NEBRASKA TECHNICAL NOTE

U. S. Department of Agriculture
Natural Resources Conservation Service

May 25, 2004

BIOLOGY TECHNICAL NOTE NO. 55
Ritch Nelson
Wildlife Biologist

A GUIDE TO PRAIRIE AND WETLAND RESTORATION IN EASTERN NEBRASKA

The enclosed publication, *A Guide to Prairie and Wetland Restoration in Eastern Nebraska*, is an updated publication which will replace the 1998 article from Prairie Plains Journal titled *Ecological Restoration of High-Diversity Prairie, PPRI's Basic Guide* by Bill Whitney. This new reference was published by Prairie Plains Resource Institute and the Nebraska Game and Parks Commission. It includes information related to seed collection, processing, storage, mixtures, planting, and follow-up management. It also contains a plant list which is useful in locating and harvesting seed for use in prairie and wetland restoration efforts.

When using the techniques described in this publication, refer to the standards and specifications for Restoration and Management of Declining Habitats and Range Planting as well as the Grass and Forb Seed Source Requirements to ensure that the methods used are acceptable for certification by NRCS requirements when necessary.

Enclosure

A Guide to Prairie and Wetland Restoration in Eastern Nebraska

A Joint Publication of

Prairie Plains Resource Institute and Nebraska Game and Parks Commission

A Joint Publication of
Prairie Plains Resource Institute and Nebraska Game and Parks Commission

1307 L STREET AURORA NE 68818-2126
Phone: (402) 694-5535 cellular (402) 694-9847
ppri@hamilton.net prairieplains.org

PPRI Mission

Maintaining and restoring Nebraska ecosystems: creating opportunities for education, research, stewardship, and community development.

Prairie Plains Resource Institute (PPRI), is an educational land trust incorporated in 1980 as a nonprofit, 501(c)(3) tax-exempt membership organization. The mission of PPRI is being carried out through four major efforts: **Ecological Restoration**, **Prairie Preserves**, **Education** and the **Platte River Corridor Initiative**.

Nebraska Game and Parks Commission

The mission of the Nebraska Game and Parks Commission is stewardship of the state's fish, wildlife, park, and outdoor recreation resources in the best long-term interests of the people and those resources.

A Guide to Prairie and Wetland Restoration in Eastern Nebraska

by

Gerry Steinauer

Nebraska Game and Parks Commission
1307 L Street
Aurora, Nebraska 68818
402-694-2498
gstein@ngpc.state.ne.us

with assistance from

Bill Whitney, Krista Adams and Mike Bullerman

Prairie Plains Resource Institute
1307 L Street
Aurora, NE 68818
402-694-5535
ppri@hamilton.net

Chris Helzer

The Nature Conservancy
P. O. Box 438
1228 L Street, Suite 1
Aurora, Nebraska 68818
402-694-4191
chelzer@tnc.org

Photos by Gerry Steinauer and PPRI staff unless otherwise acknowledged.
Editorial Assistance: Tom White, *NEBRASKAland Magazine*
Layout: Bill Whitney

Cover Photo: Krista Adams collecting porcupine grass (*Hesperostipa spartea*) seeds in a Sandhills prairie near Pierce, Nebraska.

Table of Contents

Acknowledgements

We would like to thank Pauline Drobney, Tom Koerner and Brad Krohn of the U.S. Fish and Wildlife Service, Kent Pfeiffer of the Platte River Whooping Crane Habitat Maintenance Trust and Scott Wessel of the Nebraska Game and Parks Commission for their review of this document. We also thank Tom White of the Nebraska Game and Parks Commission for editorial assistance.

There are several excellent publications on prairie and wetland restoration (Appendix A). These provided valuable information for this publication, particularly *Going native – a prairie restoration handbook for Minnesota landowners*, *The tallgrass restoration handbook* and *A practical guide to prairie reconstruction*.

We also wish to thank the Rainwater Basin Joint Venture for additional funds to cover binding costs.

This publication has been produced with major support from the Nebraska Environmental Trust Fund and the Nebraska Lottery

Chapter 1 - Introduction

History of Prairie Restoration in Eastern Nebraska

Inspired by a trip to restored prairies in Illinois and Wisconsin in 1978, Bill Whitney of Aurora, Nebraska began harvesting prairie seed and studying the prairies of central Nebraska. In the spring of 1979, he conducted his first prairie restoration, a garden-sized plot on a friend's farm. The mixed seed, a big coffee can full, included about 35 native grasses and wildflowers collected from local prairies and roadsides.

