita	Gentianaceae	884	184	Protected
Gentianopsis procera	Gentianaceae	885	184	Protected
Geocaulon lividum	Santalaceae	1712	276	Special Concern
Geranium bicknellii	Geraniaceae	887	184	
Geranium carolinianum	Geraniaceae	888	184	
Geranium maculatum	Geraniaceae	889	184	
Geum aleppicum v. strictum	Rosaceae	1609	264	
Geum canadense	Rosaceae	1610	264	
Geum laciniatum v. trichocarpum	Rosaceae	1611	264	
Geum macrophyllum v. perincisum	Rosaceae	1612	265	
Geum rivale	Rosaceae	1613	265	

Geum triflorum	Rosaceae	1614	265	
Glaux maritima	Primulaceae	1505	253	Special Concern
Glyceria borealis	Gramineae	970	193	
Glyceria canadensis	Gramineae	971	193	
Glyceria grandis	Gramineae	972	193	
Glyceria striata	Gramineae	973	194	
Glycyrrhiza	Leguminosae	1192	218	
Gnaphalium obtusifolium	Compositae	434	134	
Gnaphalium uliginosum	Compositae	435	134	
Gnaphalium viscosum	Compositae	436	134	
Goodyera pubescens	Orchidaceae	1367	237	Protected
Goodyera repens v. ophioides	Orchidaceae	1368	237	Protected
Goodyera tesselata	Orchidaceae	1369	238	Protected
Gratiola neglecta	Scrophulariaceae	1756	281	
Grindelia squarrosa	Compositae	437	134	Secondary Noxious Weed
Hackelia deflexa v. americana	Boraginaceae	201	108	
Hackelia virginiana	Boraginaceae	202	108	
Halenia deflexa	Gentianaceae	886	184	
Haplopappus spinulosus	Compositae	438	134	Special Concern
Hedeoma hispida	Labiatae	1139	212	
Hedyotis longifolia	Rubiaceae	1685	273	
Helenium autumnale	Compositae	439	134	
Helianthemum bicknellii	Cistaceae	316	121	
Helianthemum canadense	Cistaceae	317	121	
Helianthus annuus	Compositae	440	134	Secondary Noxious Weed
Helianthus giganteus	Compositae	441	134	
Helianthus grosseserratus	Compositae	442	135	
Helianthus hirsutus	Compositae	443	135	
Helianthus maximilani	Compositae	444	135	
Helianthus nuttallii ssp. rydbergii	Compositae	445	135	Special Concern
Helianthus occidentalis	Compositae	446	135	
Helianthus petiolaris	Compositae	447	135	
Helianthus rigidus	Compositae	448	135	
Helianthus strumosus	Compositae	449	135	Secondary Noxious Weed
Helianthus tuberosus	Compositae	450	135	
Helictotrichon hookeri	Gramineae	974	194	
Heliopsis helianthoides ssp. occidentalis	Compositae	451	136	
Hemicarpha micrantha	Cyperaceae	791	173	
Hepatica acutiloba	Ranunculaceae	1542	257	

Hepatica americana	Ranunculaceae	1543	257	
Heracleum lanatum	Umbelliferae	1820	288	
Heterotheca villosa	Compositae	452	136	
Heuchera richardsonii	Saxifragaceae	1716	276	
Hieracium kalmii	Compositae	455	136	
Hieracium longipilum	Compositae	456	136	
Hieracium scabriusculum	Compositae	458	136	
Hieracium scabrum	Compositae	459	136	
Hierochloë odorata ssp. hirta	Gramineae	975	194	
Hippuris vulgaris	Hamamelidaceae	1078	205	
Hordeum jubatum	Gramineae	976	194	
Hordeum pusillum	Gramineae	977	194	
Hudsonia tomentosa	Cistaceae	318	121	
Humulus lupulus	Moraceae	1305	230	
Hydrastis canadensis	Ranunculaceae	1544	257	Endangered
Hydrocotyle americana	Umbelliferae	1821	288	Special Concern
Hydrophyllum appendiculatum	Hydrophyllaceae	1083	206	
Hydrophyllum virginianum	Hydrophyllaceae	1084	206	
Hypericum boreale	Hypericaceae	1086	206	
Hypericum ellipticum	Hypericaceae	1087	206	
Hypericum majus	Hypericaceae	1088	206	
Hypericum punctatum	Hypericaceae	1090	207	
Hypericum pyramidatum	Hypericaceae	1091	207	
Hypoxis hirsuta	Amaryllidaceae	140	101	
Impatiens capensis	Balsaminaceae	178	105	
Impatiens pallida	Balsaminaceae	179	105	
Iodanthus pinnatifidus	Cruciferae	590	151	Special Concern
Iris versicolor	Iridaceae	1093	207	
Iris virginica v. shrevei	Iridaceae	1094	207	
Isanthus brachiatus	Labiatae	1140	212	
Isopyrum biternatum	Ranunculaceae	1545	257	
Iva xanthifolia	Compositae	460	137	Secondary Noxious Weed
Jeffersonia diphylla	Berberidaceae	182	106	Threatened
Juncus alpinoarticulatus	Juncaceae	1102	208	
Juncus articulatus	Juncaceae	1103	208	
Juncus balticus v. littoralis	Juncaceae	1104	208	
Juncus brachycarpus	Juncaceae	1105	208	
Juncus brevicaudatus	Juncaceae	1106	208	
Juncus bufonius	Juncaceae	1107	208	
Juncus canadensis	Juncaceae	1108	209	
Juncus compressus	Juncaceae	1109	209	
Juncus dudleyi	Juncaceae	1110	209	

Juncus effusus	Juncaceae	1111	209	
Juncus filiformis	Juncaceae	1112	209	
Juncus gerardi	Juncaceae	1113	209	
Juncus greenei	Juncaceae	1115	209	
Juncus interior	Juncaceae	1116	209	
Juncus longistylis	Juncaceae	1117	210	
Juncus marginatus	Juncaceae	1118	210	Threatened
Juncus nodosus	Juncaceae	1119	210	
Juncus pelocarpus	Juncaceae	1120	210	
Juncus stygius v. americana	Juncaceae	1121	210	Special Concern
Juncus tenuis	Juncaceae	1122	210	
Juncus torreyi	Juncaceae	1123	210	
Juncus vaseyi	Juncaceae	1124	210	
Juncus x gracilescens	Juncaceae	1114	209	
Koeleria macrantha	Gramineae	978	194	
Krigia biflora	Compositae	461	137	
Kuhnia eupatorioies v. corymbulosa	Compositae	462	137	
Lactuca biennis	Compositae	463	137	
Lactuca canadensis	Compositae	464	137	
Lactuca ludoviciana	Compositae	465	137	
Lactuca pulchella	Compositae	466	137	
Laportea canadensis	Urticaceae	1840	290	
Lathyrus japonicus v. glaber	Leguminosae	1194	218	
Lathyrus ochroleucus	Leguminosae	1195	218	
Lathyrus palustris	Leguminosae	1196	218	
Lathyrus venosus v. intonsus	Leguminosae	1197	218	
Lechea intermedia	Cistaceae	319	121	
Lechea stricta	Cistaceae	320	121	
Lechea tenuifolia	Cistaceae	321	121	
Leersia lenticularis	Gramineae	979	194	Special Concern
Leersia oryzoides	Gramineae	980	194	
Leersia virginica	Gramineae	981	194	
Lepidium densiflorum	Cruciferae	592	151	
Lepidium virginicum	Cruciferae	593	151	
Leptoloma cognatum	Gramineae	982	195	
Lespedeza capitata	Leguminosae	1198	219	
Lespedeza capitata x L. leptostachya	Leguminosae	1199	219	
Lespedeza leptostachya	Leguminosae	1200	219	Endangered
Lesquerella ludoviciana	Cruciferae	594	151	Endangered
Liatris aspera	Compositae	469	138	
Liatris cylindracea	Compositae	470	138	

iatris ligulistylis	Compositae	471	138	
Liatris punctata	Compositae	472	138	
Liatris pycnostachya	Compositae	473	138	
Lilium michiganense	Liliaceae	1259	225	Protected
Lilium philadelphicum v. andinum	Liliaceae	1260	225	Protected
Limosella aquatica	Scrophulariaceae	1757	281	Special Concern
Linaria canadensis	Scrophulariaceae	1758	281	
Lindernia anagallidea	Scrophulariaceae	1761	281	
Lindernia dubia	Scrophulariaceae	1762	281	
Linum rigidum	Linaceae	1285	228	
Linum sulcatum	Linaceae	1286	228	
Liparis liliifolia	Orchidaceae	1370	238	Protected
Liparis loeselii	Orchidaceae	1371	238	Protected
Listera auriculata	Orchidaceae	1372	238	Endangered, Protected
Listera convallarioides	Orchidaceae	1373	238	Protected
Listera cordata	Orchidaceae	1374	238	
Lithospermum canescens	Boraginaceae	205	108	
Lithospermum caroliniense ssp. croceum	Boraginaceae	206	108	
Lithospermum incisum	Boraginaceae	207	108	
Lithospermum latifolium	Boraginaceae	208	109	
Littorella americana	Plantaginaceae	1402	241	Endangered
Lobelia cardinalis	Campanulaceae	229	111	
Lobelia dortmanna	Campanulaceae	230	111	
Lobelia inflata	Campanulaceae	231	111	
Lobelia kalmii	Campanulaceae	232	111	
Lobelia siphilitica	Campanulaceae	233	111	
Lobelia spicata	Campanulaceae	234	111	
Lomatium orientale	Umbelliferae	1822	288	
Lophotocarpus calycinus	Alismataceae	125	99	
Lotus purshianus	Leguminosae	1202	219	
Ludwigia palustris	Onagraceae	1339	234	
Ludwigia polycarpa	Onagraceae	1340	234	
Lupinus perennis	Leguminosae	1203	219	
Luzula acuminata	Juncaceae	1125	210	
Luzula multiflora	Juncaceae	1127	211	
Luzula parviflora v. melanocarpa	Juncaceae	1128	211	Threatened
Lycopus americanus	Labiatae	1142	212	
Lycopus asper	Labiatae	1143	212	
Lycopus uniflorus	Labiatae	1144	213	
Lycopus virginicus	Labiatae	1145	213	
Lygodesmia juncea	Compositae	474	138	

Lysimachia ciliata	Primulaceae	1506	253	
Lysimachia hybrida	Primulaceae	1507	253	
Lysimachia quadriflora	Primulaceae	1509	253	
Lysimachia quadrifolia	Primulaceae	1510	253	
Lysimachia terrestris	Primulaceae	1511	253	
Lysimachia thyrsiflora	Primulaceae	1512	253	
Lythrum alatum	Lythraceae	1292	229	
Maianthemum canadense	Liliaceae	1261	226	
Malaxis monophylla v. brachypoda	Orchidaceae	1375	238	Protected
Malaxis paludosa	Orchidaceae	1376	238	Endangered, Protected
Malaxis unifolia	Orchidaceae	1377	238	Protected
Megalodonta beckii	Compositae	476	138	
Melampyrum lineare	Scrophulariaceae	1763	281	
Melica nitens	Gramineae	984	195	Threatened
Menispermum canadense	Menispermaceae	1302	230	
Mentha arvensis v. glabrata	Labiatae	1146	213	
Menyanthes trifoliata v. minor	Menyanthaceae	1303	230	
Mertensia paniculata	Boraginaceae	209	109	
Mertensia virginica	Boraginaceae	210	109	
Milium effusum v. cisatlanticum	Gramineae	985	195	
Mimulus glabratus v. fremontii	Scrophulariaceae	1764	281	
Mimulus ringens	Scrophulariaceae	1765	282	
Mirabilis hirsuta	Nyctaginaceae	1314	231	
Mirabilis linearis	Nyctaginaceae	1315	232	
Mirabilis nyctaginea	Nyctaginaceae	1316	232	
Mitchella repens	Rubiaceae	1686	273	
Mitella diphylla	Saxifragaceae	1717	276	
Mitella nuda	Saxifragaceae	1718	276	
Monarda fistulosa	Labiatae	1148	213	
Monarda punctata v. villicaulis	Labiatae	1149	213	
Moneses uniflora	Pyrolaceae	1516	254	
Monolepis nuttalliana	Chenopodiaceae	311	120	
Monotropa hypopitys	Pyrolaceae	1517	254	
Monotropa uniflora	Pyrolaceae	1518	254	
Montia chamissoi	Portulacaceae	1471	249	Endangered
Muhlenbergia asperifolia	Gramineae	987	195	
Muhlenbergia cuspidata	Gramineae	988	195	
Muhlenbergia frondosa	Gramineae	989	195	Secondary Noxious Weed
Muhlenbergia glomerata	Gramineae	990	195	
Muhlenbergia mexicana	Gramineae	991	196	
Muhlenbergia racemosa	Gramineae	992	196	

Muhlenbergia richardsonis	Gramineae	993	196	
Muhlenbergia schreberi	Gramineae	994	196	
Muhlenbergia sylvatica	Gramineae	995	196	
Muhlenbergia uniflora	Gramineae	996	196	Threatened
Myosotis laxa	Boraginaceae	212	109	
Myosotis verna	Boraginaceae	214	109	
Myosurus minimus	Ranunculaceae	1546	257	Special Concern
Napaea dioica	Malvaceae	1300	230	Endangered
Nelumbo lutea	Nymphaeaceae	1318	232	Protected
Nothocalais cuspidata	Compositae	477	138	
Nuphar luteum ssp. pumilum	Nymphaeaceae	1319	232	
Nuphar luteum ssp. variegatum	Nymphaeaceae	1320	232	
Nymphaea odorata	Nymphaeaceae	1321	232	
Nymphaea tetragona	Nymphaeaceae	1322	232	Threatened
Nymphaea tuberosa	Nymphaeaceae	1323	232	
Oenothera biennis	Onagraceae	1341	234	
Oenothera clelandii	Onagraceae	1342	235	
Oenothera laciniata	Onagraceae	1343	235	
Oenothera nuttallii	Onagraceae	1344	235	
Oenothera oakesiana	Onagraceae	1345	235	
Oenothera parviflora	Onagraceae	1346	235	
Oenothera perennis	Onagraceae	1347	235	
Oenothera rhombipetala	Onagraceae	1348	235	Special Concern
Oenothera villosa	Onagraceae	1349	235	
Onosmodium molle ssp. hispidissimum	Boraginaceae	215	109	
Onosmodium molle ssp. occidentale	Boraginaceae	216	109	
Opuntia fragilis	Cactaceae	220	110	
Opuntia macrorhiza	Cactaceae	221	110	Special Concern
Orthocarpus luteus	Scrophulariaceae	1766	282	
Oryzopsis asperifolia	Gramineae	997	196	
Oryzopsis hymenoides	Gramineae	998	196	Endangered
Oryzopsis pungens	Gramineae	999	196	
Oryzopsis racemosa	Gramineae	1000	197	
Osmorhiza chilensis	Umbelliferae	1823	288	Endangered
Osmorhiza claytonii	Umbelliferae	1824	288	
Osmorhiza longistylis	Umbelliferae	1825	288	
Osmorhiza obtusa	Umbelliferae	1826	288	Threatened
Oxalis dillenii	Oxalidaceae	1396	241	
Oxalis montana	Oxalidaceae	1397	241	
Oxalis stricta	Oxalidaceae	1398	241	
Oxalis violacea	Oxalidaceae	1399	241	

Oxypolis rigidior	Umbelliferae	1827	288	
Oxytropis campestris v. dispar	Leguminosae	1209	220	
Oxytropis lambertii	Leguminosae	1210	220	
Oxytropis viscida	Leguminosae	1211	220	Endangered
Panax quinquefolium	Araliaceae	162	103	Special Concern
Panax trifolium	Araliaceae	163	104	
Panicum boreale	Gramineae	1001	197	
Panicum capillare	Gramineae	1002	197	
Panicum columbianum	Gramineae	1003	197	
Panicum commonsianum v. euchlamydeum	Gramineae	1004	197	
Panicum depauperatum	Gramineae	1005	197	
Panicum dichotomiflorum	Gramineae	1006	197	Secondary Noxious Weed
Panicum lanuginosum v. fasciculatum	Gramineae	1007	197	
Panicum lanuginosum v. implicatum	Gramineae	1008	197	
Panicum lanuginosum v. praecocius	Gramineae	1009	198	
Panicum latifolium	Gramineae	1010	198	
Panicum leibergii	Gramineae	1011	198	
Panicum linearifolium	Gramineae	1012	198	
Panicum meridionale	Gramineae	1013	198	
Panicum oligosanthes	Gramineae	1015	198	
Panicum perlongum	Gramineae	1016	198	
Panicum philadelphicum	Gramineae	1017	198	
Panicum virgatum	Gramineae	1018	199	
Panicum wilcoxianum	Gramineae	1019	199	
Panicum xanthophysum	Gramineae	1020	199	
Parietaria pensylvanica	Urticaceae	1841	290	
Parnassia glauca	Saxifragaceae	1719	276	
Parnassia palustris v. neogaea	Saxifragaceae	1720	277	
Paronychia canadensis	Caryophyllaceae	269	115	Special Concern
Paronychia fastigiata	Caryophyllaceae	270	115	Special Concern
Parthenium integrifolium	Compositae	478	139	Endangered
Paspalum ciliatifolium v. stramineum	Gramineae	1021	199	
Pedicularis canadensis	Scrophulariaceae	1767	282	
Pedicularis lanceolata	Scrophulariaceae	1768	282	
Penstemon albidus	Scrophulariaceae	1769	282	
Penstemon gracilis	Scrophulariaceae	1771	282	
Penstemon grandiflorus	Scrophulariaceae	1772	282	