Bill Whitney, in 1978, standing amidst the Morton Arboretum prairie restoration in Lisle, Illinois.

In 1980 Bill and his wife, Jan, founded Prairie Plains Resource Institute (PPRI), a nonprofit organization based in Aurora and dedicated to prairie restoration, preservation and environmental education. During the 1980s Whitney conducted several additional small restorations around Aurora and managed three remnant prairies owned by PPRI. At that time, few people in the Midwest were restoring prairies containing large numbers of species, and restoration methods were not well documented. Much of Bill's knowledge of prairie restoration was gained through practical experience.

Young seed collector on the Platte River bluffs of Hamilton County, Nebraska in 1980.

Beginning in 1991, PPRI was contracted to restore wet meadows on cropland in the central Platte River valley owned by the Platte River Whooping Crane Habitat Maintenance Trust (PRCT) and The Nature Conservancy (TNC). Between 1991 and 1996, Whitney and a host of volunteers hand planted nearly 400 acres of wet meadow in the valley. Using methods Whitney developed, the Crane Trust

PPRI's custom fabricated seed harvester used during the early 1990s.

and Conservancy continue to do prairie restorations in the Platte River valley.

With a grant from the Nebraska Environmental Trust in 2000, PPRI established the Prairie Restoration Cooperative in partnership with the Nebraska Game and Parks Commission (NGPC), TNC, U.S. Fish and Wildlife Service (USFWS), Pheasants Forever (PF) and Natural Resource Conservation Service (NRCS). Together they are working to expand high-diversity prairie restoration to new areas and habitats within the state, to increase their capability to do restorations, and to increase the availability of local-ecotype native seed for restorations, wildlife plantings and horticultural use. Since 2000 the Cooperative has planted more than 1,500 acres of prairie and wetland in the eastern half of Nebraska, mostly on lands owned by conservation agencies or protected through conservation easements.

A seed sower lineup on a Platte River valley restoration.

About This Publication

This publication documents the restoration methods originally developed by Bill Whitney and later refined by himself and other ecologists from TNC, PRCT, NGPC and USFWS working in eastern Nebraska. Restoration of the following plant community types is covered in this document: tallgrass prairie, mixed-grass prairie, sand prairie, freshwater wet meadow and marsh, Rainwater Basin wet meadow and marsh, and saline wet meadow and marsh.

The methods we use are generally affordable and not complicated. To quickly summarize, we handpick and machine harvest seed, do little seed cleaning and broadcast plant with a fertilizer spreader. We do not mow annual weeds during the initial years after planting and manage established restorations with prescribed fire and grazing. Many Midwestern restorationists use other methods. For example, some plant highly-cleaned seed with a seed drill, pack the soil after planting and mow annual weeds in the first year after planting. We will touch on these methods within this publication.

Our methods have proven successful and practical for restorations in eastern Nebraska. We do not wish to imply that our restoration methods work better or are more successful than the methods of others. Other restoration methods might be more appropriate for areas with different climates, soils and vegetation. Innovations in our restoration methodology over the years have resulted from our experimentation

Sowers taking a break after a 1993 planting.

and by learning from the restoration efforts of others. Our methods will likely be refined in coming years as we gain more experience and knowledge about prairie and wetland restoration and ecology.

The Plant Communities of Eastern Nebraska

Early French explorers traversing central North America had no term for the vast grasslands they encountered, so they called it prairie – literally, meadow. Then, prairie covered more than 95 percent of the Nebraska landscape. The prairies were of three basic types: tallgrass, mixed-grass and Sandhills prairie – each of which developed in response to variations in climate and soils. Trees in eastern Nebraska were restricted to well-watered and somewhat fire-protected stream valleys by wildfire, drought and competition with prairie grasses. Woodlands occupied only about 2 percent of eastern Nebraska's presettlement landscape.