Penthorum sedoides	Crassulaceae	549	146	
Petalostemon candidum	Leguminosae	1212	220	
Petalostemon occidentale	Leguminosae	1213	220	
Petalostemon purpureum	Leguminosae	1214	220	
Petalostemon villosum	Leguminosae	1215	220	
Petasites frigidus v. palmatus	Compositae	479	139	
Petasites sagittatus	Compositae	480	139	
Petasites x vitifolius	Compositae	481	139	
Phacelia franklinii	Hydrophyllaceae	1085	206	Threatened
Phalaris arundinacea	Gramineae	1022	199	
Phlox divaricata ssp. laphamii	Polemoniaceae	1413	242	
Phlox maculata	Polemoniaceae	1414	243	
Phlox pilosa ssp. fulgida	Polemoniaceae	1416	243	
Phragmites australis	Gramineae	1025	199	
Phryma leptostachya	Phrymaceae	1401	241	
Phyla lanceolata	Verbenaceae	1847	291	
Physalis heterophylla	Solanaceae	1787	284	
Physalis virginiana	Solanaceae	1788	284	
Physocarpus opulifolius	Rosaceae	1615	265	
Physostegia virginiana	Labiatae	1151	213	
Pilea fontana	Urticaceae	1842	290	
Pilea pumila	Urticaceae	1843	290	
Plagiobotrys scopulorum	Boraginaceae	217	110	
Plantago aristata	Plantaginaceae	1403	241	
Plantago elongata	Plantaginaceae	1404	241	Threatened
Plantago eriopoda	Plantaginaceae	1405	242	
Plantago rugelii	Plantaginaceae	1410	242	
Plantago virginica	Plantaginaceae	1411	242	
Platanthera clavellata	Orchidaceae	1378	239	Special Concern, Protected
Platanthera dilatata	Orchidaceae	1379	239	Protected
Platanthera flava v. herbiola	Orchidaceae	1380	239	Endangered, Protected
Platanthera hookeri	Orchidaceae	1381	239	Protected
Platanthera hyperborea	Orchidaceae	1382	239	Protected
Platanthera lacera	Orchidaceae	1383	239	Protected
Platanthera obtusata	Orchidaceae	1384	239	Protected
Platanthera orbiculata	Orchidaceae	1385	239	Protected
Platanthera praeclara	Orchidaceae	1386	239	Endangered, Protected
Platanthera psycodes	Orchidaceae	1387	240	Protected
Poa alsodes	Gramineae	1026	199	
Poa arida	Gramineae	1028	200	

Poa glauca	Gramineae	1031	200	
Poa interior	Gramineae	1032	200	
Poa languida	Gramineae	1033	200	
Poa paludigena	Gramineae	1035	200	Endangered
Poa palustris	Gramineae	1036	201	
Poa pratensis	Gramineae	1037	201	
oa saltuensis	Gramineae	1038	201	
Poa sylvestris	Gramineae	1039	201	
Poa wolfii	Gramineae	1042	201	Special Concern
Poa x tormentuosa	Gramineae	1040	201	
Podophyllum peltatum	Berberidaceae	183	106	
Pogonia ophioglossoides	Orchidaceae	1388	240	Protected
Polanisia dodecandra	Capparaceae	237	112	
Polanisia jamesii	Capparaceae	238	112	Endangered
Polemonium occidentale ssp. lacustre	Polemoniaceae	1417	243	
Polemonium reptans	Polemoniaceae	1418	243	
Polygala cruciata v. aquilonia	Polygalaceae	1419	243	Endangered
Polygala paucifolia	Polygalaceae	1420	243	
Polygala polygama v. obtusata	Polygalaceae	1421	243	
Polygala sanguinea	Polygalaceae	1422	243	
Polygala senega	Polygalaceae	1423	244	
Polygala verticillata v. isocycla	Polygalaceae	1424	244	
Polygonatum commutatum	Liliaceae	1262	226	
Polygonatum pubescens	Liliaceae	1263	226	
Polygonella articulata	Polygonaceae	1427	244	
Polygonum achoreum	Polygonaceae	1428	244	
Polygonum amphibium v. stipulaceum	Polygonaceae	1429	244	
Polygonum arenastrum	Polygonaceae	1430	244	
Polygonum arifolium v. pubescens	Polygonaceae	1431	244	Special Concern
Polygonum careyi	Polygonaceae	1434	245	Endangered
Polygonum cilinode	Polygonaceae	1435	245	
Polygonum coccineum	Polygonaceae	1436	245	
Polygonum cristatum	Polygonaceae	1438	245	
Polygonum douglasii	Polygonaceae	1439	245	
Polygonum erectum	Polygonaceae	1440	245	
Polygonum hydropiper	Polygonaceae	1441	246	
Polygonum hydropiperoides	Polygonaceae	1442	246	
Polygonum lapathifolium	Polygonaceae	1443	246	
Polygonum pensylvanicum	Polygonaceae	1444	246	Secondary Noxious Weed
Polygonum punctatur	Polygonaceae	1446	246	

Polygonum ramosissimum	Polygonaceae	1447	246	
Polygonum sagittatum	Polygonaceae	1448	246	
Polygonum scandens	Polygonaceae	1450	247	
Polygonum tenue	Polygonaceae	1451	247	
Polygonum virginianum	Polygonaceae	1452	247	
Polygonum viviparum	Polygonaceae	1453	247	Special Concern
Polymnia canadensis	Compositae	482	139	
Polytaenia nuttallii	Umbelliferae	1829	289	Endangered
Potamogeton alpinus	Potamogetonaceae	1475	249	
Potamogeton amplifolius	Potamogetonaceae	1476	249	
Potamogeton bicupulatus	Potamogetonaceae	1477	250	
Potamogeton diversifolius	Potamogetonaceae	1479	250	
Potamogeton epihydrus	Potamogetonaceae	1480	250	
Potamogeton filiformis	Potamogetonaceae	1481	250	
Potamogeton foliosus	Potamogetonaceae	1482	250	
Potamogeton friesii	Potamogetonaceae	1483	250	
Potamogeton gramineus	Potamogetonaceae	1484	250	
Potamogeton illinoensis	Potamogetonaceae	1486	251	
Potamogeton natans	Potamogetonaceae	1487	251	
Potamogeton nodosus	Potamogetonaceae	1488	251	
Potamogeton obtusifolius	Potamogetonaceae	1489	251	
Potamogeton pectinatus	Potamogetonaceae	1490	251	
Potamogeton praelongus	Potamogetonaceae	1491	251	
Potamogeton pusillus v. pusillus	Potamogetonaceae	1492	251	
Potamogeton pusillus v. tenuissimus	Potamogetonaceae	1493	251	
Potamogeton richardsonii	Potamogetonaceae	1494	251	
Potamogeton robbinsii	Potamogetonaceae	1495	252	
Potamogeton spirillus	Potamogetonaceae	1496	252	
Potamogeton strictifolius	Potamogetonaceae	1497	252	
Potamogeton vaginatus	Potamogetonaceae	1498	252	
Potamogeton vaseyi	Potamogetonaceae	1499	252	Special Concern
Potamogeton x haynesii	Potamogetonaceae	1485	250	
Potamogeton zosteriformis	Potamogetonaceae	1500	252	
Potentilla anserina	Rosaceae	1616	265	
Potentilla arguta	Rosaceae	1618	265	
Potentilla bipinnatifida	Rosaceae	1619	265	
Potentilla effusa	Rosaceae	1620	265	
Potentilla finitima	Rosaceae	1621	266	
Potentilla fruticosa	Rosaceae	1622	266	
Potentilla gracilis	Rosaceae	1623	266	
Potentilla millegrana	Rosaceae	1631	267	
Potentilla nicolletii	Rosaceae	1625	266	

Potentilla norvegica	Rosaceae	1626	266	
Potentilla palustris	Rosaceae	1627	266	
Potentilla paradoxa	Rosaceae	1628	266	
Potentilla pensylvanica	Rosaceae	1629	266	
Potentilla pentandra	Rosaceae	1631	267	
Potentilla rivalis	Rosaceae	1631	267	
Potentilla simplex	Rosaceae	1632	267	
Potentilla tridentata	Rosaceae	1633	267	
Prenanthes alba	Compositae	483	139	
Prenanthes aspera	Compositae	484	139	
Prenanthes crepidinea	Compositae	485	139	
Prenanthes racemosa	Compositae	486	139	
Primula mistassinica	Primulaceae	1513	254	
Prunella vulgaris	Labiatae	1152	213	
Psoralea argophylla	Leguminosae	1216	221	
Psoralea esculenta	Leguminosae	1217	221	
Psoralea tenuiflora	Leguminosae	1218	221	Special Concern
Puccinellia nuttalliana	Gramineae	1043	201	
Pulsatilla nuttalliana	Ranunculaceae	1547	257	
Pycnanthemum virginianum	Labiatae	1153	214	
Pyrola asarifolia	Pyrolaceae	1519	254	
Pyrola chlorantha	Pyrolaceae	1520	254	
Pyrola elliptica	Pyrolaceae	1521	254	
Pyrola minor	Pyrolaceae	1522	255	Special Concern
Pyrola rotundifolia v. americana	Pyrolaceae	1523	255	
Pyrola secunda	Pyrolaceae	1524	255	
Ranunculus abortivus	Ranunculaceae	1548	257	
Ranunculus aquatilis v. capillaceus	Ranunculaceae	1550	258	
Ranunculus circinatus v. subrigidus	Ranunculaceae	1551	258	
Ranunculus cymbalaria	Ranunculaceae	1552	258	
Ranunculus fascicularis	Ranunculaceae	1553	258	
Ranunculus flabellaris	Ranunculaceae	1554	258	
Ranunculus flammula	Ranunculaceae	1555	258	
Ranunculus gmelini	Ranunculaceae	1556	258	
Ranunculus hispidus v. caricetorum	Ranunculaceae	1557	258	
Ranunculus hispidus v. nitidus	Ranunculaceae	1558	259	
Ranunculus lapponicus	Ranunculaceae	1559	259	Special Concern
Ranunculus longirostris	Ranunculaceae	1560	259	
Ranunculus macounii	Ranunculaceae	1561	259	
Ranunculus pensylvanicus	Ranunculaceae	1562	259	

Ranunculus recurvatus	Ranunculaceae	1563	259	
Ranunculus rhomboideus	Ranunculaceae	1565	259	
Ranunculus sceleratus	Ranunculaceae	1566	259	
Ratibida columnifera	Compositae	487	140	
Ratibida pinnata	Compositae	488	140	
Rhynchospora alba	Cyperaceae	792	173	
Rhynchospora capillaceae	Cyperaceae	793	174	Threatened
Rhynchospora fusca	Cyperaceae	794	174	Special Concern
Rorippa islandica	Cruciferae	597	152	
Rorippa sinuata	Cruciferae	598	152	
Rotala ramosior	Lythraceae	1294	229	Threatened
Rudbeckia hirta v. pulcherrima	Compositae	489	140	
Rudbeckia laciniata	Compositae	490	140	
Rudbeckia triloba	Compositae	491	140	Special Concern
Rumex altissimus	Polygonaceae	1456	247	
Rumex maritmus v. fueginus	Polygonaceae	1459	248	
Rumex mexicanus	Polygonaceae	1460	248	
Rumex orbiculatus	Polygonaceae	1462	248	
Rumex verticillatus	Polygonaceae	1465	248	
Ruppia occidentalis	Ruppiaceae	1687	273	
Sagina nodosa ssp. borealis	Caryophyllaceae	271	116	Endangered
Sagina procumbens	Caryophyllaceae	272	116	
Sagittaria brevirostra	Alismataceae	126	99	
Sagittaria cristata	Alismataceae	127	100	
Sagittaria cuneata	Alismataceae	128	100	
ittaria graminea	Alismataceae	129	100	
Sagittaria latifolia	Alismataceae	130	100	
Sagittaria rigida	Alismataceae	131	100	
Salicornia rubra	Chenopodiaceae	312	120	Threatened
Salvia reflexa	Labiatae	1154	214	
Sanguinaria canadensis	Papaveraceae	1400	241	
Sanicula canadensis	Umbelliferae	1830	289	Special Concern
Sanicula gregaria	Umbelliferae	1831	289	
Sanicula marilandica	Umbelliferae	1832	289	
Sanicula trifoliata	Umbelliferae	1833	289	Special Concern
Sarracenia purpurea	Sarraceniaceae	1713	276	
Satureja vulgaris v. neogaea	Labiatae	1155	214	
Saxifraga aizoon v. neogaea	Saxifragaceae	1733	278	Threatened
Saxifraga cernua	Saxifragaceae	1734	278	Endangered
Saxifraga pensylvanica	Saxifragaceae	1735	278	
Saxifraga virginiensis	Saxifragaceae	1736	278	
Schedonnardus paniculatus	Gramineae	1044	201	Special Concern

Scheuchzeria palustris v. americana	Juncaginaceae	1129	211	
Schizachne purpurascens	Gramineae	1045	202	
Schizachyrium scoparium v. frequens	Gramineae	1046	202	
Scirpus acutus	Cyperaceae	795	174	
Scirpus atrocinctus	Cyperaceae	796	174	
Scirpus atrovirens	Cyperaceae	797	174	
Scirpus cespitosus v. callosus	Cyperaceae	798	174	
Scirpus clintonii	Cyperaceae	799	174	
Scirpus cyperinus	Cyperaceae	800	174	
Scirpus fluviatilis	Cyperaceae	801	174	
Scirpus georgianus	Cyperaceae	802	175	
Scirpus hattorianus	Cyperaceae	803	175	
Scirpus heterochaetus	Cyperaceae	804	175	
Scirpus hudsonianus	Cyperaceae	805	175	
Scirpus microcarpus	Cyperaceae	806	175	
Scirpus pallidus	Cyperaceae	807	175	
Scirpus paludosus	Cyperaceae	808	175	
Scirpus pedicellatus	Cyperaceae	809	175	
cirpus pungens	Cyperaceae	810	175	
Scirpus purshianus	Cyperaceae	811	176	
Scirpus smithii	Cyperaceae	812	176	
Scirpus subterminalis	Cyperaceae	813	176	
Scirpus torreyi	Cyperaceae	814	176	
Scirpus validus v. creber	Cyperaceae	815	176	
Scleria triglomerata	Cyperaceae	816	176	Endangered
Scleria verticillata	Cyperaceae	817	176	Threatened
Scolochloa festucacea	Gramineae	1047	202	
Scrophularia lanceolata	Scrophulariaceae	1774	283	
Scrophularia marilandica	Scrophulariaceae	1775	283	
Scutellaria galericulata	Labiatae	1156	214	
Scutellaria lateriflora	Labiatae	1157	214	
Scutellaria leonardi	Labiatae	1158	214	
Scutellaria ovata ssp. versicolor	Labiatae	1159	214	Special Concern
Scutellaria parvula	Labiatae	1160	214	
Sedum integrifolium ssp. leedyi	Crassulaceae	551	147	Endangered
Senecio aureus	Compositae	492	140	
Senecio canus	Compositae	493	140	
Senecio congestus	Compositae	494	140	
Senecio indecorus	Compositae	495	140	
Senecio integerrimus	Compositae	496	141	
Senecio pauperculus	Compositae	497	141	

Senecio plattensis	Compositae	498	141	
Senecio psuedaureus v. semicordatus	Compositae	499	141	
Shinnersoseris rostrata	Compositae	501	141	Threatened
Sicyos angulatus	Cucurbitaceae	605	153	
Silene antirrhina	Caryophyllaceae	275	116	
Silene drummondii	Caryophyllaceae	279	116	
Silene nivea	Caryophyllaceae	281	117	Threatened
Silene stellata	Caryophyllaceae	283	117	
Silphium laciniatum	Compositae	502	141	
Silphium perfoliatum	Compositae	503	141	
Sisyrinchium campestre	Iridaceae	1095	207	
Sisyrinchium montanum	Iridaceae	1096	207	
Sisyrinchium mucronatum	Iridaceae	1097	207	
Sium suave	Umbelliferae	1834	289	
Smilacina racemosa	Liliaceae	1264	226	
Smilacina stellata	Liliaceae	1265	226	
Smilacina trifolia	Liliaceae	1266	226	
Smilax ecirrata	Liliaceae	1267	226	
Smilax herbacea	Liliaceae	1268	226	
Smilax hispida	Liliaceae	1269	226	
Smilax illinoensis	Liliaceae	1270	227	
Smilax lasioneura	Liliaceae	1271	227	
Solanum carolinense	Solanaceae	1789	284	
Solanum ptycanthum (S. nigrum)	Solanaceae	1791	284	Secondary Noxious Weed
Solidago canadensis	Compositae	505	142	
Solidago flexicaulis	Compositae	506	142	
Solidago gigantea	Compositae	507	142	
Solidago hispida	Compositae	508	142	
Solidago juncea	Compositae	509	142	
Solidago missouriensis	Compositae	510	142	
Solidago mollis	Compositae	511	142	Special Concern
Solidago nemoralis	Compositae	512	142	
Solidago ptarmicoides	Compositae	513	142	
Solidago riddellii	Compositae	514	143	
Solidago rigida	Compositae	515	143	
Solidago sciaphila	Compositae	516	143	Special Concern
Solidago speciosa	Compositae	517	143	
Solidago uliginosa	Compositae	518	143	
Solidago ulmifolia	Compositae	519	143	
Solidago x bernardii	Compositae	504	141	
Sorghastrum nutans	Gramineae	1054	203	

Sparganium americanum	Sparganiaceae	1793	285	
Sparganium androcladum	Sparganiaceae	1794	285	
Sparganium angustifolium	Sparganiaceae	1795	285	
Sparganium chlorocarpum	Sparganiaceae	1796	285	
Sparganium eurycarpum	Sparganiaceae	1797	285	
Sparganium fluctuans	Sparganiaceae	1798	285	
Sparganium glomeratum	Sparganiaceae	1799	285	Endangered
Sparganium minimum	Sparganiaceae	1800	285	
Spartina gracilis	Gramineae	1055	203	Special Concern
Spartina pectinata	Gramineae	1056	203	
Sphaeralcea coccinea	Malvaceae	1301	230	
Sphenopholis intermedia	Gramineae	1057	203	
Sphenopholis obtusata	Gramineae	1058	203	
Spiranthes cernua	Orchidaceae	1389	240	Protected
Spiranthes lacera	Orchidaceae	1390	240	Protected
Spiranthes magnicamporum	Orchidaceae	1391	240	Protected
Spiranthes romanzoffiana	Orchidaceae	1392	240	Protected
Sporobolus asper	Gramineae	1059	203	
Sporobolus cryptandrus	Gramineae	1060	203	
Sporobolus heterolepis	Gramineae	1061	203	
Sporobolus neglectus	Gramineae	1062	203	
Sporobolus vaginiflorus	Gramineae	1063	204	
Stachys palustris	Labiatae	1161	214	
Stachys tenuifolia	Labiatae	1162	215	
Staphylea trifolia	Staphyleaceae	1801	286	
Stellaria alsine	Caryophyllaceae	285	117	
Stellaria borealis	Caryophyllaceae	286	117	
Stellaria crassifolia	Caryophyllaceae	287	117	
Stellaria longifolia	Caryophyllaceae	289	118	
Stellaria longipes	Caryophyllaceae	290	118	Special Concern
Stipa comata	Gramineae	1064	204	
Stipa spartea	Gramineae	1065	204	
Stipa viridula	Gramineae	1066	204	
Streptopus amplexifolius	Liliaceae	1272	227	
Streptopus roseus v. longipes	Liliaceae	1273	227	
Strophostyles helvula	Leguminosae	1220	221	
Strophostyles leiosperma	Leguminosae	1221	221	
Suaeda calceoliformis	Chenopodiaceae	315	120	
Subularia aquatica ssp. americana	Cruciferae	602	152	Endangered
Sullivantia renifolia	Saxifragaceae	1737	278	Endangered
Symplocarpus foetidus	Araceae	158	103	
Taenidia integerrima	Umbelliferae	1835	289	
Talinum parviflorum	Portulacaceae	1473	249	

Talinum rugospermum	Portulacaceae	1474	249	Endangered
Tephrosia virginiana	Leguminosae	1222	221	Special Concern
Teucrium canadense	Labiatae	1163	215	
Thalictrum dasycarpum	Ranunculaceae	1567	260	
Thalictrum dioicum	Ranunculaceae	1568	260	
Thalictrum venulosum	Ranunculaceae	1569	260	
Thaspium barbinode	Umbelliferae	1836	289	
Tillaea aquatica	Crassulaceae	553	147	Endangered
Tofieldia glutinosa	Liliaceae	1274	227	Special Concern
Tofieldia pusilla	Liliaceae	1275	227	Endangered
Torreyochloa pallida	Gramineae	1067	204	
Tradescantia bracteata	Commelinaceae	324	121	
Tradescantia occidentalis	Commelinaceae	325	122	
Tradescantia ohiensis	Commelinaceae	326	122	Special Concern
Triadenum fraseri	Hypericaceae	1092	207	
Trientalis borealis	Primulaceae	1514	254	
Triglochin maritima	Juncaginaceae	1130	211	
Triglochin palustris	Juncaginaceae	1131	211	Special Concern
Trillium cernuum	Liliaceae	1276	227	Protected
Trillium flexipes	Liliaceae	1277	227	Protected
Trillium grandiflorum	Liliaceae	1278	227	Protected
Trillium nivale	Liliaceae	1279	228	Special Concern, Protected
Triodanis leptocarpa	Campanulaceae	235	112	
Triodanis perfoliata	Campanulaceae	236	112	
Triosteum perfoliatum	Caprifoliaceae	253	114	
Triplasis purpurea	Gramineae	1068	204	Special Concern
Trisetum spicatum	Gramineae	1069	204	
Typha angustifolia	Typhaceae	1804	286	
Typha latifolia	Typhaceae	1805	286	
Uvularia grandiflora	Liliaceae	1280	228	
Uvularia sessilifolia	Liliaceae	1281	228	
Urtica dioica ssp. gracilis	Urticaceae	1844	290	
Vaccinium macrocarpon	Ericaceae	843	179	
Vaccinium oxycoccus	Ericaceae	845	179	
Valeriana edulis ssp. ciliata	Valerianaceae	1845	290	Threatened
Verbena bracteata	Verbenaceae	1848	291	
Verbena hastata	Verbenaceae	1849	291	
Verbena simplex	Verbenaceae	1850	291	Special Concern
Verbena stricta	Verbenaceae	1851	291	
Verbena urticifolia	Verbenaceae	1852	291	
Vernonia fasciculata	Compositae	529	144	
Veronica americana	Scrophulariaceae	1777	283	

Veronica catenata	Scrophulariaceae	1779	283	
Veronica officinalis	Scrophulariaceae	1781	283	
Veronica peregrina	Scrophulariaceae	1782	283	
Veronica scutellata	Scrophulariaceae	1783	284	
Veronicastrum virginicum	Scrophulariaceae	1785	284	
Vicia americana	Leguminosae	1229	222	
Viola adunca	Violaceae	1853	291	
Viola affinis	Violaceae	1854	291	
Viola canadensis v. rugulosa	Violaceae	1855	292	
Viola conspersa	Violaceae	1856	292	
Viola cucullata	Violaceae	1857	292	
Viola incognita	Violaceae	1858	292	
Viola labradorica	Violaceae	1859	292	
Viola lanceolata	Violaceae	1860	292	Special Concern
Viola macloskeyi ssp. pallens	Violaceae	1861	292	
Viola missouriensis	Violaceae	1862	292	
Viola nephrophylla	Violaceae	1863	292	
Viola novae-angliae	Violaceae	1864	293	Special Concern
Viola nuttallii	Violaceae	1865	293	Special Concern
Viola pedata	Violaceae	1866	293	
Viola pedatifida	Violaceae	1867	293	
Viola pratincola	Violaceae	1868	293	
Viola pubescens	Violaceae	1869	293	
Viola renifolia	Violaceae	1870	293	
Viola sagittata	Violaceae	1871	293	
Viola selkirkii	Violaceae	1872	293	
Viola sororia	Violaceae	1873	294	
Vulpia octoflora v. glauca	Gramineae	1070	204	
Waldsteinia fragarioides	Rosaceae	1672	271	Special Concern
Xanthium strumarium	Compositae	530	144	Secondary Noxious Weed
Xyris montana	Xyridaceae	1879	294	Special Concern
Xyris torta	Xyridaceae	1880	294	Threatened
Zannichellia palustris v. major	Zannichelliaceae	1881	294	
Zanthoxylum americanum	Rutaceae	1688	273	
Zigadenus elegans	Liliaceae	1282	228	
Zigadenus glaucus	Liliaceae	1282	228	
Zizania palustris	Gramineae	1071	204	
Zizia aptera	Umbelliferae	1837	290	
Zizia aurea	Umbelliferae	1838	290	

* Sources for these comments are:

1. Durgan, Beverl; 'entification of the Primary Weeds of Minnesota, MN De, .f Agriculture: Page

Agronomy Service of Weed Control, 1991. Leaflet AG-FO-5620-S. None of the primary noxious weeds are native to Minnesota, but a number of native plants have been placed on the secondary list and may be defined as "Noxious" by individual counties.

2. Coffin, Barbara, L. Pfannmuller. Minnesota Endangered Flora and Fauna, Minneapolis: University of Minnesota Press, 1988. Coffin and Pfannmuller define three grades of endangered plants, those that have been designated as "Endangered" and "Threatened" by the state, and those that are in enough ecological danger to warrant a designation of "Special Concern" and monitoring.

3. The designation of protected plants is according to the State Wildflower Law, Section 17.23 "Conservation of Certain Wildflowers."

TABLE 3: 1991 AND 1992 SEED COLLECTIONS - PRODUCTION RESEARCH

1991 SEED COLLECTIONS

SCIENTIFIC NAME	COMMON NAME	SAMPLE NUMBER	DATE	LOCATION
Grasses				
Andropogon gerardii	Big Bluestem	C27	9-10-91	5
Muhlenbergia cf. mexicana	Muhly	C33	9-11-91	7
Schizachyrium scoparium	Little Bluestem	C20	9-10-91	6
		C28	9-10-91	5
Spartina pectinata	Prairie Cordgrass	C37	9-11-91	7
		D3	10-1-91	33
Sporobolus heterolepis	Prairie Dropseed	C34	9-11-91	7
Forbs				
Amorpha canescens	Leadplant	C18	9-10-91	6
		C46	9-11-91	7
		C60	9-12-91	21
Asclepias tuberosa	Butterflyweed	D1	9-18-91	26
Aster sericeus	Silky Aster	D5	10-1-91	3
Astragalus canadensis	Canada Milk Vetch	B3	9-9-91	3
		C67	9-12-91	18
Coreopsis palmata	Prairie Coreopsis	A20	8-24-91	D
Petalostemum candida	White Prairie Clover	B7	9-9-91	3
		C48	9-11-91	8
		C50	9-11-91	S
Petalostemum purpurea	Purple Prairie Clover	A56	9-4-91	2
		B6	9-9-91	3
		C2	9-10-91	5
		C32	9-11-91	7
		C47	9-11-91	8
		C68	9-12-91	18
Galium boreale	Northern Bedstraw	C6	9-10-91	5
Gentiana cf. andrewsii	Bottle Gentian	C62	9-12-91	21
		C3	9-10-91	5
Liatris cf. punctata	Dotted Blazingstar	C69	9-12-91	19
Liatris pycnostachya	Prairie Blazingstar	B5	9-9-91	3
Lilium philadelphicum	Wood Lily	C71	9-12-91	16
Monarda fistulosa	Bergamot	A11	8-24-91	B
		A54	9-4-91	1
		C22	9-10-91	6
		D11	10-1-91	34

SCIENTIFIC NAME	COMMON NAME	SAMPLE NUMBER	DATE	LOCATION
Onosmodium molle	False Gromwell	D4	10-1-91	34
Veronicastrum virginicum	Culver's Root	C42	9-11-91	8

1992 SEED COLLECTIONS

SCIENTIFIC NAME	COMMON NAME	SAMPLE NUMBER	DATE	LOCATION
Grasses				
Andropogon gerardii	Big Bluestem	92F8	10-3-92	BL
		92T1	10-3-92	TW
		92A8	10-14-92	3
Koeleria pyramidata	Junegrass	92S2	9-2-92	SC
		92O3	9-3-92	OR
		92F4	10-3-92	FR
Muhlenbergia spp.	Muhly	92F13	10-3-92	BL
		92T4	10-3-92	TW
Schizachyrium scoparium	Little Bluestem	92F15	10-3-92	BL
		92T5	10-3-92	TW
		92G7	10-4-92	OT
Spartina pectinata	Prairie Cordgrass	92F14	10-3-92	BL
		92T6	10-3-92	TW
		92G2	10-4-92	RE
		92G8	10-4-92	OT
Sporobolus heterolepis	Prairie Dropseed	92O7	9-3-92	OR
Forbs				
Amorpha canescens	Leadplant	92F1	10-3-92	FR
		92F7	10-3-92	BL
Aster sericeus	Silky Aster	92F9	10-3-92	BL
		92A12	10-21-9	3
Astragalus canadensis	Canada Milk Vetch	92T2	10-3-92	TW
		92G3	10-4-92	WE
		92A10	10-14-92	3
Coreopsis palmata	Prairie Coreopsis	92O1	9-3-92	OR
		92B1	9-14-92	BU
Petalostemum candida	White Prairie Clover	92A6	10-9-92	3
		92A7	10-14-9	3
Petalostemum purpureum	Purple Prairie Clover	92B3	9-14-92	BU

SCIENTIFIC NAME	COMMON NAME	SAMPLE NUMBER	DATE	LOCATION
Petalostemum purpureum	Purple Prairie Clover	92F2	10-3-92	FR
		92F10	10-3-92	BL
		92G4	10-4-92	WE
		92G6	10-4-92	OT
		92A9	10-14-92	3
Galium boreale	Northern Bedstraw	92O2	9-3-92	OR
		92S1	9-2-92	SC
		92B2	9-14-92	BU
		92F3	10-3-92	FR
Galium boreale	Northern Bedstraw	92F12	10-3-92	BL
Gentiana andrewsii	Bottle Gentian	92F11	10-3-92	BL
Liatris pycnostachya				
Lilium philadelphicum	Wood Lily	92T3	10-3-92	TW
		92G1	10-4-92	RE
Lithospermum carolinense	Puccoon	92O4	9-3-92	OR
Phlox pilosa	Prairie Phlox	92Z1	8-1-92	PE
		92S0	9-2-92	SC
		92O6	9-3-92	OR
Onosmodium molle	False Gromwell	92O5	9-3-92	OR
Pycnanthemum virginicum	Virginia Mint			
Verbena hastata	Blue Vervain			
Verbena stricta	Hoary Vervain	92F5	10-3-92	FR
Veronicastrum virginicum	Culver's Root	92F16	10-3-92	BL
		92T7	10-3-92	TW
Zizia aurea	Golden Alexander	92S5	9-2-92	SC
		92B6	9-14-92	BU

TABLE 4: 1991 AND 1992 SEED COLLECTIONS - GENETIC DIVERSITY RESEARCH

SCIENTIFIC NAME	COMMON NAME	POPULATION NUMBER	DATE	LOCATION
Grasses				
Andropogon gerardii	Big Bluestem	AG-4	9-10-91	4
		AG-5	9-10-91	5
		AG-6	9-10-91	6
		AG-7	9-11-91	7
		AG-8	9-11-91	8
		AG-9	9-11-91	9
		AG-12	9-12-91	12
		AG-14	9-12-91	14
		AG-17	9-12-91	17
		AG-18	9-12-91	18
		AG-20	9-12-91	20
		AG-21	9-12-91	21
		AG-22	9-12-91	22
		AG-23	9-12-91	23
		AG-24	9-18-91	24
		AG-25	9-18-91	25
		AG-26	9-18-91	26
		AG-28	9-18-91	28
		AG-29	9-18-91	30
		AG-31	9-18-91	31
		AG-32	9-20-91	32
		AG-33	10-1-91	33
		AG-34T	10-1-91	34
		AG-34B	10-1-91	34
		AG-36	10-1-91	36
		AG-TW	10-3-92	TW
		AG-BL	10-3-92	BL
		AG-WE	10-4-92	WE
		AG-OT	10-4-92	OT
Schizachyrium scoparium	Little Bluestem	SS-4	9-10-91	4
		SS-6	9-10-91	6
		SS-7	9-11-91	7
		SS-8	9-11-91	8
		SS-14	9-12-91	14
		SS-17	9-12-91	17
		SS-22	9-12-91	22
		SS-23	9-12-91	23

SCIENTIFIC NAME	COMMON NAME	POPULATION NUMBER	DATE	LOCATION
Schizachyrium scoparium	Little bluestem	SS-26	9-18-91	26
		SS-27	9-18-91	27
		SS-33	10-1-91	33
		SS-34.1	10-1-91	34
		SS-34.2	10-1-91	34
		SS-36	10-1-91	36
		SS-36	10-1-91	36
		SS-FR	10-3-92	FR
		SS-BL	10-3-92	BL
		SS-WE	10-4-92	WE
		SS-OT	10-4-92	OT
Forbs				
Liatris aspera	Rough Blazing Star	LA-37	10-3-91	37
		LA-FR	10-3-92	FR
		LA-BL	10-3-92	BL
Liatris ligulistylis	Meadow Blazing Star	LL-BU	9-14-92	BU
Liatris aspera or ligulistylis		L-3	9-9-91	3
		L-4	9-10-91	4
		L-5.1	9-10-91	5
		L-5.2	9-10-91	5
		L-5.3	9-10-91	5
		L-6.1	9-10-91	6
		L-6.2	9-10-91	6
		L-7.1	9-11-91	7
		L-7.2	9-11-91	7
		L-8	9-11-91	8
		L-13.1	9-12-91	13
		L-13.2	9-12-91	13
		L-17	9-12-91	17
		L-33.1	10-1-91	33
		L-33.2	10-1-91	33
		L-34.1	10-1-91	34
		L-34.2	10-1-91	34
		L-34.3	10-1-91	34
		L-34.4	10-1-91	34

SCIENTIFIC NAME	COMMON NAME	POPULATION NUMBER	DATE	LOCATION
Liatris punctata	Dotted Blazing Star	LPU-6	9-10-91	6
		LPU-19	9-12-91	19
		LPU-FR	10-3-92	FR
Liatris punctata	Dotted Blazing Star	LPU-BL	10-3-92	BL
Liatris pycnostachya	Prairie Blazing Star	LPY-3	9-9-91	3
		LPY-4	9-10-91	4
		LPY-5	9-10-91	5
		LPY-15	9-12-91	15
		LPY-16	9-12-91	16
		LPY-17	9-12-91	17
		LPY-20	9-12-91	20
		LPY-35	9-?-91	35
		LPY-TW	10-3-92	TW
		LPY-BL	10-3-92	BL
		LPY-RE	10-4-92	RE
		LPY-WE	10-4-92	WE
		LPY-OT	10-4-92	0T
Monarda fistulosa	Wild Bergamot	MF-1	9-4-92	1
		MF-5	9-10-91	5
		MF-6	9-10-91	6
		MF-8	9-11-91	8
		MF-26	9-18-91	26
		MF-27	9-18-91	27
		MF-34	10-1-91	34
		MF-37	10-3-91	37

TABLE 5: LOCATION KEY FOR SEED COLLECTION LIST

1	Roadside, Hwy 8, .25 miles south of Taylor's Falls. Chisago Co.
2	Roadside, at junction of Oriole Ave. and River Rd., Co. Rd. 71. Chisago Co.
3	University of Minnesota Landscape Arboretum. Carver Co.
4	Roadside, Hwy. 102 at mile marker no. 7. Polk Co.
5	Roadside, 2.5 miles west of Hwy 102 on Co. 41. Polk Co.
6	Roadside, 4 miles east of Hwy 102 on Co. 45. Polk Co.
7	Remnant prairie leased by Oscar Carlson, Marsh Grove Township, SE and W1/2 of section 36. Marshall Co.
8	Privately owned prairie, Clow Township, NE corner of NW1/4 of section 35, T164N, R49W. Kittson Co.
9	Roadside, St. Joseph Township, SW1/4 Section 27, T163N, R47W. Kittson Co.
11	Roadside, Gravel Rd. approximately 1 mile south of Co. Rd. 3, 3 mile from Hwy 32. Pennington Co.
12	Roadside, Hwy. 32, 1 mile south of the Pennington/Red Lake Co. line. Red Lake Co.
13	Roadside, Hwy. 32, 1.5 miles south of Pennington/Red Lake Co. line. Red Lake Co.
14	Roadside, Hwy. 9, 3 miles north of Lockhart. Norman Co.
15	Roadside, Hwy. 9, 1 mile north of Lockhart. Norman Co.
16	Roadside, Co. Rd. 39 about 4 miles west of Syre. Norman Co.
17	Roadside, Hwy 32, 2 miles north of Syre. Norman Co.
18	Roadside, 2 miles west of Ulen on Co. Rd. 34. Clay Co.
19	Roadside, Co. Rd. 27, 2 miles south of Co. 34. Clay Co.
20	Roadside, Hwy 9 just south of Downer. Clay Co.
21	Roadside, 1 mile south of Barnesville on Co. Rd. 52. Clay Co.
22	Roadside, Co. Rd. 52, 2 miles south of Barnesville. Wilkin Co.
23	Roadside, Co. Rd. 52, just south of Carlisle. Ottertail Co.
24	Roadside, Hwy. 316, 2 miles SE of Hastings. Dakota Co.
25	Roadside, Hwy 61, 1.5 miles north of Lake Pepin. Goodhue Co.
26	Roadside, Hwy 74, 2 miles southwest of Hwy 61. Wabasha Co.
27	Roadside, Hwy 74, .5 miles south of Elba. Winona Co.
28	Roadside, Hwy 76, 5.5 miles NW of Caledonia. Houston Co.
29	Roadside, Co. Rd. 8, .25 miles from junction of Hwy 44. Houston Co.
30	Roadside adjacent to Riceford Our Saviour Lutheran Church near Co. Rd. 8. Houston/Fillmore Co.
31	Roadside, gravel road .25 miles from Co. Rd. 24 near Lenora. Fillmore Co.
32	Roadside, 2 miles south of Co. Rd. 8A. Washington Co.
33	Railroad right of way between Co. Rd. 32 and Hwy. 23, south of Cottonwood. Lyon Co.
34	Remnant prairie leased by Robert Mohn, approximately 8 miles south of Minneota. Lyon Co.
35	Collection by Robert Mohn, south of Lakefield. Jackson Co.
36	Collection by Roy Robison. Ramsey Co.
37	Collection by Roy Robison. Ramsey Co.
B	Roadside, Co. N, 1 mile north of Colfax, Wisconsin. Dunn Co.
D	Roadside, Co. A NE of Colfax, Wisconsin.
S	Vacant Lot , town of Halma
BL	Blazing Star Prairie, TNC
BU	Prairie leased by Wayne Feder, Butternut MN
FR	Frenchman's Bluff Scientific and Natural Area
OR	Ordway Prairie, TNC
OT	Ottertail Prairie Scientific and Natural Area
PE	Roadside, Hwy 12 westbound, at mile marker 68
RE	Rice Elliotte Prairie Scientific and Natural Area
SC	Schaeffer Prairie, TNC
TW	Twin Valley Prairie Scientific and Natural Area
WE	Western Prairie South Scientific and Natural Area

TABLE 6: COLUMNS DEFINITIONS AND EXAMPLE FOR LOTUS 123 SPREDSHEET.