Tallgrass prairie covered the rolling hills of the eastern third of Nebraska where annual precipitation averaged more than 25 inches. It also extended westward into the drier plains in stream valleys, such as those of the Platte, Republican, Elkhorn, Niobrara and Loup rivers. Tall grasses – big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*) – were the dominant plants of the tallgrass prairie. In the rich soils of wet valleys these grasses often grew 6 feet or taller.

Tallgrass prairie soils, which developed over thousands of years, commonly had topsoils over 18 inches thick and rich in organic matter and nutrients. Hundreds of species of wildflowers, grasses and sedges added color and diversity to the tallgrass landscape. The large majority of prairie plants are perennials, which resprout each spring from roots, bulbs or corms. Annuals and biennials are a minor component of the prairie flora.

The tallgrass prairie region was the first in Nebraska to be settled by Europeans. Immigrants, who first arrived in large numbers after the passage of the Homestead Act in 1862, found the fertile soils and ample rainfall in the tallgrass region well suited for growing corn and other crops. By 1900, most of the tallgrass prairie had been plowed. Today less than two

NEBRASKAland Magazine

Tallgrass prairie.

Mixed-grass prairie on the loess bluffs of the Platte River east of Grand Island, Nebraska.

West of the tallgrass prairie region, but excluding the Sandhills, mixed-grass prairie cloaked the drier loess covered plains and hills. The word "mixed" represents the combination of short, mid and tall grasses that dominated this prairie type. Mid and short grasses, primarily little bluestem (*Schizachrium scoparium*), needle-and-thread (*Hesperostipa comata*), side-oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*) and buffalograss (*Buchloe dactyloides*) grew on the upper slopes and hilltops. Tall grasses grew on lower slopes and bottoms.

Roughly a third of eastern Nebraska's mixed-grass prairie has survived, primarily in areas too steep, rocky, dry or infertile to farm. The largest expanses remain on the steep loess hills of central Nebraska and on the breaks and bluffs of the Platte, Republican and Niobrara rivers.

percent of Nebraska's original tallgrass prairie remains.

The majority of remnant tallgrass prairies are usually less than 80 acres and have survived as hay meadows and grazed pastures. They are literally islands of prairie in a sea of cropland. A few larger tracts exceeding a square mile are found on land too steep, rocky or infertile to plow. Hayed prairies are generally in better condition and have a higher diversity of native plants than pastured prairies. Many pastures have been overgrazed and sprayed with herbicides leading to loss of native plant diversity. Encroachment of shrubs, trees and exotic plants has reduced the value of most remnant prairies as native plant and wildlife habitats.

NEBRASKAland Magazine

An eastern extension of mixed-grass prairie occurs on Pierre Shale-derived soils near the Missouri River in northeast Nebraska.