A. Name
B. Family
C. Map # in Ownbey and Morley
D. Noxious Weed
E. Endangered/Protected
F. Fruiting Structure
G. Harvest Time
H. Seed Yield
I. % Viable
J. Seed Type
K. Storage Requirements
L. Reference for Seed Data (columns F-K)
M. Seed Treatment 1
N. Reference
O. Seed Treatment 2
P. Reference
Q. Light/Dark/Heat Germination Requirement
R. Reference
S. Comments for Seed Propagation
T. Cutting Technique
U. Reference
V. Division
W. Reference
X. Tissue Culture
Y. Reference
Z. Other Asexual Propagation
AA. Comments
AB. Reference
AC. Allelopathy or Complimentary Plant Associations
AD. Production Treatment 1
AE. Reference
AF. Production Treatment 2
AG. Reference
AH. Preferred Soil
AI. Preferred Sun
AJ. Preferred Moisture
AK. Cultivation Comments
AL. Reference for Cultivation Comments (columns AH-AK)
AM. Root Structure
AN. Reference
AO. Genetic Information
AP. Reference
AQ. Further Comments
AR. Research Conducted at University of Minnesota

Example of a Spread-Sheet Entry

Asclepias tuberosa L. (Butterfly-Weed)

A. Name	Asclepias tuberosa
B. Family	Asclepiadaceae
C. Map #	175
D. Noxious Weed	No
E. Endangered/Protected	No
F. Fruiting Structure	Hairy, spindle-shaped pod
G. Harvest Time	As soon as seed ripens but before pod splits, 6-8 weeks after flowering.
H. Seed Yield	No information
I. % Viable	No information
J. Seed Type	No information
K. Storage Requirements	Regrows well after storage at 28 to 34, or 41 C.
L. Reference for Seed Data	790, 258, 1035
M. Seed Treatment 1	Plant seed as soon as pod opens: needs cold/warm period.
N. Reference	811
O. Seed Treatment 2	Germinates best if planted in soil mix of equal parts peat, perlite, and loamy soil, amended with nutrients; germinates poorly if pretreated with water-soak or provided bottom heat during germination.
P. Reference	422
Q. Light/Dark/Heat Requirement	Best germination was at 30C with constant light. Germinated only when temperature in range 25-30 C.
R. Reference	109
S. Comments for Seed Propagation	Seed never germinated if held at or below 10 C - Ref. 10
T. Cutting Technique	Tip cuttings; or cuttings made at end of dormant season. Success rate: good.
U. Reference	811, 258
V. Division	Taproot can be sliced into pieces. Success rate: only partly successful since taproot does not like to be disturbed.
W. Reference	804, 492
X. Tissue Culture	No information
Y. Reference	No information
Z. Other Asexual Propagation	No further information
AA. Comments	No further comments
AB. Reference	No information
AC. Allelopathy or Complimentary	No information
AD. Production Treatment 1	Responds with increased vigor to burning: will bloom second time after a July burn.
AE. Reference	902
AF. Production Treatment 2	Tolerates mowing through the end of May and will still bloom in July.

AG. Reference	258
AH. Preferred Soil	Well- drained, pH 5-7, usually prefers sandy, loamy or rocky-limestone-derived soil: prairie or open woods.
AI. Preferred Sun	Exposed sunny areas
AJ. Preferred Moisture	Dry
AK. Cultivation Comments	Responds well in cultivation.
AL. Reference (AH-AK)	911, 494, 1035
AM. Root Structure	Fast-growing, long, taproot, branched crown.
AN. Reference	804, 132
AO. Genetic Information	No information
AP. Reference	No information
AQ. Further Comments	Plants grown in greenhouse bloom more profusely than those grown in field. Ref. 10
AR. Research Conducted at U.of M.	No research for this project

TABLE 7: SLIDES TAKEN FOR SEED AND SEEDLING IDENTIFICATION MATERIALS

SPECIES	SEEDLING	SEED
Agastache foeniculum	X	X
Allium stellatum		X
Anemone canadensis		X
Anemone cylindrica	X	X
Apocynum cf. androsaemifolium	X	X
Asclepias incarnata	X	X
Asclepias tuberosa		X
Asclepias verticillata	X	X
Aster oolentangiensis	X	X
Aster sericeus	X	X
Astragalus canadensis		X
Astragalus crassicarpus	X	X
Baptisia leucantha	X	X
Bouteloua gracilis	X	
Campanula rotundifolia	X	X
Ceanothus americanus		X
cf. Heterotheca villosa		X
Coreopsis palmata	X	X
Petalostemum candidum	X	
Petalostemum purpureum	X	X
Delphinium virescens	X	X
Desmodium canadense		X
Echinacea spp.	X	
Elymus canadensis		X
Eryngium yuccifolium	X	X
Eupatorium spp.	X	X
Euphorbia corollata	X	X
Galium boreale	X	X
Gentiana andrewsii		X
Geum triflorum		X
Heuchera richardsonii	X	X
Hypericum cf. pyramidatum		X
Liatris aspera	X	
Liatris punctata		X
Liatris pycnostachya	X	X
Lilium michiganense		X
Lilium philadelphicum	X	X
Monarda fistulosa		X
Oenothera biennis		X
Onosmodium molle	X	X
Panicum virgatum	X	X
Phlox pilosa	X	X
Physalis spp.		X
Potentilla arguta		X
Psoralea esculenta	X	X
Pycnanthemum flexuosum		X
Ratibida columnifera		X
Ratibida pinnata	X	X
Rudbeckia hirta	X	X
Ruellia humilis		X
Silphium laciniatum		X
Sorghastrum nutans	X	
Spartina pectinata	X	
Sporobolus asper		X
Sporobolus heterolepis		X
Thalictrum spp.	X	X
Tradescantia occidentalis		X
Tradescantia ohiensis	X	X
Verbena hastata	X	X
Verbena stricta	X	X
Vernonia spp.	X	X
Veronicastrum virginicum		X
Zizia aurea	X	X

TABLE 8: ADDITIONAL SPECIES FOR WHICH GERMINATION TRIALS HAVE BEEN CONDUCTED

SPECIES	ACCESSIONS	TREATMENTS APPLIED: SCARIFY	STRATIFY	AFTER-RIPEN	LEACH	GA
Amorpha canescens	C18, C60, AW1, AW2	X				X
Aster oolentangiensis	AW3, AW4		X			X
Aster sericeus	92F9, 92A12, CP		X			X
Astragalus canadensis	WF	X				
Coreopsis palmata	92B1, 92O1, AW9, AW10		X			
Desmodium canadense	WF	X				
Galium boreale	C6, AW11		X			
Gentiana andrewsii	C62, AW13		X			
Koeleria macrantha	AW39, AW40		X	X		
Liatris pycnostachya	B5		X			X
Lilium philadelphicum	C71, 92G1, AW14		X			
Lithospermum carolinense	AW15	X	X			
Onosmodium molle	92O5, AW16, AW17	X	X			
Petalostemum candidum	C48, AW18	X				
Petalostemum purpureum	C47, C68, 92A9, 92G6, WF, AW19, AW20, PP	X				
Phlox pilosa	WF91, WF92, 92SE, 92Z1		X			X
Pycnanthemum virginianum	AW24		X			X
Spartina pectinata	C37, AW42, CP		X	X		X
Sporobolus heterolepis	C34, AW43, AW44, AW47	X	X		X	
Tradescantia occidentalis	AW25		X			X
Tradescantia ohiensis	92A11		X			
Verbena hastata	AW26, AW27		X			
Verbena stricta	AW28, AW29		X			
Veronicastrum virginicum	AW31, AW32		X			
Zizia aurea	AW34, AW35		X		X	

TABLE 9: PRELIMINARY ISOZYME ANALYSIS

Population	AAT	ACP	ADH	EST	G6PDH	GDH	IDH	MDH	PGD	PGI	PGM	PRX
AG - 4	0	i	i	i	i	0	0	0	i	i	+	i
AG - 5	i	i	i	i	i	0	0	0	i	i	+	i
AG - 7	i	i	i	i	i	0	0	0	i	i	+	i
AG - 9	i	i	i	i	i	0	0	0	i	i	+	i
AG - 12	i	i	i	i	i	0	0	0	i	i	+	i
AG - 14	i	i	i	i	i	0	0	0	i	i	+	i
AG - 20	i	i	i	i	i	0	0	0	i	i	+	i
SS - 4	0	i	i	i	i	i	i	0	i	i	i	i
SS - 7	0	i	i	i	i	i	i	0	i	i	i	i
SS - 17	0	i	i	i	i	i	i	+	i	i	i	i
SS - 23	0	i	i	i	i	i	i	0	i	i	i	i
SS - 27	0	i	i	i	i	i	i	+	i	i	i	i
SS - 34.1	0	i	i	i	i	i	i	+	i	i	i	i
SS - 36	0	i	i	i	i	i	i	+	i	i	i	i
LPU - 6	+	+	+	i	i	i	i	0	0	0	+	i
LPU - 19	+	+	i	i	i	i	i	0	0	0	+	i
L - 7.1	i	i	+	i	i	i	i	0	0	0	+	i
LPY - 3	i	i	+	i	i	i	i	0	0	0	+	i
LPY - 4	i	i	+	i	i	i	i	0	0	0	+	i
LPY - 15	i	i	+	i	i	i	i	0	0	0	+	i
LPY - 17	i	i	+	i	i	i	i	0	0	0	+	i
LPY - 20	i	i	+	i	i	i	i	0	0	0	+	i

+ - polymorphic; 0 - monomorphic; i - inconclusive.

TABLE 10: MORPHOLOGICAL DIFFERENCES OBSERVED

Grasses

Population	Height (cm)		No. of Stems		No. of Inflorescences	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
AG - 4	63.72	12.93	6.56	4.55	11.78	7.37
AG - 5	65.83	18.00	12.33	6.62	16.00	9.44
AG - 6	72.63	12.91	6.13	3.40	12.13	6.31
AG - 7	73.60	11.93	7.40	3.44	15.20	7.95
AG - 8	55.90	11.03	5.45	2.30	10.18	5.84
AG - 9	65.00	4.24	8.00	2.83	15.00	9.90
AG - 11	67.23	9.60	8.69	4.71	15.15	8.20
AG - 17	66.86	5.24	6.86	1.57	12.86	3.98
AG - 20	75.38	11.78	7.00	3.39	10.38	5.21
AG - 22	68.75	4.57	8.25	8.54	15.50	18.45
AG - 24	79.75	16.58	5.38	3.96	10.38	5.76
AG - 26	88.15	14.80	8.75	3.86	17.30	7.83
AG - 29	82.13	14.15	6.88	4.32	11.25	5.75
AG - 31	87.13	20.26	9.78	4.54	14.43	5.73
AG - 33	71.71	20.54	9.00	4.65	13.06	6.99
AG - 34B	63.29	15.18	10.57	6.39	14.07	7.36
SS - 4	29.95	7.08	5.18	5.84	14.59	17.33
SS - 6	25.67	6.23	10.28	8.23	24.00	16.97
SS - 8	18.00	2,83	8.00	8.49	18.00	15.56
SS - 23	41.00	8.88	7.50	4.45	30.79	20.37

Forbs

Population	Number of Leaves		Leaf Length (cm)		Leaf Width (cm)		Dry Weight (g)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
L - 5.2	3.00	2.19	4.07	1.36	0.42	0.10	0.11	0.08
L - 6.1	5.50	4.20	4.78	1.51	0.48	0.10	0.17	0.07
L - 8	3.33	2.06	4.33	2.29	0.51	0.20	0.09	0.03
L - 13.1	4.11	2.42	5.10	1.81	0.69	0.20	0.21	0.13
L - 17	3.00	2.71	6.03	1.37	0.73	0.10	0.28	0.30
L - 33.1	6.20	2.59	7.92	2.37	0.88	0.19	0.62	0.39
LA - 37	5.25	2.63	8.63	1.10	1.20	0.33	0.38	0.40
LPY - 3	10.75	6.70	10.68	2.89	0.75	0.20	1.07	0.88
LPY - 4	8.88	7.97	10.13	1.50	0.63	0.26	0.71	0.80
LPY - 5	6.33	2.52	3.73	1.44	0.40	0.17	0.22	0.10

Forbs (continued)

Population	Number of Leaves		Leaf Length (cm)		Leaf Width (cm)		Dry Weight (g)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
LPY - 15	13.00	6.24	10.53	1.70	0.63	0.05	0.70	0.44
LPY - 17	9.67	5.86	10.43	1.26	0.57	0.05	0.79	0.41
LPY - 20	10.22	6.57	14.37	2.19	0.83	0.36	1.15	0.77
LPY - 35	9.50	6.36	10.60	3.82	0.50	0.00	0.79	0.65
LPU - 6	4.40	1.95	4.08	0.99	0.24	0.05	0.10	0.07
LPU - 19	5.00	2.16	3.95	0.91	0.23	0.05	0.14	0.04

I. Producer Information

Name	
Business/Farm Name	
Address	
City/State/Zip	
Phone Number	
Fax Number	

1. I am presently producing native wildflower crops.

   ☐Yes
   ☐No

2. I am presently producing native grass crops.

   ☐Yes
   ☐No

3. In which counties and state(s) are your native wildflower/grass seed production located?

   ________________ (county) and ________________ (state).
   ________________ (county) and ________________ (state).
   ________________ (county) and ________________ (state).
   ________________ (county) and ________________ (state).
   ________________ (county) and ________________ (state).
   ☐ I do not currently have native wildflower/grass seed production.

4. During 1991, how much time did you devote to native wildflower/grass seed production?

   ☐ Full-time
   ☐ Part-time
   ☐ Hobby farm
   ☐ None

• ***If you currently have native wildflower/grass seed crops in production please skip to question number 6 below.***

5. If you do not currently have a native wildflower/grass seed crop, how many years until your crop will be in production?

   ________________ years

• ***Since you do not currently have a crop, please skip to Section IV on page 6.***

II. Production Information

6. How many years has your native wildflower crop been in production?

   ________________ years

7. How many years has your native grass crop been in production?

   ________________ years

8. In 1991, how many acres did you have in wildflower production?

   ________________ acres in cultivation
   ________________ acres in wild

9. In 1991, how many acres did you have in native grass production?

   ________________ acres in cultivation
   ________________ acres in wild

10. In 1991, what was your total wildflower production in pounds?

    ________________ pounds from cultivation
    ________________ pounds from wild

11. In 1991, what was your total native grass production in pounds?

    ________________ pounds from cultivation
    ________________ pounds from wild

12. From which of the following sources do you receive your native wildflower/grass seed? (Please check all that apply.)
    - ☐ I collect the seed from wild or other natural sites.
    - ☐ I collect the seed from my own crop.
    - ☐ I purchase the seed from other native wildflower/grass seed producers.
    - ☐ Other (please identify)________________________________

13. Please identify your 1991 production by species and variety, including both the actual yield, amount available for sale, and the county of seed origin. Attach additional sheets if necessary. (If you publish a catalog, please send us a copy.)

	Native Grass or Wildflower Seed Species and Variety	Actual Yield (Pounds)	Salable Quantity (Pounds)	County of Origin
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				
11)				
12)				
13)				
14)				
15)				

14. In 1991 what were your ten best-selling (in pounds) native wildflower/grass seed species and varieties [illegible] how long have those species been in production and avai[illegible] for sale?

	Native Grass or Wildflower Seed Species and Variety	Pounds Sold	Years in Production	Years for Sale
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				

III. Marketing/Processing Information

15. How is your native wildflower/grass seed processed or conditioned prior to selling? (Please check all that apply.)
    - ☐ Cleaned ☐ Graded
    - ☐ Packaged ☐ Mixed
    - ☐ Certified or Tested ☐ Other (please identify)________________
    - ☐ I do not process or condition the seed prior to selling.

16. Is the seed processed or conditioned:
    - ☐ In-house (by you or an employee) ☐ By another processor or conditioner.

17. Please identify the types of products you sell: (Check all that apply)
    - ☐ Pure Seed by Pounds ☐ Pure Seed by Ounces
    - ☐ Seed Mix by Pounds ☐ Seed Mix by Ounces
    - ☐ Seedlings ☐ Plants
    - ☐ Other (please identify)________________________________

18. Do you sell all your native wildflower/grass seed crops in a typical year?
    - ☐ Yes
    - ☐ No. (Please estimate the percentage of your crop that is typically carried over. ______%)

19. What percentage of your product is sold to: (Total should add to 100%)

Retail

_______ On-Farm Sales Location
_______ Off-Farm Sales Location (farmers' markets, roadside stands, etc.)
_______ Mail Order
_______ Other (please identify)________________________________

Wholesale

_______ Lanscaping Firms
_______ Retail Garden/Nursery Centers
_______ Other Businesses
_______ Other (please identify)________________________________

Government

_______ Federal Agencies
_______ State Agencies
_______ Local Agencies

In-House

_______ Used In-House for Own Seed Source
__100%__ **TOTAL**

20. What percentage of your product is sold in the following states? (Total should add to 100%)

_______ Minnesota
_______ Iowa
_______ North Dakota
_______ South Dakota
_______ Wisconsin
_______ Other U.S. States
_______ Canada
_______ Other (please identify) ________________________________
__100%__ **TOTAL**

21. What percentage of your product is sold within the following areas of production? (Total should add to 100%)

_______ 0-50 Mile Radius
_______ 51-100 Mile Radius
_______ 101-200 Mile Radius
_______ Over 200 Mile Radius
__100%__ **TOTAL**

IV. Future Projections/Assessments

22. Please identify your short-term and long-term production plans for native wildflower/grass seed by species and variety. (Please add additional pages if necessary.)

	Native Grass or Wildflower Seed Species and Variety	1992 Acreage		1995 Acreage		1997 Acreage	
		Seed	Seedlings	Seed	Seedlings	Seed	Seedlings
1)							
2)							
3)							
4)							
5)							
6)							
7)							
8)							
9)							
10)							
11)							
12)							
13)							
14)							
15)							

23. Please identify and discuss what you believe to be obstacles in the expansion of your native wildflower/grass seed production. Topics may include financial, technical, production management, seed source, availability of markets, and marketing issues among others. (Feel free to add pages or use additional space on the back of this questionnaire.)

*Obstacle #1 - Topic (please identify)*________________________

*Obstacle #2 - Topic (please identify)*________________________

*Obstacle #3 - Topic (please identify)*________________________

*Obstacle #4 - Topic (please identify)*________________________

*Obstacle #5 - Topic (please identify)*________________________

24. Please rank the importance of your answers in question number 23, with "1" being the biggest obstacle to expansion, "2" being the second biggest obstacle, and so on.

_______ Obstacle #1 (see question 23)
_______ Obstacle #2 (see question 23)
_______ Obstacle #3 (see question 23)
_______ Obstacle #4 (see question 23)
_______ Obstacle #5 (see question 23)

V. Other

25. Additional comments and remarks:

26. Please identify the names and addresses of other native wildflower/grass seed producers in the space provided below.

Name	
Address	
City/State/Zip	
Phone	

Name	
Business/Farm Name	
Address	
City/State/Zip	

Name	
Business/Farm Name	
Address	
City/State/Zip	

Name	
Business/Farm Name	
Address	
City/State/Zip	

27. The next step in the research process will be identifying and surveying native wildflower/grass seed consumers. Would you please help us by identifying the names and addresses of any consumers of whom you are aware in the space provided below?

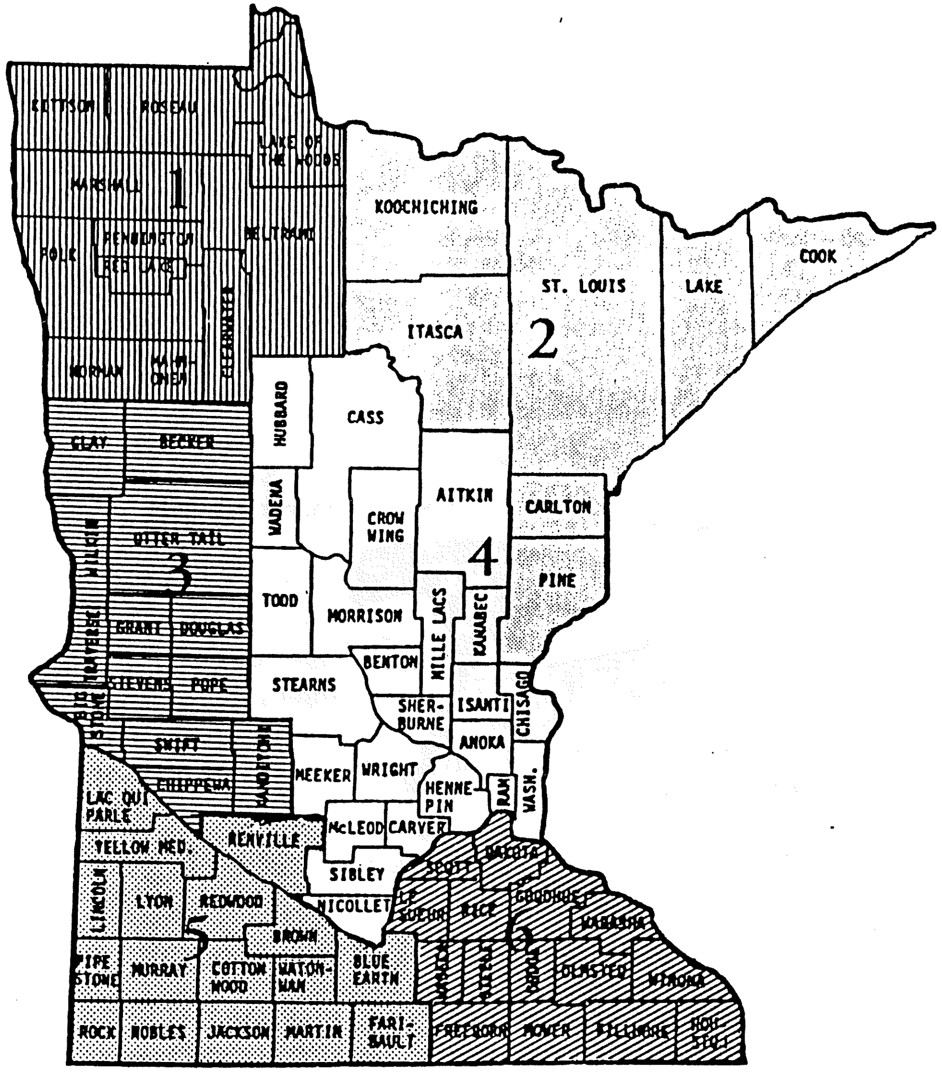
Name	
Business/Farm Name	
Address	
City/State/Zip	