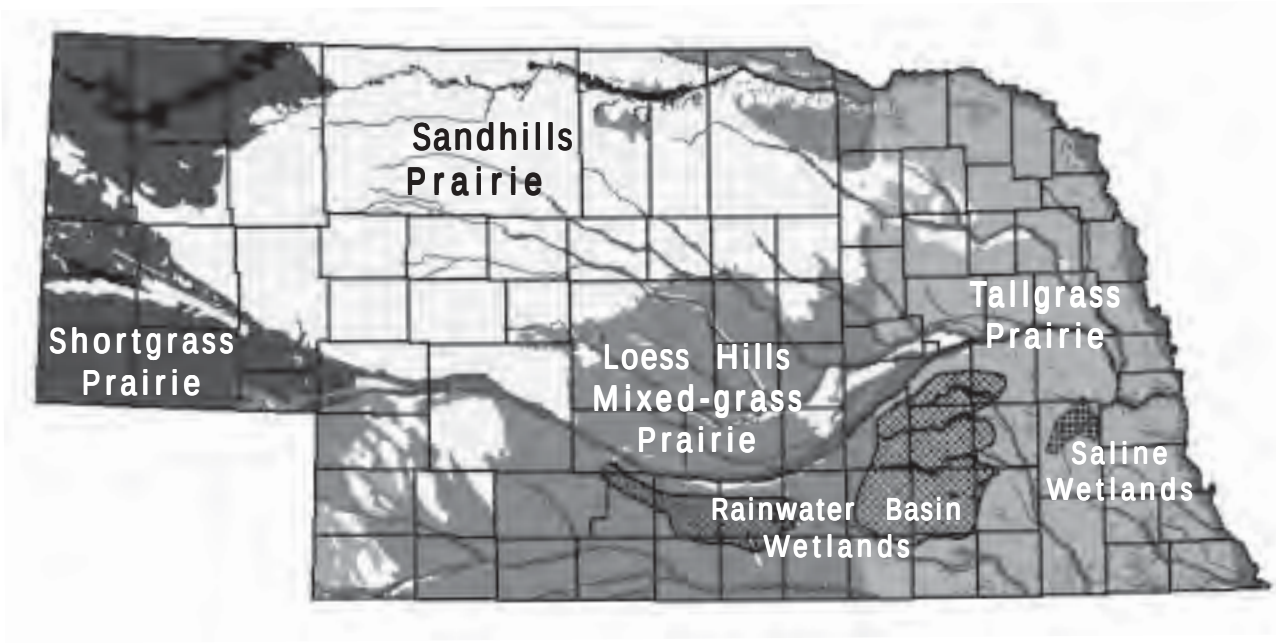


Figure 1. Presettlement distribution of the major plant community types of Nebraska (modified from Native vegetation map of Nebraska., Kaul and Rolfsmeier 1993).

Settlement and farming in the mixed-grass prairie region started slightly later and proceeded at a slower pace than in the tallgrass prairie region. Initial plowing of the mixed-grass prairie continued until the 1920s, when nearly all land capable of supporting dryland farming was under cultivation. Some mixed-grass prairie not suitable for dryland farming went under the plow when well irrigation was developed in the 1950s. This conversion was further spurred with the advent of center-pivot irrigation in the early 1970s. Since the early 1980s, the conversion of prairie to irrigated cropland has slowed.

The Nebraska Sandhills, North America's largest dune field, covers much of north-central Nebraska. The dune soils support Sandhills prairie dominated by a variety of tall, mid and short grasses including sand bluestem (*Andropogon hallii*), prairie sandreed (*Calamovilfa longifolia*), sand dropseed (*Sporobolus cryptandrus*), little bluestem, needle-and-thread and hairy grama (*Bouteloua hirsuta*). Valleys between dunes support a more lush growth of vegetation and many scattered wetlands.

Attracted by the free and open range, cattlemen in the 1870s were the first to settle in the Sandhills. Passage of the Kincaid Act in 1904 attracted farmers to the region. However, a succession of dry years and crop failures soon forced most to sell out to ranchers. Ranching has remained the predominant land use in the Sandhills. Today only about 5 percent of the Sandhills is cultivated.

Sandhills prairie, like all of Nebraska's prairie types, developed under the influence of wildfire and grazing by large ungulates, such as

NEBRASKAland Magazine

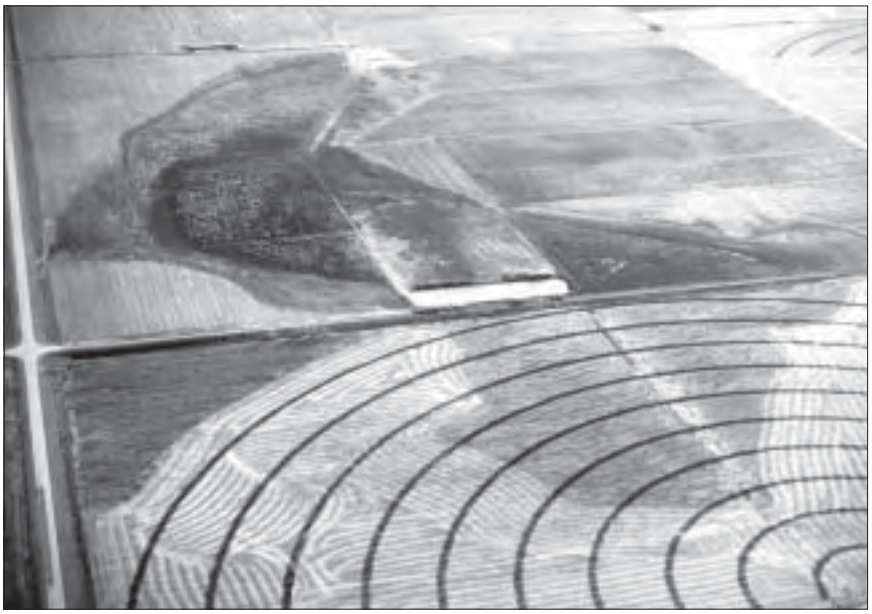
The Sandhills contain Nebraska's largest concentration and diversity of wetland types.