Name	
Business/Farm Name	
Address	
City/State/Zip	

Name	
Business/Farm Name	
Address	
City/State/Zip	

Name	
Business/Farm Name	
Address	
City/State/Zip	

TABLE 12; FIGURE . - MINNESOTA NATIVE GRASS AND WILDFLOWER SEED REGIONS



Region 1 Region 2 Region 3

Region 4 Region 5 Region 6

FIGURE 2 - MINNESOTA NATIVE GRASS AND WILDFLOWER SEEDS, COUNTY PRODUCTION SITES

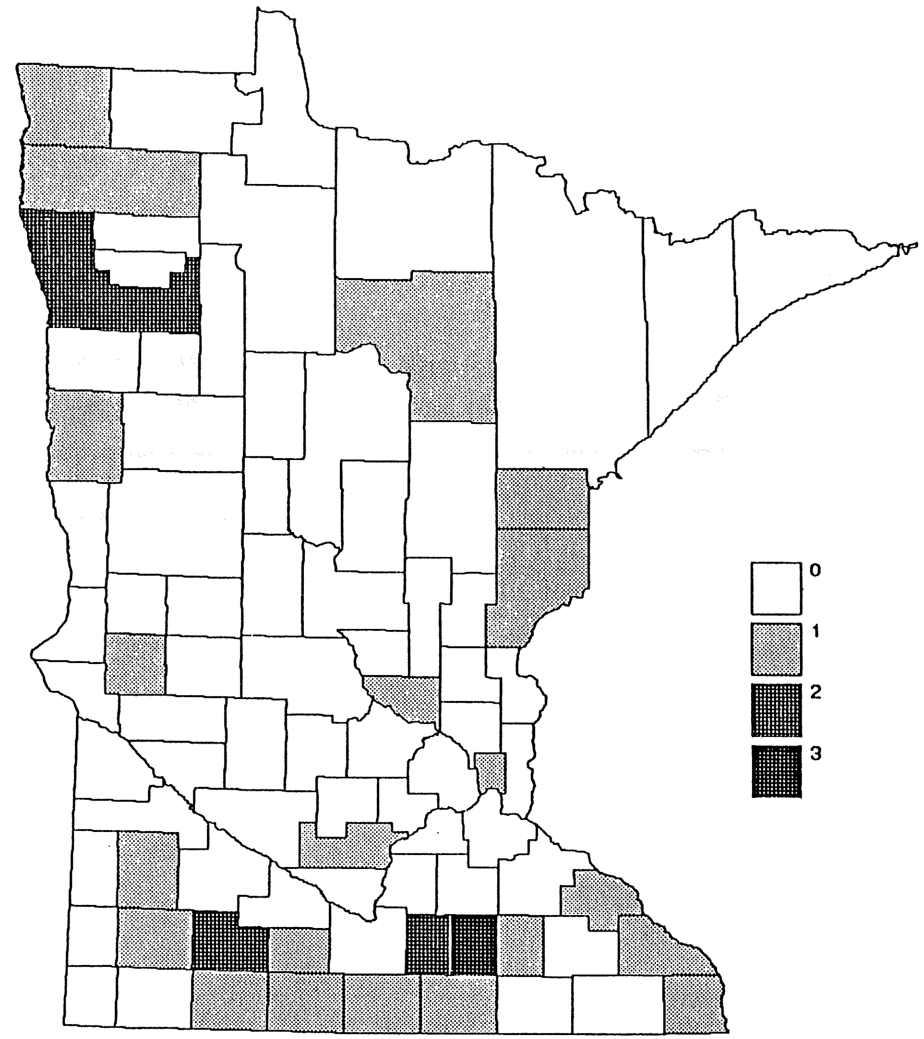


FIGURE 3 - 1991 PRODUCTION, MAJOR SPECIES

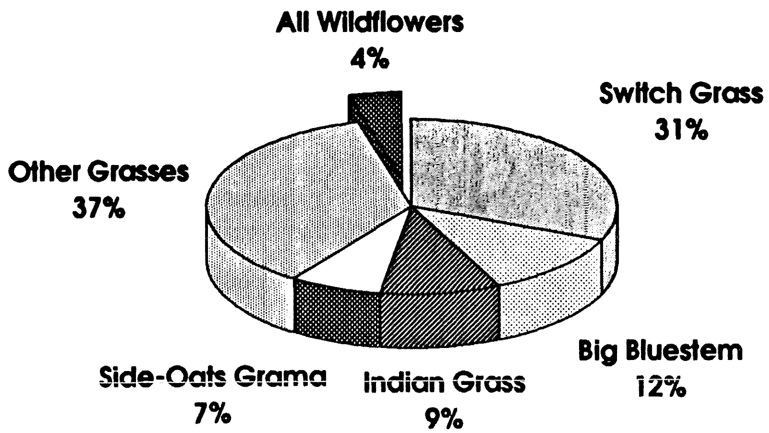


FIGURE 4 - FULL-TIME, PART-TIME, AND HOBBY FARMS: THEIR SHARE IN NATIVE SEED PRODUCTION

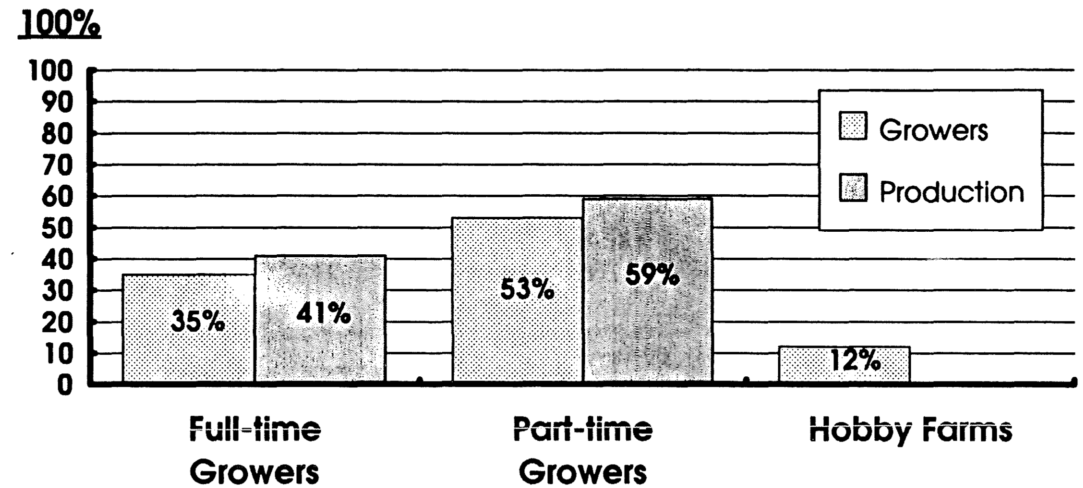


FIGURE 5 - MINNESOTA'S NATIVE SEED MARKET

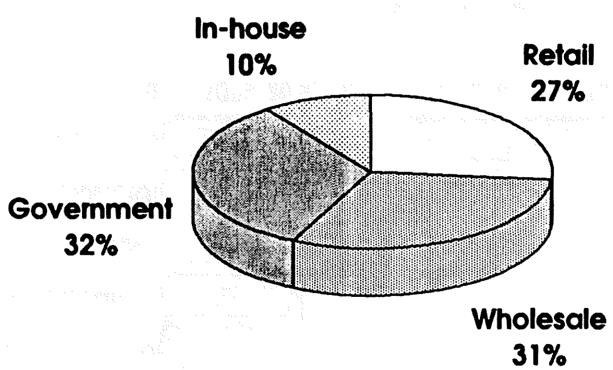


FIGURE 6 - NATIVE SEED SALES: MINNESOTA AND OUT-OF-STATE MARKETS

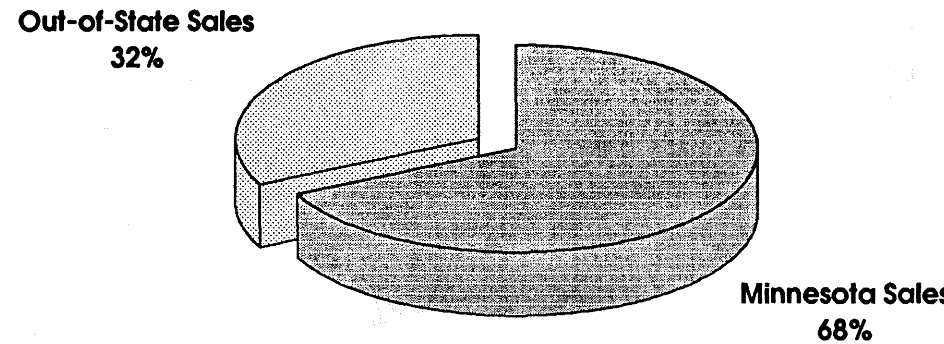


FIGURE 7 - OBSTACLES TO PRODUCTION EXPANSION

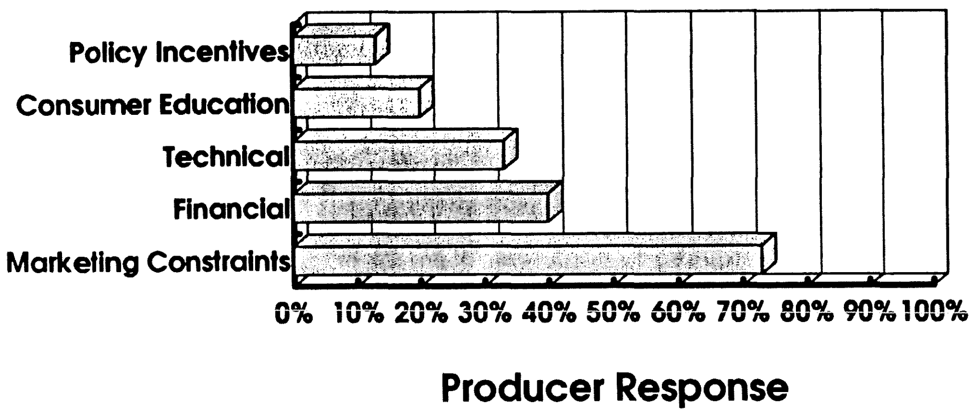


FIGURE 8 - NATIVE GRASS AND WILDFLOWER SEED PRODUCTION AND UTILIZATION RATIO

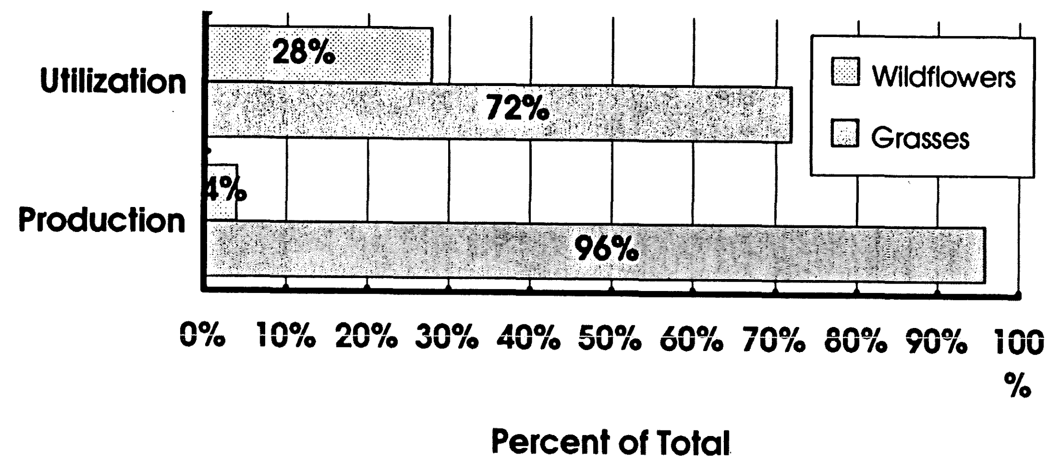


FIGURE 9 - NATIVE SEED UTILIZATION

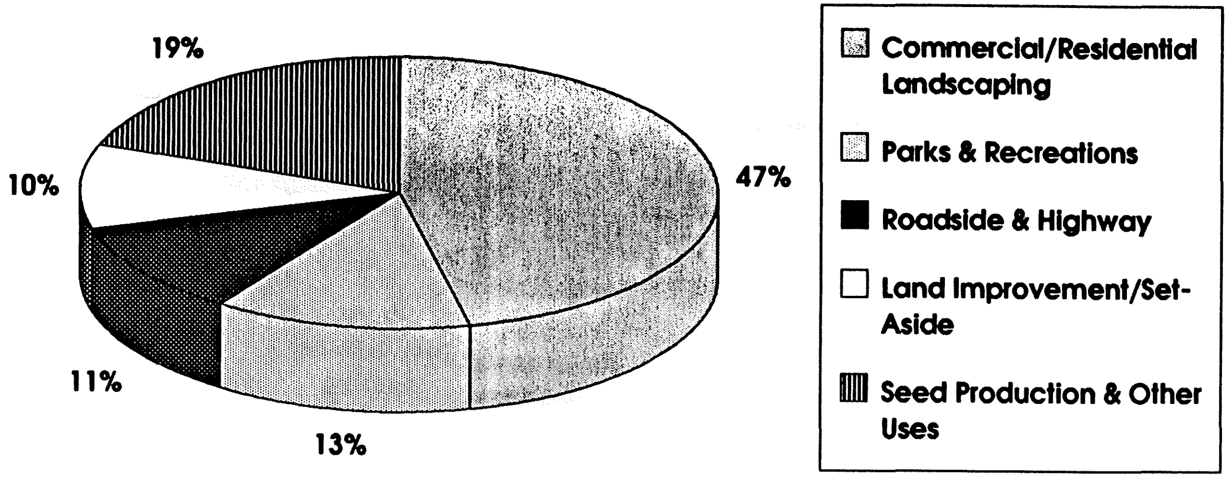


FIGURE 10 - GEOGRAPHIC DISTRIBUTION OF NATIVE GRASS AND WILDFLOWER USERS

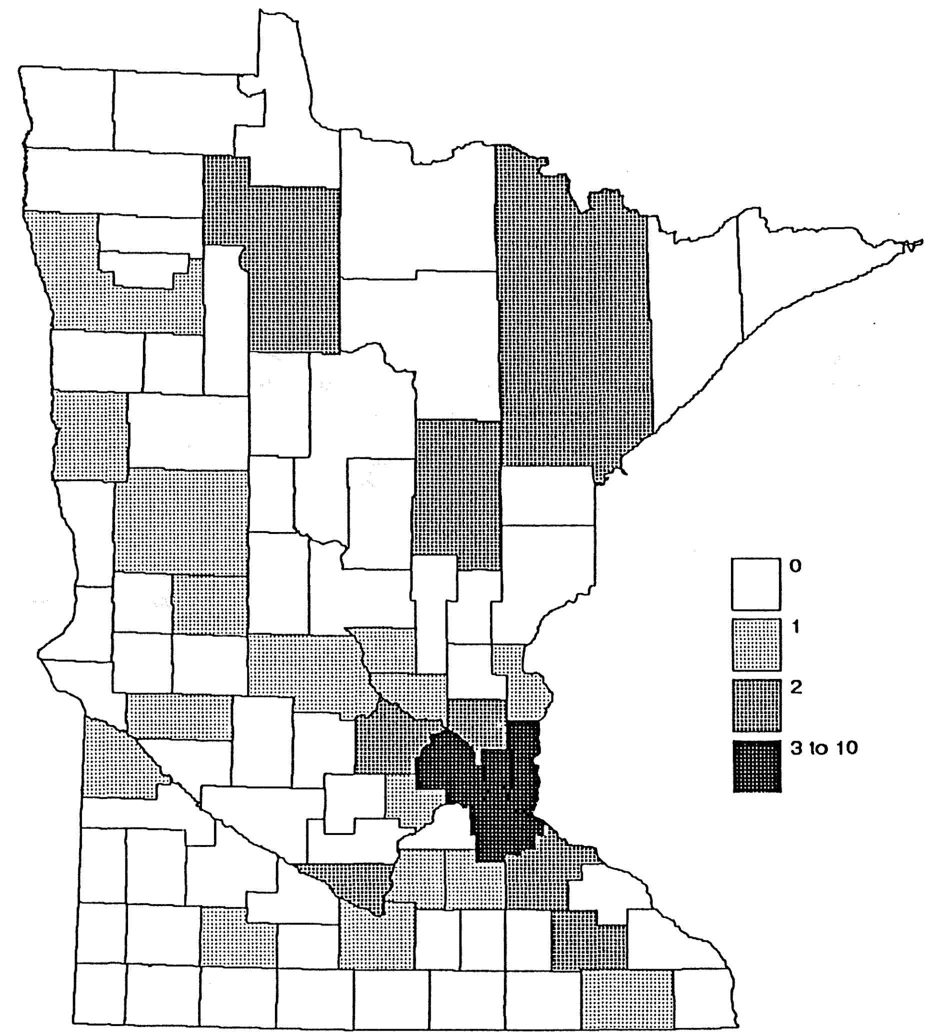


FIGURE 11 - NATIVE SEED CONSUMERS

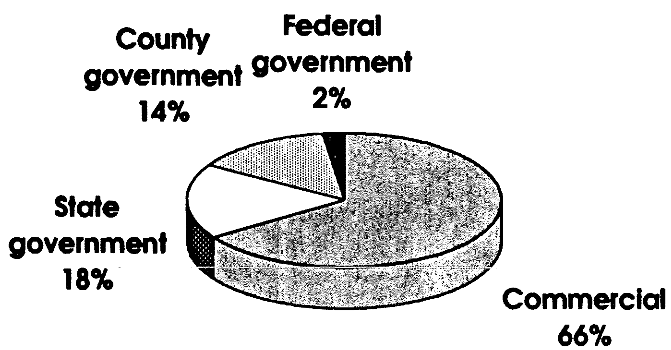
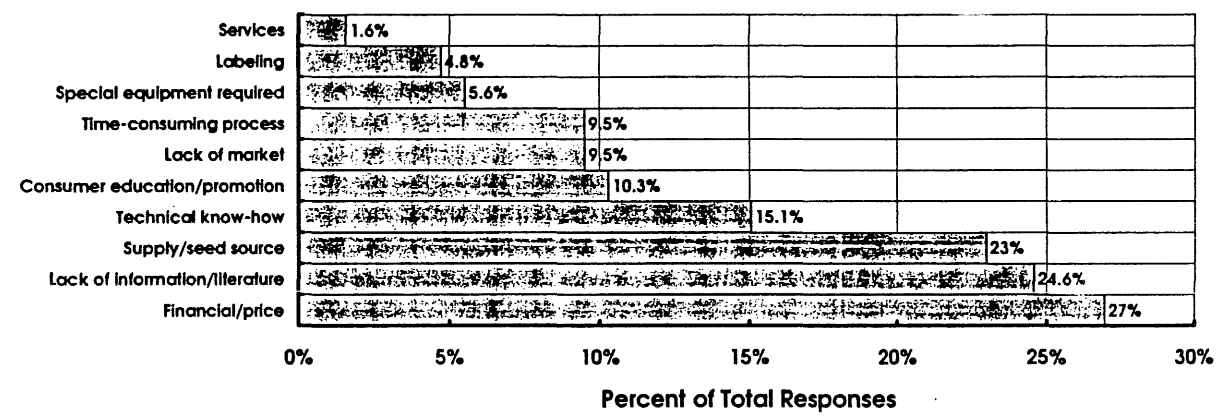


FIGURE 12 - OBSTACLES IN NATIVE SEED UTILIZATION



60000001	*AGASTACHE NEPETOIDES*	YELLOW GIANT HYSSOP
60000002	*AGASTACHE SCROPHULARIAEFOLIA*	PURPLE GIANT HYSSOP
60000003	*AGOSERIS CUSPIDATA*	PRAIRIE DANDELION
60000004	*ALLIUM CANADENSE*	WILD GARLIC
60000005	*ALLIUM CERNUUM*	NODDING ONION
60000006	*ALLIUM STELLATUM*	PRAIRIE ONION
60000007	*ALLIUM TRICOCCUM*	WILD LEEK
60000008	*AMORPHA CANESCENS*	LEAD PLANT
60000009	*AMORPHA FRUTICOSA*	FALSE INDIGO
60000010	*AMORPHA NANA*	FRAGRANT FALSE INDIGO
60000011	*ANEMONE CANADENSIS*	CANADA ANEMONE
60000012	*ANEMONE CYLINDRICA*	THIMBLE WEED
60000013	*ANEMONE PATENS WOLFGANGIANA*	PASQUE FLOWER
60000014	*ANGELICA ATROPURPUREA*	ANGELICA
60000015	*ANTENNARIA NEGLECTA*	CAT'S PAW
60000016	*ANTENNARIA PLANTAGINIFOLIA*	PUSSYTOES
60000017	*AQUILEGIA CANADENSIS*	COLUMBINE
60000018	*ARALIA RACEMOSA*	SPIKENARD
60000019	*ARENARIA STRICTA*	STIFF SANDWORT
60000020	*ARTEMISIA LUDOVICIANA*	PRAIRIE SAGE
60000021	*ASARUM CANADENSE*	WILD GINGER
60000022	*ASCLEPIAS INCARNATA*	SWAMP MILKWEED
60000023	*ASCLEPIAS TUBEROSA*	BUTTERFLY WEED
60000024	*ASCLEPIAS VERTICILLATA*	WHORLED MILKWEED
60000025	*ASTER AZUREUS*	SKY BLUE ASTER
60000026	*ASTER ERICOIDES*	HEATH ASTER
60000027	*ASTER LAEVIS*	SMOOTH BLUE ASTER
60000028	*ASTER LINARIIFOLIUS*	STIFF ASTER
60000029	*ASTER NOVAE-ANGLIAE*	NEW ENGLAND ASTER
60000030	*ASTER OBLONGIFOLIUS*	AROMATIC ASTER
60000031	*ASTER PTARMICOIDES*	UPLAND WHITE ASTER
60000032	*ASTER PUNICEUS*	SWAMP ASTER
60000033	*ASTER SERICEUS*	SILKY ASTER
60000034	*ASTER SIMPLEX*	PANICLED ASTER
60000035	*ASTER UMBELLATUS*	FLAT-TOPPED ASTER
60000036	*ASTRAGALUS CANADENSIS*	CANDIAN MILK VETCH
60000037	*BAPTISIA AUSTRALIS*	BLUE WILD INDIGO
60000038	*BAPTISIA LEUCANTHA*	WHITE WILD INDIGO
60000039	*BAPTISIA LEUCOPHAEA*	CREAM WILD INDIGO
60000040	*BIDENS CERNUA*	NODDING BUR MARIGOLD
60000041	*BLEPHILIA CILIATA*	DOWNY WOOD MINT
60000042	*BLEPHILIA HIRSUTA*	HAIRY WOOD MINT
60000043	*CACALIA ATRIPLICIFOLIA*	PALE INDIAN PLANTAIN
60000044	*CACALIA MUHLENBERGII*	GREAT INDIAN PLANTAIN
60000045	*CACALIA SUAVEOLENS*	SWEET INDIAN PLANTAIN
60000046	*CALLIRHOE TRAINGULATA*	CLUSTERED POPPY MALLOW
60000047	*CALTHA PALUSTRIS*	MARSH MARIGOLD
60000048	*CAMASSIA SCILLOIDES*	WILD HYACINTH
60000049	*CAMPANULA AMERICANA*	TALL BELLFLOWER
60000050	*CAMPANULA ROTUNDIFOLIA*	HAREBELL
60000051	*CASSIA FASCICULATA*	PARTRIDGE PEA
60000052	*CASSIA HEBECARPA*	WILD SENNA
60000053	*CASSIA MARILANDICA*	MARYLAND SENNA
60000054	*CEANOTHUS AMERICANUS*	NEW JERSEY TEA
60000055	*CEANOTHUS OVATUS*	RED ROOT
60000056	*CELASTRUS SCANDENS*	BITTERSWEET
60000057	*CEPHALANTHUS OCCIDENTALIS*	BUTTONBUSH
60000058	*CHELONE GLABRA*	TURTLEHEAD
60000059	*CHRYSOPSIS CAMPORUM*	GOLDEN ASTER
60000060	*CICUTA MACULATA*	WATER HEMLOCK
60000061	*CLEMATIS VIRGINIANA*	VIRGIN'S BOWER
60000062	*COREOPSIS LANCEOLATA*	SAND COREOPSIS
60000063	*COREOPSIS PALMATA*	PRAIRIE COREOPSIS
60000064	*COREOPSIS TRIPTERIS*	TALL COREOPSIS
60000065	*CROTALARIA SAGITTALIS*	RATTLEBOX
60000066	*CRYPTOTAENIA CANADENSIS*	HONEWORT
60000067	*DELPHINIUM VIRESCENS*	PRAIRIE LARKSPUR
60000068	*DESMANTHUS ILLINOENSIS*	ILLINOIS BUNDLE FLOWER
60000069	*DESMODIUM CANADENSE*	SHOWY TICK TREFOIL
60000070	*DESMODIUM GLUTINASUM*	POINTED-LEAF TICK TREFOIL
60000071	*DESMODIUM ILLINOENSE*	ILLINOIS TICK TREFOIL
60000072	*DESMODIUM SESSILIFOLIUM*	SESSILE TICK TREFOIL
60000073	*DODECATHEON AMETHYSTINUM*	AMETHYST SHOOTING STAR
60000074	*DODECATHEON MEADIA*	MIDLAND SHOOTING STAR
60000075	*ECHINACEA ANGUSTIFOLIA*	NARROW-PURPLE CONEFLOWER
60000076	*ECHINACEA PALLIDA*	PALE PURPLE CONEFLOWER
60000077	*ECHINACEA PURPUREA*	PURPLE CONEFLOWER
60000078	*EPILOBIUM ANGUSTIFOLIUM*	FIREWEED
60000079	*ERYNGIUM YUCCIFOLIUM*	RATTLESNAKE MASTER
60000080	*EUPATORIUM ALTISSIMUM*	TALL BONESET
60000081	*EUPATORIUM MACULATUM*	JOE PYE WEED
60000082	*EUPATORIUM PERFOLIATUM*	BONESET
60000083	*EUPATORIUM PURPUREUM*	SWEET JOE PYE WEED
60000084	*EUPATORIUM RUGOSUM*	WHITE SNAKEROOT

60000085	*EUPHORBIA COROLLATA*	FLOWERING SPURGE
60000086	*FILIPENDULA RUBRA*	QUEEN OF THE PRAIRIE
60000087	*FRAGARIA VIRGINIANA*	WILD STRAWBERRY
60000088	*FROELICHIA FLORIDANA*	COTTONWEED
60000089	*GALIUM BOREALE*	NORTHERN BEDSTRAW
60000090	*GAURA BIENNIS*	GAURA
60000091	*GENTIANA ANDREWSII*	BOTTLE GENTIAN
60000092	*GENTIANA CRINITA*	FRINGED GENTIAN
60000093	*GENTIANA FLAVIDA*	CREAM GENTIAN
60000094	*GENTIANA PUBERULA*	PRAIRIE GENTIAN
60000095	*GENTIANA QUINQUEFOLIA*	STIFF GENTIAN
60000096	*GERANIUM MACULATUM*	WILD GERANIUM
60000097	*GERARDIA TENUIFOLIA*	SLENDER GERARDIA
60000098	*GEUM ALEPPICUM*	YELLOW AVENS
60000099	*GEUM TRIFLORUM*	PRAIRIE SMOKE
60000100	*GLYCYRRHIZA LEPIDOTA*	WILD LICORICE
60000101	*GNAPHALIUM OBTUSIFOLIUM*	SWEET EVERLASTING
60000102	*HELENIUM AUTUMNALE*	SNEEZEWEED
60000103	*HELIANTHUS GROSSESERRATUS*	SAW-TOOTH SUNFLOWER
60000104	*HELIANTHUS LAETIFLORUS*	SHOW SUNFLOWER
60000105	*HELIANTHUS MAXIMILLIANI*	MAXIMILLIAN SUNFLOWER
60000106	*HELIANTHUS MOLLIS*	DOWNY SUNFLOWER
60000107	*HELIANTHUS OCCIDENTALIS*	WESTERN SUNFLOWER
60000108	*HELIOPSIS HELIANTHOIDES*	EARLY SUNFLOWER
60000109	*HERACLEUM MAXIMUM*	COW PARSNIP
60000110	*HEUCHERA RICHARDSONII*	PRAIRIE ALUMROOT
60000111	*HIERACIUM CANADENSE*	CANADA HAWKWEED
60000112	*HIERACIUM LONGIPILUM*	HAIRY HAWKWEED
60000113	*HYDROPHYLLUM VIRGINIANUM*	VIRGINIA WATERLEAF
60000114	*HYPERICUM PYRAMIDATUM*	GREAT ST. JOHN'S WORT
60000115	*HYPOXIS HIRSUTA*	YELLOW STAR GRASS
60000116	*IRIS PRISMATICA*	SLENDER BLUE FLAG IRIS
60000117	*IRIS VIRGINICA SHREVEI*	BLUE FLAG IRIS
60000118	*IRIS VERSICOLOR*	WILD IRIS
60000119	*JEFFERSONIA DIPHYLLA*	TWINLEAF
60000120	*KUHNIA EUPATORIOIDES*	FALSE BONESET
60000121	*LESPEDEZA CAPITATA*	ROUND-HEADED BUSH CLOVER
60000122	*LIATRIS ASPERA*	BUTTON BLAZING STAR
60000123	*LIATRIS CYLINDRACEA*	DWARF BLAZING STAR
60000124	*LIATRIS LIGULISTYLIS*	MEADOW BLAZING STAR
60000125	*LIATRIS PUNCTATA*	DOTTED BLAZING STAR
60000126	*LIATRIS PYCNOSTACHYA*	PRAIRIE BLAZING STAR
60000127	*LIATRIS SPICATA*	MARCH BLAZING STAR

60000128	*LILIUM MICHIGANESE*	TURK'S CAP LILY
60000129	*LILIUM PHILDELPHICUM*	WOOD LILY
60000130	*LINUM SULCATUM*	GROOVED YELLOW FLAX
60000131	*LOBELIA CARDINALIS*	CARDINAL FLOWER
60000132	*LOBELIA INFLATA*	INDIAN TOBACCO
60000133	*LOBELIA SIPHILITICA*	GREAT BLUE LOBELIA
60000134	*LOBELIA SIPHILITICA ALBA*	WHITE GREAT BLUE LOBELIA
60000135	*LOBELIA SPICATA*	PALE SPIKED LOBELIA
60000136	*LUPINUS PERENNIS*	WILD LUPINE
60000137	*LYSIMACHIA QUADRIFLORA*	PRAIRIE LOOSESTRIFE
60000138	*LYTHRUM ALATUM*	WINGED LOOSESTRIFE
60000139	*MIMULUS RINGENS*	MONKEY FLOWER
60000140	*MONARDA FISTULOSA*	WILD BERGAMOT
60000141	*MONARDA PUNCTATA*	SPOTTED BEE BALM
60000142	*NAPAEA DIOICA*	GLADE MALLOW
60000143	*NICOTIANA RUSTICA*	MIDEWIWAN SACRED TOBACCO
60000144	*OENOTHERA BIENNIS*	EVENING PRIMROSE
60000145	*OENOTHERA RHOMBIPETALA*	SMALL-FLOWERED PRIMROSE
60000146	*OPUNTIA HUMIFUSA*	PRICKLY PEAR CACTUS
60000147	*OSMORHIZA CLAYTONI*	SWEET CICELY
60000148	*OXYPOLIS RIGIDIOR*	COWBANE
60000149	*PARTHENIUM INTEGRIFOLIUM*	WILD QUININE
60000150	*PEDICULARIS CANADENSIS*	WOOD BETONY
60000151	*PEDICULARIS LANCEOLATA*	MARSH BETONY
60000152	*PENSTEMON DIGITALIS*	FOXGLOVE BEARDTONGUE
60000153	*PENSTEMON GRACILIS*	SLENDER BEARDTONGUE
60000154	*PENSTEMON GRANDIFLORUS*	LARGE-FLOWER BEARDTONGUE
60000155	*PENSTEMON PALLIDUS*	PALE BEARDTONGUE
60000156	*PETALOSTEMUM CANDIDUM*	WHITE PRAIRIE CLOVER
60000157	*PETALOSTEMUM FOLIOSUM*	LEAFY PRAIRIE CLOVER
60000158	*PETALOSTEMUM PURPUREUM*	PURPLE PRAIRIE CLOVER
60000159	*PETALOSTEMUM VILLOSUM*	SILKY PRAIRIE CLOVER
60000160	*PHLOX DIVARICATA*	WILD BLUE PHLOX
60000161	*PHLOX GLABERRIMA INTERIOR*	MARSH PHLOX
60000162	*PHLOX PILOSA*	PRAIRIE PHLOX
60000163	*PHYSOCARPUS OPULIFOLUS*	PRAIRIE NINEBARK
60000164	*PHYSOTEGIA VIRGINIANA*	OBEDIENT PLANT
60000165	*PLANTAGO PURSHII*	WOOLLY PLANTAIN
60000166	*POLEMONIUM REPTANS*	JACOB'S LADDER
60000167	*POLYGALA POLYGAMA*	SAND MILKWORT
60000168	*POLYGONATUM CANALICULATUM*	SOLOMON'S SEAL