bison, pronghorns, elk and deer. Fires kept trees and shrubs from encroaching upon the prairies, reduced litter buildup, enhanced nutrient availability and, in general, stimulated the growth of prairie plants. Like fire, grazing reduced litter buildup and recycled nutrients. Random grazing patterns also produced areas of varying vegetation height and density, which in turn, provided habitat for a diversity of prairie animals.

With settlement the natural disturbance patterns of Nebraska's prairies changed. Wildfires were suppressed and grazing patterns changed as the free-roaming ungulates were replaced by fenced herds of cattle. Since settlement many native prairies have been overgrazed, which has reduced native plant diversity and promoted invasion by aggressive exotic plants, such as Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), cheatgrass (*Bromus* spp.) and thistles.

Many of Nebraska's prairie remnants have lost ecological value because of their small size and fragmented distribution within a cropland-dominated landscape. Small prairies provide few nesting opportunities for grassland nesting birds, such as bobolinks and prairie chickens, which require larger blocks of nesting habitat. These small prairies surrounded by croplands and roads are also susceptible to invasion by exotic plants, herbicide drift, erosion and loss of native species. Though small and highly vulnerable, small prairies are important seed collecting sites and habitat for many species of plants, wildlife and insects.

Before settlement, wetlands were commonly interspersed among Nebraska's prairies, primarily in the Rainwater Basin region



NEBRASKAland Magazine

A drained and partially farmed Rainwater Basin wetland in south-central Nebraska.

of south-central Nebraska, in the Sandhills and in stream and river valleys. Wetlands, shallow bodies of water or areas with water-saturated soils, are among Nebraska's most productive habitats and home to a diversity of aquatic plants and animals.

Rainwater Basin wetlands formed over thousands of years as wind-excavated depressions in the south-central Nebraska loess plain. The rainwater- and snowmelt-filled basins are a key spring staging area for millions of ducks, geese and shorebirds, which feed and rest there before continuing their northward migration.

By the early 1900s, most good soils in the loess plains of south-central Nebraska were already farmed. Farmers then began draining the basins, which were considered wastelands, to increase their acres of cropland. By 1920, 20 to 35 percent of the basins in Fillmore County had been drained and converted to cropland. Today less than 10 percent of the original basins remain.

Valuable bird habitat, as well as habitat for other aquatic species, was lost when the basins were filled or drained. Migrating waterfowl have been forced to concentrate in large numbers on the remaining basins. Numbers sometimes approach a million ducks and geese per basin. Crowding has made birds susceptible to outbreaks of fowl cholera, a disease that claims thousands of birds some years.

The Sandhills contain Nebraska's largest concentration and diversity of wetland types. They include wet meadows (lowlands with water-saturated soils dominated by sedges and grasses), marshes (deeper water areas with emergent vegetation such as rushes and spikerushes), lakes and fens (spring-fed wetlands with peat or muck soils). Sandhills wetlands have not undergone the intense conversion to cropland that occurred in other regions of Nebraska, but many have been ditched and drained to facilitate haying.

Before Euroamerican settlement, Nebraska's river floodplains were a mosaic of oxbow lakes, backwater marshes, wet meadows and woodlands. Annual spring and early summer floods were vital to the ecological health of these floodplain ecosystems. The floods cut new channels, leaving the old channels to form backwater wetlands, and saturated the floodplain soils. The majority of Nebraska's floodplain wetlands have been ditched, drained and converted to cropland. In addition, stream channelization, dam construction and reduced stream flows have greatly altered the hydrology of remaining floodplain wetlands beyond the Sandhills.

NEBRASKAland Magazine

A natural floodplain in the Nebraska's Sandhills with an unchannelized meandering stream. In some highly disturbed floodplains in eastern Nebraska restoration practices could include modification of channels and wetlands and reseeding of native vegetation.

NEBRASKAland Magazine

Salt-adapted vegetation of a saline wetland near Lincoln, Nebraska.