60000169	*POLYTAENIA NUTTALLII*	PRAIRIE PARSLEY
60000170	*POTENTILLA ARGUTA*	PRAIRIE CINQUEFOIL
60000171	*PRENANTHES ALBA*	LION'S FOOT
60000172	*PRENANTHES RACEMOSA*	RATTLESNAKE ROOT
60000173	*PSORALEA TENUIFLORA*	SCURFY PEA
60000174	*PYCNANTHEMUM TENUIFOLIUM*	SLENDER MOUNTAIN MINT
60000175	*PYCNANTHEMUM VIRGINIANUM*	MOUNTAIN MINT
60000176	*RANUNCULUS RHOMBOIDEUS*	PRAIRIE BUTTERCUP
60000177	*RANUNCULUS PENSYLVANICUS*	BRISTLY CROWFOOT
60000178	*RATIBIDA COLUMNIFERA*	LONG-HEADED CONEFLOWER
60000179	*RATIBIDA PINNATA*	YELLOW CONEFLOWER
60000180	*ROSA ARKANSANA*	PASTURE ROSE
60000181	*ROSA SETIGERA*	ILLINOIS ROSE
60000182	*RUDBECKIA HIRTA*	BLACK-EYED SUSAN
60000183	*RUDBECKIA LACINIATA*	GREEN-HEADED CONEFLOWER
60000184	*RUDBECKIA SUBTOMENTOSA*	SWEET BLACK-EYED SUSAN
60000185	*RUDBECKIA TRILOBA*	BROWN-EYED SUSAN
60000186	*RUELLIA HUMILIS*	WILD PETUNIA
60000187	*SANGUISORBA CANADENSIS*	AMERICAN BURNET
60000188	*SAXIFRAGA PENSYLVANICA*	SWAMP SAXIFRAGE
60000189	*SILENE REGIA*	ROYAL CATCHFLY
60000190	*SILPHIUM INTEGRIFOLIUM*	ROSIN WEED
60000191	*SILPHIUM LACINIATUM*	COMPASS PLANT
60000192	*SILPHIUM PERFOLIATUM*	CUP PLANT
60000193	*SILPHIUM TEREBINTHINACEUM*	PRAIRIE DOCK
60000194	*SISYRINCHIUM CAMPESTRE*	BLUE-EYED GRASS
60000195	*SISYRINCHIUM CAMPESTRE ALBA*	WHITE BLUE-EYED GRASS
60000196	*SMILACINA RACEMOSA*	SOLOMON'S PLUME
60000197	*SMILACINA STELLATA*	STARRY SOLOMON'S PLUME
60000198	*SOLIDAGO GRAMINIFOLIA*	GRASS-LEAVED GOLDENROD
60000199	*SOLIDAGO NEMORALIS*	OLD FIELD GOLDENROD
60000200	*SOLIDAGO RIDDELLII*	RIDDELL'S GOLDENROD
60000201	*SOLIDAGO RIGIDA*	STIFF GOLDENROD
60000202	*SOLIDAGO SPECIOSA*	SHOWY GOLDENROD
60000203	*SOLIDAGO ULMIFOLIA*	ELM-LEAVED GOLDENROD
60000204	*TAENIDIA INTEGERRINA*	YELLOW PIMPERNEL
60000205	*TEPHROSIA VIRGINIANA*	GOAT'S RUE
60000206	*TEUCRIUM CANADENSE*	GERMANDER
60000207	*THALICTRUM DASYCARPUM*	PURPLE MEADOW RUE
60000208	*THALICTRUM DIOICUM*	EARLY MEADOW RUE
60000209	*THASPIUM TRIFOLIATUM*	MEADOW PARSNIP
60000210	*TRADESCANTIA BRACTEATA*	PRAIRIE SPIDERWORT
60000211	*TRADESCANTIA OCCIDENTALIS*	WESTERN SPIDERWORT

60000212	*TRADESCANTIA OHIENSIS*	OHIO SPIDERWORT
60000213	*VALERIANA EDULIS*	VALERIAN
60000214	*VERBENA HASTATA*	BLUE VERVAIN
60000215	*VERBENA STRICTA*	HOARY VERVAIN
60000216	*VERNONIA FASCICULATA*	IRONWEED
60000217	*VERNONIA MISSURICA*	MISSOURI IRONWEED
60000218	*VERONICASTRUM VIRGINICUM*	CULVER'S ROOT
60000219	*VIOLA CONSPERSA*	DOG VIOLET
60000220	*VIOLA ERIOCARPA*	YELLOW VIOLET
60000221	*VIOLA PALMATA*	EARLY BLUE VIOLET
60000222	*VIOLA PAPILIONACEA*	COMMON BLUE VIOLET
60000223	*VIOLA PEDATA*	BIRD'S FOOT VIOLET
60000224	*VIOLA PEDATIFIDA*	PRAIRIE VIOLET
60000225	*VIOLA SAGITTATA*	ARROWLEAF VIOLET
60000226	*WULFENIA BULLII*	KITTENTAILS
60000227	*ZIZIA APTERA*	HEART-LEAF GOLDEN ALEX
60000228	*ZIZIA AUREA*	GOLDEN ALEXANDER
60000229	*ACHILLEA MILLEFOLIUM*	YARROW
60000230	*AGASTACHE FOENICULUM*	FRAGRANT GIANT HYSSOP
60000231	*ASTER SAGITTIFOLIUS*	ARROW LEAVED ASTER
60000232	*ASTAGALUS CRASSICARPUS*	PRAIRIE PLUM
60000233	*CIRSIUM MUTICUM*	SWAMP THISTLE
60000234	*EPILOBIUM COLORATUM*	WILLOW-HERB
60000235	*GERARDIA PAUPERCULA*	SMALL-FLOWERED GERARDIA
60000236	*HELIANTHEMUM BICKNELLII*	FROSTWEED
60000237	*HELIANTHUS DIVARICATUS*	WOODLAND SUNFLOWER
60000238	*HELIANTHUS GIGANTEUS*	GIANT SUNFLOWER
60000239	*HELIANTHUS TUBEROSUS*	JERUSALEM ARTICHOKE
60000240	*HETEROTHECA VILLOSA*	GOLDEN ASTER
60000241	*HOUSTONIA LONGIFOLIA*	LONG-LEAVED BLUETS
60000242	*HYPERICUM MAJUS*	SMALL ST. JOHN'S WORT
60000243	*LILIUM SUPERBUM*	TURK'S CAP LILY
60000244	*LYSIMACHIA CILIATA*	FRINGED LOOSESTRIFE
60000245	*OENOTHERA SURRULATA*	TOOTH-LEAVED PRIMROSE
60000246	*POTENTILLA FRUTICOSA*	SHRUBBY CINQUEFOIL
60000247	*SAGITTARIA LATIFOLIA*	ARROW-HEAD
60000248	*SENECIO AUREUS*	GOLDEN RAGWORT
60000249	*SENECIO PLATTENSIS*	PRAIRIE RAGWORT
60000250	*SENECIO PAUPERCAULIS*	BALSAM RAGWORT
60000251	*SOLIDAGO MISSOURIENSIS*	MISSOURI GOLDENROD
60000252	*STACHYS PALUSTRIS*	WOUNDWORT
60000253		OXEYE

60000254		MARSH MILKWEED
60000255		BLAZING STAR
60000256		CREAM FALSE INDIGO
60000257		TALL BLAZING STAR
60000258	*CASTILLEJA SESSIFLORA*	
60000259	*POLYGALA SENEGA*	
60000260	*ACORUS CALAMUS*	SWEET FLAG
60000261		ROUGH BLZING STAR
60000262		GIANT HYSSOP
60000263		STIFF TIC-SEED
60000264		NEWPORT BLUEGRASS
60000265		PARK BLUEGRASS
60000266		PERENNIAL RYE
60000267		CREEP RED FESCUE
60000268		OLD MIDWEST WILDFLOWER MIX
60000269		SHORT DRY WILDFLOWER MIX #1
60000270		NK NORTH AMERICAN WILDFLOWERS
60000271		MESIC MIX
60000272		MESIC WILDFLOWER MIX
60000273		ROSA SPECIES
60000274	*OSMUNDO CINNAMOMEA*	
60000275	*ADIANTUM PEDATUM*	
60000276	*ATHYRIAM FELIXIFEMINA*	
60000277	*MERTENSIA VIRGINICA*	VIRGINIA BLUEBELLS
60000278		BLANKET FLOWER
60000279		UPRIGHT PRAIRIE CONEFLOWER
60000280		GREYHEAD PRAIRIE CONEFLOWER
60000281		DANE'S ROCKET
60000282		ROUGH OXEYE
60000283		THICKSPIKE GAYFEATHER
60000284		SPIKED GAYFEATHER
60000285		WHITE YARROW
60000286		PITCHER SAGE
60000287		LANCE LEAF COREOPSIS
60000288		MEXICAN RED HAT
60000289		COMMON VETCH
60000290		COUNTRY WILDFLOWERS
60000291		BUTTERFLY

60000292		CUTTING GARDEN
60000293		FLORAL GROUNDCOVER
60000294		NATIVE HARVEST
60000295		MIXED NATIVE FORBS
60000296		SHOWY PENSTEMON
60000297		STIFF SUNFLOWER
60000298		COLUMNAR CONEFLOWER
60000299		PRAIRIE BUSH CLOVER
60000300		NARROW-LEAVED MILKWEED
60000301		DOTTED MINT
60000302	*DICENTRA CUCULLARIA*	DUTCHMAN'S BREECHES
60000303	*SPIREA ALBA ROSEA*	MEADOWSWEET
60000304	*CORNUS STOLONIFERA*	RED OSIER DOGWOOD
70000001	*AGROPYRON SMITHII*	WESTERN WHEAT GRASS
70000002	*AGROPYRON TRACHYCAULUM*	SLENDER WHEAT GRASS
70000003	*ANDROPOGON GERARDI*	BIG BLUESTEM
70000004	*ANDROPOGON HALLII*	SAND BLUESTEM
70000005	*ANDROPOGON SCOPARIUS*	LITTLE BLUESTEM
70000006	*BOUTELOUA CURTIPENDULA*	SIDE-OATS GRAMA
70000007	*BOUTELOUA GRACILIS*	BLUE GRAMA
70000008	*BOUTELOUA HIRSUTA*	HAIRY GRAMA
70000009	*BROMUS KALMII*	PRAIRIE BROME
70000010	*BROMUS PURGANS*	HAIRY WOOD CHESS
70000011	*BUCHLOE DACTYLOIDES*	BUFFALO GRASS
70000012	*CALAMAGROSTIS CANADENSIS*	BLUE JOINT GRASS
70000013	*CAREX ALOPECOIDEA*	FOXTAIL SEDGE
70000014	*CAREX ANNECTENS XANTHOCARPA*	YELLOW-FRUITED SEDGE
70000015	*CAREX HYSTICINA*	BOTTLEBRUSH SEDGE
70000016	*CAREX PENSYLVANICA*	PENNSYLVANIA SEDGE
70000017	*CAREX SCOPARIA*	POINTED BROOM SEDGE
70000018	*CAREX SPRENGELII*	LONG-BEAKED SEDGE
70000019	*CAREX STIPATA*	AWL-FRUITED SEDGE
70000020	*CAREX VULPINOIDEA*	FOX SEDGE
70000021	*ELYMUS CANADENSIS*	CANADA WILD RYE
70000022	*ELYMUS VIRGINICUS*	VIRGINIA WILD RYE
70000023	*HIERCHLOE ODORATA*	SWEET GRASS
70000024	*HYSTRIX PATULA*	BOTTLEBRUSH GRASS
70000025	*JUNCUS TENUIS*	PATH RUSH
70000026	*KOELERIA CRISTATA*	JUNE GRASS
70000027	*PANICUM VIRGATUM*	SWITCH GRASS
70000028	*PASPALUM CILIATIFOLIUM*	HAIRY LENS GRASS
70000029	*SCIRPUS ATROVIRENS*	DARK-GREEN BULRUSH
70000030	*SCIRPUS VALIDUS*	GREAT BULRUSH

70000031	*SORGHASTRUM NUTANS*	INDIAN GRASS
70000032	*SPARTINA PECTINATA*	CORD GRASS
70000033	*SPOROBOLUS ASPER*	ROUGH DROPSEED
70000034	*SPOROBOLUS HETEROLEPIS*	NORTHERN DROPSEED
70000035	*STIPA SPARTEA*	PORCUPINE GRASS
70000036	*STIPA VIRIDULA*	GREEN NEEDLE GRASS
70000037	*BROMUS CILIATUS*	FRINGED BROME
70000038	*CALAMOVILFA LONGIFOLIA*	SAND REED GRASS
70000039	*JUNCUS GREENEI*	GREENE'S RUSH
70000040	*MUHLENBERGIA CUSPIDATA*	STONYHILLS MUHLY
70000041	*MUHLENBERGIA GLOMERATA*	SWAMP SATIN GRASS
70000042	*PHRAGMITES COMMUNIS*	REED GRASS
70000044	*TYPHA LATIFOLIA*	CATTAIL
70000045		BIG BLUESTEM ROUNDTREE
70000046		BUG BLUESTEM BONILLA
70000047		NATIVE TALL GRASS PRAIRIE SEED
70000048		TALL GRASS MIX
70000049		BLUEGRASS MIX
70000050		MN/DOT 150
70000051		MN/DOT 300
70000052		SHORT DRY MIX (GRASSES)
70000053		MESIC GRASS MIX
70000054		MN/DOT 500
70000055		LOCAL MIXED PRAIRIE
70000056		SAND DROPSEED
70000057		PRAIRIE DROPSEED

TABLE 14: NATIVE GRASS AND WILDFLOWER SEED CONSUMER SURVEY.

For the purpose of this survey, native grasses and wildflowers are defined as an unaltered or naturally occurring herbaceous plant species indigenous to Minnesota.

I. General Information

Business Name:		
Contact Person:		
Street Address:		
City:	**State:**	**Zip:**
Telephone Number:	**Fax Number:**	

1. During 1991, did you purchase and/or use native <u>wildflower</u> seeds?

   ☐ Yes ☐ No

2. During 1991, did you purchase and/or use native <u>grass</u> seeds?

   ☐ Yes ☐ No

If you checked "NO" to both questions 1 and 2, please skip to question number 12 on page 5.

II. Usage Information

3. For how many years have you been purchasing and/or using native wildflower seeds?

   ☐__________ Years ☐ I have not purchased or used native wildflower seeds.

4. For how many years have you been purchasing and/or using native grass seeds?

   ☐__________ Years ☐ I have not purchased or used native grass seed

5. Please complete the following table. For each species of native grass or wildflower seed, provide the quantity purchased in pounds, the quantity used in pounds, and the geographic region in which the seed was used or planted (see enclosed map for regions).

	1989		1990		1991		
Species	**Purchased**	**Used**	**Purchased**	**Used**	**Purchased**	**Used**	**Region**

6. For which of the following uses have you been purchasing native grass and wildflower seeds?

- ☐ Highway Projects
- ☐ Residential Landscaping
- ☐ Commerical Landscaping
- ☐ Park and Recreation Areas
- ☐ Land Improvement
- ☐ Set-Aside Acres
- ☐ Native Wildflower/Grass Seed Production
- ☐ Other (please identify)______________________________________

7. What is the distance between your place of business and your native wildflower or grass seed supplier? (Please check all that apply.)

Minnesota Suppliers

- ☐ 0-50 Mile Radius
- ☐ 51-100 Mile Radius
- ☐ 101-200 Mile Radius
- ☐ Over 200 Mile Radius

Non-Minnesota Suppliers

- ☐ North Dakota
- ☐ South Dakota
- ☐ Wisconsin
- ☐ Iowa
- ☐ Other U.S. States (please identify)________________________________
- ☐ Canada
- ☐ Other Countries (please identify)________________________________

8. What percentage of the wildflowers or grass seed that you purchase is from suppliers within Minnesota and what percentage is from suppliers outside Minnesota?

Wildflower Seeds	Grass Seeds
_____% Minnesota Suppliers	_____% Minnesota Suppliers
_____% Non-Minnesota Suppliers	_____% Non-Minnesota Suppliers
__100__% **TOTAL**	__100__% **TOTAL**

9. What type and in what form do you purchase native grass and wildflower seed products?

Wildflowers	Grasses
☐ Pure Seed by Pounds	☐ Pure Seed by Pounds
☐ Pure Seed by Ounces	☐ Pure Seed by Ounces
☐ Seed Mix by Pounds	☐ Seed Mix by Pounds
☐ Seed Mix by Ounces	☐ Seed Mix by Ounces
☐ Seedlings	☐ Seedlings
☐ Plants	☐ Plants
☐ Other (identify)____________	☐ Other (identify)____________

10. Do you require your native wildflower or grass seed to be (please check all that apply):

- ☐ Cleaned & Conditioned
- ☐ Tested
- ☐ Certified According to an Official Seed Certifying Agency Standards
- ☐Treated with a Pesticide

11. Please supply the name, address and phone number of your major native wildflower or grass seed suppliers. (Attach additional sheets if necessary.)

Name:
Contact:
Address:
City/State/Zip:
Telephone:

Name:
Contact:
Address:
City/State/Zip:
Telephone:

III. Future Usage Projections

12. Please identify your short term and long term usage plans for wildflower and grass seed. For each species estimate the number of pounds you plan to use (or the number of seedlings) and the region of origin you require (see enclosed map for regions). If no plans, go to question 13 on page 6.