Saline wetlands occur in the floodplain of Salt Creek and its tributaries in Lancaster and southern Saunders counties. Groundwater seepage over thousands of years from deeply buried saline aquifers has accumulated salts in the floodplain soils, allowing this unique wetland type to form. The wetlands' vegetation is composed of salt-adapted plants such as saltgrass (*Distichlis spicata*) and seablite (*Suaeda calceoliformis*). Salt-encrusted mudflats are a common feature of saline wetlands. These mudflats are rich in invertebrate life and are heavily used by migrating shorebirds.

The channelization of Salt Creek, initiated in 1917 as a flood-protection measure for the city of Lincoln, greatly affected the saline wetlands. Completed in 1942, the channelization encouraged tributary streams to head-cut, carving deeper into their beds to adjust to the gradients. The lowered streambeds eventually cut into saline wetlands, draining them and diluting their salt concentrations. Many saline wetlands were filled and developed as Lincoln expanded over the years. Others were drained, filled and farmed.

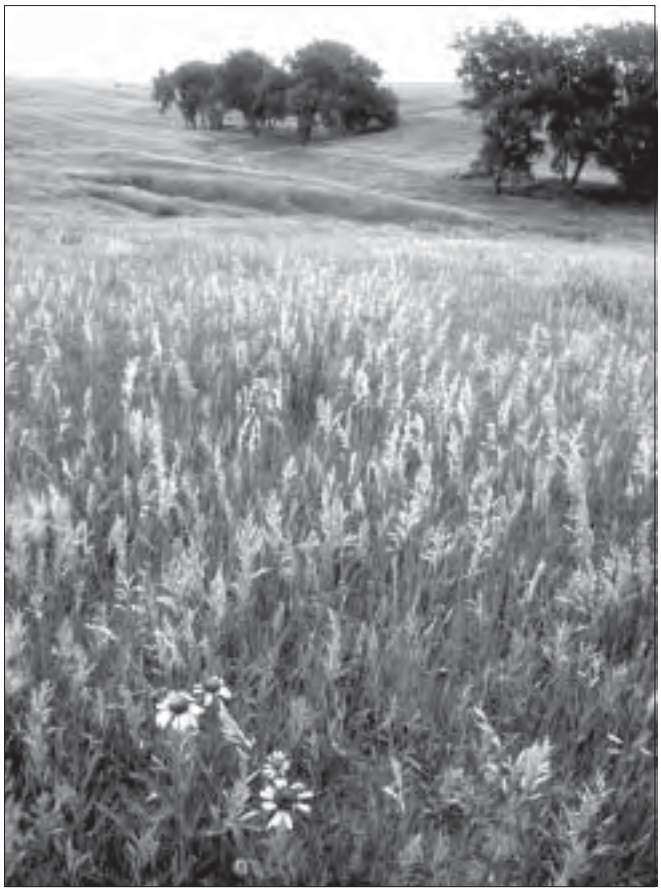
Today, only about 5 percent of Nebraska's original saline wetlands remain. Wetlands with representative salt-adapted vegetation are scarce and shorebird use of the wetlands has dwindled substantially over the years.

What is restoration?

Restoration is the process of recreating a plant community (i.e. prairie or wetland) where one once existed but is now gone. Most of our restorations are sown on land that has been farmed for many years. In some cases, overgrazing, indiscriminant herbicide spraying or exotic plant invasion have degraded remnant prairies and wetlands to a point where few native plants remain, though the natural soil profile remains intact. Such sites are often interseeded with native plants after exotic species are controlled. We also consider this process restoration. Ecologists sometimes use the term "reconstruction" in a context similar to the term restoration – creating a prairie or wetland from scratch where none currently exists.

Native plant composition and diversity, and wildlife habitat values of many prairies and wetlands can be improved through use of prescribed fire, controlled grazing, tree clearing, selective herbicide spraying and other practices without the need for interseeding. We define these activities as management or enhancement.

Restoration stresses ecological accuracy with strong emphasis on plant community composition and structure. We seed only those species that are natural components of the plant



A smooth brome dominated native pasture in northeast Nebraska contains few native plants such as purple coneflower in the foreground.

community. We also use local ecotype seed (see definition below) with genetics similar to the plants native to the region of interest. Ecological accuracy is what distinguishes restoration from plantings that include exotic species, only a few native species or native plant cultivars (plants whose genetics have been modified through selective breeding). For example, Conservation Reserve Program (CRP) plantings sometimes contain five or fewer native grass cultivars and are not considered prairie restorations.