	1992 Projections		1995 Projections		1997 Projections		
Species	**Seed**	**Seedlings**	**Seed**	**Seedlings**	**Seed**	**Seedlings**	**Region of Origin**

13. Please identify which of the following categories classifies you the best:

Government
- ☐ Federal Agency
- ☐ State Agency
- ☐ Local Agency

Wholesale
- ☐ Landscaping Firm
- ☐ Seed Company
- ☐ Other (please identify)________________________

Retail
- ☐ On-Farm Sales Location
- ☐ Off-Farm Sales Location (farmers' market, roadside stand, etc.)
- ☐ Retail Garden/Nursery Center
- ☐ Mail Order
- ☐ Other (please identify)

Other
- ☐ Farmer
- ☐ Homeowner
- ☐ Other (please identify)________________________

14. Please identify and discuss what you believe to be obstacles in purchasing and using wildflower and grass seed. Topics may include financial, technical, seed source and geographic production of seed among others. (Feel free to add pages or use additional space on the back of this questionnaire.)

*Obstacle #1 - Topic (please identify)*________________________

*Obstacle #2 - Topic (please identify)*________________________

*Obstacle #3 - Topic (please identify)*____

*Obstacle #4 - Topic (please identify)*____

15. Please rank the importance of your answers in question number 14, with "1" being the biggest obstacle to purchasing/using wildflower and grass seed, "2" being the second biggest obstacle, and soon.

    _______ Obstacle #1 (see question 14)
    _______ Obstacle #2 (see question 14)
    _______ Obstacle #3 (see question 14)
    _______ Obstacle #4 (see question 14)

16. Please use the following space to make a "Wish List" for wildflower and grass seeds. What are your special requirements for seeds? What services would you like to receive from suppliers? What can be improved?

17. Additional comments and remarks:

Thank you for your assistance!

I. WILDFLOWER SPECIES

Agastache nepetoides
Agoseris cuspidata
Allium canadense
Allium cernuum
Allium stellatum
Allium tricoccum
Amorpha canescens
Amorpha fruticosa
Amorpha nana
Anemone canadensis
Anemone cylindrica
Anemone patens wolfgangiana
Angelica atropurpurea
Antennaria neglecta
Antennaria plantaginifolia
Aquilegia canadensis
Aralia racemosa
Arenaria stricta
Artemisia ludoviciana
Asarum canadense
Asclepias incarnata
Asclepias tuberosa
Asclepias verticillata
Aster azureus
Aster ericoides
Aster laevis
Aster linariifolius
Aster novae-angliae
Aster oblongifolius
Aster ptarmicoides
Aster puniceus
Aster sericeus
Aster simplex
Aster umbellatus
Astragalus canadensis
Baptisia australis
Baptisia leucantha
Baptisia leucophaea
Bidens cernua
Blephilia ciliata
Blephilia hirsuta
Cacalia atriplicifolia
Cacalia muhlenbergii
Cacalia suaveolens
Callirhoe traingulata
Caltha palustris
Camassia scilloides
Campanula americana
Campanula rotundifola
Cassia fasciculata
Cassia hebecarpa
Cassia marilandica
Ceanothus americanus
Ceanothus ovatus
Celastrus scandens
Cephalanthus occidentalis
Chelone glabra
Chrysopsis camporum
Cicuta maculata
Clematis virginiana
Coreopsis lanceolata
Coreopsis palmata
Coreopsis tripteris
Crotalaria sagittalis
Cryptotaenia canadensis
Delphinium virescens
Desmanthus illinoensis
Desmodium canadense
Desmodium glutinasum
Desmodium illinoense
Desmodium sessilifolium
Dodecatheon amethystinum
Dodecatheon meadia
Echinacea angustifolia
Echinacea pallida
Echinacea purpurea
Epilobium angustifolium
Eryngium yuccifolium
Eupatorium altissimum
Eupatorium maculatum
Eupatorium perfoliatum
Eupatorium purpureum
Eupatorium rugosum
Euphorbia corollata
Filipendula rubra
Fragaria virginiana
Froehlichia floridana
Galium boreale
Gaura biennis
Gentiana andrewsii
Gentiana crinita
Gentiana flavida
Gentiana puberula
Gentiana quinquefolia
Geranium maculatum
Gerardia tenuifolia
Geum aleppicum
Geum triflorum
Glycyrrhiza lepidota
Gnaphalium obtusifolium
Helenium autumnale
Helianthus grosseserratus
Helianthus laetiflorus
Helianthus maximilliani
Helianthus mollis
Helianthus occidentalis
Heliopsis helianthoides
Heracleum maximum
Heuchera richardsonii
Hieracium canadense
Hieracium longipilum
Hydrophyllum virginianum
Hypericum pyramidatum
Hypoxis hirsuta
Iris prismatica
Iris shrevei
Iris versicolor
Jeffersonia diphylla
Kuhnia eupatorioides
Lespedeza capitata
Liatris aspera
Liatris cylindracea
Liatris ligulistylis
Liatris punctata
Liatris pycnostachya
Liatris spicata
Lilium michiganese
Lilium phildelphicum
Linum sulcatum
Lobelia cardinalis
Lobelia inflata
Lobelia siphilitica
Lobelia siphilitica alba
Lobelia spicata
Lupinus perennis
Lysimachia quadriflora
Lythrum alatum
Mimulus ringens
Monarda fistulosa
Monarda punctata
Napaea dioica
Nicotiana rustica
Oenothera biennis
Oenothera rhombipetala
Opuntia humifusa
Osmorhiza claytoni
Oxypolis rigidior
Parthenium integrifolium
Pedicularis canadensis
Pedicularis lanceolata
Penstemon dtgitalis
Penstemon gracilis
Penstemon grandiflorus
Penstemon pallidus
Petalostemum candidum
Petalostemum foliosum
Petalostemum purpureum
Petalostemum villosum
Phlox divaricata
Phlox glaberrima interior
Phlox pilosa
Physocarpus opulifolus
Physotegia virginiana
Plantago purshii
Polemonium reptans
Polygala polygama
Polygonatum canaliculatum
Polytaenia nuttallii
Potentilla arguta

Prenanthes alba
Prenanthes racemosa
Psoralea tenuiflora
Pycnanthemum tenuifolium
Pycnanthemum virginianum
Ranunculus rhomboideus
Ranunculus pensylvanic
Ratibida columnifera
Ratibida pinnata
Rosa arkansana
Rosa setigera
Rudbeckia hirta
Rudbeckia laciniata
Rudbeckia subtomentosa
Rudbeckia triloba
Ruellia humilis
Sanguisorba canadensis
Saxifraga pensylvanica
Silene regia
Silphium integrifolium
Silphium laciniatum
Silphium perfoliatum
Silphium terebinthinaceum
Sisyrinchium campestre
Sisyrinchium campestre alba
Smilacina racemosa
Smilacina stellata
Solidago graminifolia
Solidago nemoralis
Solidago riddellii
Solidago rigida
Solidago speciosa
Solidago ulmifolia
Taenidia integerrina
Tephrosia virginiana
Teucrium canadense
Thalictrum dasycarpum
Thalictrum dioicum
Thaspium trifoliatum
Tradescantia bracteata
Tradescantia occidentalis
Tradescantia ohiensis
Valeriana edulis

Verbena hastata
Verbena stricta
Vernonia fasciculata
Vernonia missurica
Veronicastrum virginicum
Viola conspersa
Viola eriocarpa
Viola palmata
Viola papilionacea
Viola pedata
Viola pedatifida
Viola sagittata
Wulfenia bullii
Zizia aptera
Zizia aurea
Achillea millefolium
Agastache foeniculum
Aster sagittifolius
Astagalus crassicarpus
Cirsium muticum
Epilobium coloratum
Gerardia paupercula
Helianthemum bicknelli
Helianthus divaricatus
Helianthus giganteus
Helianthus tuberosus
Heterotheca villosa
Houstonia longifolia
Hypericum majus
Lilium superbum
Lysimachia ciliata
Oenothera surrulata
Potentilla fruticosa
Sagittaria latifolia
Senecio aureus
Senecio plattensis
Senecio paupercaulis
Solidago missouriensis
Stachys palustris
Oxeye)
(Marsh Milkweed)
(Blazing Star)

(Cream False Indigo)
(Tall Blazing Star)
Castilleja sessiliflor
Polygala senega
(Azure Aster)
(Rough Blazing Star)
(Giant Hyssop)
(Stiff Tic-Seed)
(Olds Midwest Wildflower Mix)
(Short Dry Wildflower Mix #1)
(NK North American Wildflowers)
(Mesic Mix)
(Mesic Wildflower Mix)
(Rosa Species)
Osmundo cinnamomea
Adiantum pedatum
Athyriam felixfemina
Merlinsia verginica
(Blanket Flower)
(Upright Prairie Coneflower)
(Greyhead Prairie Coneflower)
(Danes Rocket)
(Rough Oxeye)
(Thickspike Gayfeather)
(Spiked Gayfeather)
(White Yarrow)
(Pitcher Sage)
(Lance Leaf Coreopsis)
(Mexican Red Hat)
(Common Vetch)
(Country Wildflower)
(Butterfly)
(Cutting Garden)
(Floral Ground Cover)
(Native Harvest Mix)
(Mixed Native Forbs)
(Showy Penstemon)
(Stiff Sunflower)
(Columnar Coneflower)
(Prairie Bush Clover)
(Narrow-Leaved Milkweed)
Generic Wildflower Mix

II. GRASSES

Agropyron smithii
Agropyron trachycaulum
Andropogon gerardi
Andropogon hallii
Andropogon scoparius
Bouteloua curtipendula
Bouteloua gracilis
Bouteloua hirsuta
Bromus kalmii
Bromus purgans
Buchloe dactyloides
Calamagrostis candensis
Carex alopecoidea
Carex annectens xanthocarpa
Carex hysticina
Carex pensylvanica
Carex scoparia
Carex sprengelii
Carex stipata
Carex vulpinoidea
Elymus canadensis
Elymus virginicus
Hierchloe odorata
Hystrix patula
Juncus tenuis
Koeleria cristata
Panicum virgatum
Paspalum ciliatifolium
Scirpus atrovirens
Scirpus validus
Sorghastrum nutans
Spartina pectinata
Sporobolus asper
Sporobolus heterolepis
Stipa spartea
Stipa viridula
Bromus ciliatus
Calamovilfa longifolia
Juncus greenei
Muhlenbergia cuspidata
Muhlenbergia glom

Phragmites communis
Typha latifolia
(Big bluestem roundtree)
(Big bluestem bonilla)
(Native tall grass prairie seed)
(Tall Grass Mix)
(Blue Grass Mix)
(Mn/DOT 150)
(Mn/DOT 300)
(Short Dry Mix)
(Mesic Grass Mix)
(Wetland Prairie Mix)
(Mn/DOT 500)
(Local Mixed Prairie)
(Prairie Dropseed)
Generic Grass Seed Mix
(Newport Bluegrass)
(Park Bluegrass)
(Perennial Rye)
(Creep Red Fescue)

TABLE 10: GERMINATION METHOD TESTING RESULTS

A. The following seven species will be included in the trials:

Koeleria macrantha *Spartina pectinata*
Petalostemum purpureum *Verbena stricta*
Liatris pycnostachya *Sporobolus heterolepis*
Zizia aurea

The following data is from the testing done by the Minnesota State Seed Laboratory as a part of the LCMR project Native Grass and Wildflower Seed.

B. Germination percentages achieved under various temperatures and methods:

KOELERIA MACRANTHA (CRISTATA)

METHODS	TEMPERATURES-CELSIUS 15	15-25	10-30	15-30	20-30
5 DAY - (KNO_3) PRECHILL	60%	88%	84%	77%	84%
5 DAY - (H_2O) PRECHILL	56%	87%	83%	77%	78%
5 DAY PRECHILL GIBBERELLIC ACID	86%	85%	86%	83%	77%
14 DAY- (KNO_3) PRECHILL	70%	80%	62%	39%	65%
14 DAY - (H_2O) PRECHILL	62%	72%	51%	49%	54%
14 DAY PRECHILL GIBBERELLIC ACID	83%	83%	82%	66%	81%
NO PRECHILL - (KNO_3)	68%	86%	86%	79%	84%
NO PRECHILL - (H_2O)	67%	86%	86%	39%	83%
NO PRECHILL GIBBERELLIC ACID	86%	84%	86%	74%	80%

SPARTINA PECTINATA

METHODS	TEMPERATURES-CELSIUS 15	15-25	10-30	15-30	20-30
5 DAY PRECHILL (KNO_3)	2%	11%	11%	12%	13%
5 DAY PRECHILL (H_2O)	1%	24%	16%	10%	12%
5 DAY PRECHILL GIBBERELLIC ACID	3%	17%	8%	6%	8%
14 DAY PRECHILL (KNO_3)	1%	8%	14%	7%	7%
14 DAY PRECHILL (H_2O)	5%	9%	8%	5%	14%
14 DAY PRECHILL GIBBERELLIC ACID	6%	9%	11%	5%	8%
NO PRECHILL (KNO_3)	3%	22%	21%	22%	22%
NO PRECHILL (H_2O)	1%	27%	30%	25%	22%
NO PRECHILL GIBBERELLIC ACID	2%	26%	25%	25%	23%

PETALOSTEMUM PURPUREUM

METHODS	TEMPERATURES-CELSIUS 15	15-25	10-30	15-30	20-30
NO CHILL - (KNO_3)	3%	1%	5%	3%	3%
5 DAY PRECHILL - (KNO_3)	2% (82 HARD)	4%	3%	5%	2% (80 HARD)
14 DAY PRECHILL - (KNO_3)	3%	3%	5%	5%	4%
HOT WATER TREATMENT (KNO_3)	6%	2%	3%	5%	2%
ACID SCARIFICATION (KNO_3)	9% (38 HARD)	5% (65 HARD)	10% (36 HARD)	4% (59 HARD)	7% (62 HARD)
GIBBERELLIC ACID (KNO_3)	3%	3%	3%	4%	4%
PHYSICAL SCARIFICATION (KNO_3)	41% (15 HARD)	72% (14 HARD)	58% (10 HARD)	64% (6 HARD)	56% (8 HARD)
24 HOUR FREEZE (KNO_3)	6% (34 HARD)	9% (51 HARD)	8% (53 HARD)	13% (56 HARD)	15% (55 HARD)

VERBENA STRICTA

METHODS	TEMPERATURES-CELSIUS 15	15-25	10-30	15-30	20-30	15-25(dark)
NO CHILL - (H_2O)	0%	1%	3%	0%	0%	0%
5 DAY PRECHILL - (H_2O)	0%	2%	5%	3%	0%	1%
14 DAY PRECHILL - (H_2O)	0%	8%	7%	4%	2%	3%
NO CHILL - (KNO_3)	0%	4%	5%	5%	4%	4%
5 DAY PRECHILL - (KNO_3)	0%	6%	6%	6%	3%	6%
14 DAY PRECHILL - (KNO_3)	0%	8%	4%	10%	8%	13%
24 HOUR FREEZE - (H_2O)	0%	1%	3%	1%	1%	0%
24 HOUR FREEZE - (KNO_3)	0%	1%	7%	4%	0%	2%
24 HOUR FREEZE GIBBERELLIC ACID	4%	9%	12%	9%	7%	8%
28 DAY PRECHILL - (H_2O)	0%	9%	11%	8%	3%	8%
28 DAY PRECHILL - (KNO_3)	1%	14%	10%	10%	8%	13%
28 DAY PRECHILL GIBBERELLIC ACID	11%	14%	18%	14%	9%	18%
CLIP SEED, DISTAL END - (H_2O)	0%	11%	9%	9%	10%	7%

LIATRIS PYCNOSTACHYA

METHODS	TEMPERATURES-CELSIUS 15	15-25	10-30	15-30	20-30
NO PRECHILL - (H_2O)	2%	24%	28%	41%	47%
5 DAY PRECHILL - (H_2O)	10%	31%	30%	49%	49%
NO PRECHILL - (KNO_3)	4%	19%	13%	24%	37%
5 DAY PRECHILL - (KNO_3)	8%	32%	32%	47%	56%
NO PRECHILL GIBBERELLIC ACID	11%	42%	38%	49%	65%
5 DAY PRECHILL GIBBERELLIC ACID	15%	50%	44%	61%	71%

SPOROBOLUS HETEROLEPIS

METHODS	TEMPERATURES-CELSIUS 15	15-25	10-30	15-30	20-30
5 DAY PRECHILL - (KNO_3)	45%	82%	80%	81%	77%
5 DAY PRECHILL - (H_2O)	44%	80%	82%	80%	79%
5 DAY PRECHILL GIBBERELLIC ACID	55%	85%	81%	81%	81%
14 DAY PRECHILL - (KNO_3)	56%	83%	85%	76%	83%
14 DAY PRECHILL - (H_2O)	49%	84%	78%	76%	88%
14 DAY PRECHILL GIBBERELLIC ACID	62%	86%	84%	79%	87%
NO PRECHILL - (KNO_3)	30%	76%	77%	79%	78%
NO PRECHILL - (H_2O)	22%	73%	71%	71%	78%
NO PRECHILL GIBBERELLIC ACID	25%	47%	52%	74%	74%

ZIZEA AUREA

METHODS	15	15-25	10-30	15-30	20-30
	TEMPERATURES-CELSIUS				
DOUBLE 5 DAY PRECHILL 7 DAY INTERVAL - (H_2O)	0% (98 DORM)	15% (82 DORM)	39% (55 DORM)	26% (69 DORM)	10% (87 DORM)
MECHANICAL SCARIFICATION - (H_2O)	0% (97 DORM)	10% (87 DORM)	40% (58 DORM)	12% (86 DORM)	7% (91 DORM)
ACID SCARIFICATION - (H_2O)	0% (98 DORM)	9% (88 DORM)	31% (66 DORM)	26% (71 DORM)	7% (91 DORM)
NICK SEED COAT (H_2O)	0% (97 DORM)	11% (86 DORM)	34% (60 DORM)	28% (71 DORM)	7% (91 DORM)
NO PRECHILL (H_2O)	0% (97 DORM)	8% (90 DORM)	34% (65 DORM)	11% (88 DORM)	5% (93 DORM)
5 DAY PRECHILL (H_2O)	0% (99 DORM)	8% (90 DORM)	22% (76 DORM)	18% (80 DORM)	2% (97 DORM)
14 DAY PRECHILL (H_2O)	1% (96 DORM)	26% (71 DORM)	30% (65 DORM)	23% (72 DORM)	4% (94 DORM)
24 HOUR FREEZE (H_2O)	0% (98 DORM)	6% (93 DORM)	26% (72 DORM)	16% (82 DORM)	3% (97 DORM)