Restorationists recognize that simply seeding native plants is not sufficient to bring back the bacteria, fungi, invertebrates and wildlife that inhabited presettlement native plant communities. However, the plant community provides the basic structural environment for these other life forms and many of these species may colonize the restoration on their own.

Before planting, restoration often involves earthmoving to reshape the natural landscape topography or restore wetland hydrology. For example, farm terraces are often leveled in crop fields before seeding prairie. Sediment is often excavated and ditches filled prior to seeding wetlands.

For the sake of the reader, we feel it is important to define a few terms frequently used in this publication.

Biodiversity – is the diversity of all living things: plants, animals and microorganisms, as well as the genetic material that makes up those organisms. At a higher level, biodiversity includes plant communities, ecosystems and landscapes of which the species are a part. The concept of biodiversity includes both the variety of living things and the genetic variability found within and among them.

Cool-season grass – A grass that generally makes the major portion of its growth during the fall and early spring. These plants usually possess the C-3 photosynthetic pathway. Nebraska has many native cool-season grasses, however, most of the exotic grasses that invade remnant prairies and wetlands are also cool-season species.

Cultivar – A plant developed and improved by various horticultural techniques such as selection and hybridization. Common cultivars of native grasses planted in Nebraska include Omaha Wildrye, Pawnee Big Bluestem and Cave-In-Rock Switchgrass. Cultivar grasses have generally been selected for aggressive growth characteristics for grazing use. Cultivars of native wildflowers are commonly sold as ornamental

plants in Nebraska. These generally are larger plants and have larger flowers than native varieties.

Exotic plant – A plant introduced from other continents or other regions of North America; a non-native plant. This generally refers to plants not found in Nebraska at the time of Euroamerican settlement (CA 1850).

Forb – Any herbaceous (non-woody) plant that is not a grass or sedge. The term forb is commonly used to describe the broad-leaved plants known as wildflowers.

Chris Helzer/The Nature Conservancy

A high-diversity, wet-mesic prairie restoration in the central Platte River valley.

High-diversity restoration – The term diversity refers to the number of plant species seeded in a restoration. We define high-diversity restoration as one in which >75 plant species are seeded. A **moderate-diversity restoration** is one in which 25-75 species are seeded. A l**ow-diversity restoration** is one in which < 25 species are seeded. These terms and values are for general use and can vary for different plant community types. Before Euroamerican settlement, local prairies were often home to several hundred species of native plants. Saline wetlands, because of difficult growing conditions resulting from high salt concentrations in the soil, naturally contained fewer than 25 plant species.

Local ecotype seed – This term refers to seed collected from native plants that grow near a restoration site. Local ecotype seed is preferred by many restorationists because the plants grown from this seed will likely have genetics similar to plants growing on the site prior to settlement. Local ecotype seed ensures the use of plants well-adapted to the climate and soils of a restoration site. Use of local ecotype seed also prevents potential contamination of the local native plant gene pools that can occur if plants are brought from beyond the region.

Restorationists vary in their opinion as to what constitutes local ecotype seed. Some suggest that to maintain local gene pools seeds should be collected within 100 miles north or south of a restoration site and 200 miles east or west of a site. Others suggest that seed should be collected within 25 miles of a restoration site. As a rule of thumb, we try to use seed collected within a 100-mile radius of a restoration site.

Native plant – A plant native to Nebraska, a plant species that occurred here at the time of Euroamerican settlement (CA 1850).

Remnant prairies – Those prairies that have never been plowed, retain their natural soil profile and support native vegetation though it may be altered from its presettlement condition. Remnant prairies are often referred to as native prairies. Ecologists often use the term **native prairie** to describe restorations planted with local-ecotype seed. This may be somewhat misleading because a prairie's natural soil profile or exact presettlement plant and animal composition cannot be replicated.

Plant community – An assemblage of plants growing under similar environmental conditions (i.e. soils and climate). Examples of plant community types include tallgrass prairie, mixed-grass prairie and Rainwater Basin marsh.

Warm-season grass – A grass that makes most or all of its growth during the late spring to early fall period and is usually dormant other times of the year. These plants usually possess the C-4 photosynthetic pathway. Most of the grasses that dominated Nebraska's prairies, such as big bluestem and Indiangrass, are warm-season grasses.

NEBRASKAland Magazine

Musk thistle, an invasive exotic or non-native plant originally from Eurasia, is a troublesome weed in some native grasslands.

Chapter 2 - Getting Started

Restorations can vary from less than an acre to several thousand acres. The Nature Conservancy is restoring a 5,000-acre sand prairie and wet meadow complex on their Kankakee Sands Preserve in Indiana. Backyard and school restorations are often less than a few thousand square feet.

In general, the larger the restoration, the greater the diversity and abundance of native plants and wildlife it can support. And the more genetically diverse the plant populations, the more resilient the restoration is to climatic change, diseases and other environmental factors. However, even small prairie and wetland restorations provide habitat for native plants, small mammals, birds and a diversity of insects. Prairie restorations can be a relatively low-maintenance native landscaping option. Prairie landscaping is not only dynamic and attractive, but also environmentally friendly, greatly reducing the need for water, fertilizer and lawn chemicals. Backyard and school prairies

School prairie restorations are usually small but create opportunities for educational activities, such as this prescribed burning demonstration.

Creating a school prairie is a great way to involve youth in conservation.

are excellent places to teach about nature and to foster greater appreciation of the prairie.

Restoration is fun and interesting and can be a great family, school or volunteer activity. However, restoration is a slow process with most prairie and wetland plantings taking 3-5 years to become well established. Restoration requires patience and commitment.

Checking Local Ordinances

Some city and county governments have codes or ordinances restricting the height of plants in residential lawns. These restrictions might preclude planting of a prairie in some residential areas. City or county clerks can be consulted to see if such restrictions exist. Local fire departments should be contacted if prescribed burning is planned for restoration management to determine local restrictions and needed permits. State and federal permits are often required for earthmoving in wetlands (i.e. ditch filling or excavation of fill material).

Prairie landscaping is not only attractive, but also environmentally friendly, reducing the need for water, fertilizer and lawn chemicals.

Consulting the Nebraska Game and Parks Commission, U.S. Fish and Wildlife Service or Army Corp of Engineers is recommended prior to such activities.

Choosing a Site

Most prairie plants grow poorly in shaded environments because they need a minimum of 6 to 10 hours of sunlight per day to survive. In addition, cool-season exotic plants such as smooth brome often invade shaded areas of prairie. Prairie restorations should be placed in the sunniest sites available, and removing shelterbelts or other non-native woodlands adjacent to restoration sites should be considered before planting.

If possible, avoid planting restorations adjacent to stands of smooth brome, reed canary grass (*Phalaris arundinaceae*), tall wheatgrass (*Thinopyrum ponticum*) or other aggressive and difficult to eradicate exotic plants. Unless controlled through herbicide application, mechanical means or prescribed fire before planting (see Chapter 6) these species will probably invade a restoration.

Caution must be taken when planting a prairie or wetland downslope of cropland because they may receive runoff and siltation. Cropland terraces and native grass buffer strips upslope of the restorations help prevent runoff and silt from reaching the restorations. Restorations are susceptible to herbicide and pesticide drift and attention must be paid to wind direction and speed when applying herbicides and pesticides to crops or pasture adjacent to a restoration.

Soil texture, drainage and chemistry will influence which species to plant in a prairie or wetland restoration. Many prairie plants will grow on a wide variety of soil textures. For example, in eastern Nebraska, little bluestem grows on sandy, silty and clayey soils. Other prairie plants will grow only on specific soil types. For example, in eastern Nebraska, sand bluestem will grow only on sandy soils. Chapter 5 and Appendix B provide guidance as to what species to seed on various soil types. County soil surveys, available at local Natural Resource Conservation Service offices, can be consulted to determine soil characteristics of a restoration site.

A basic knowledge of soil types and site hydrology (e.g. sand, silt and clay) and their moisture characteristics is helpful in planning the appropriate mix of species for a restoration.

Chris Helzer/The Nature Conservancy

Low-lying sites with standing water for most of the growing season should be sown with marsh plants.

Most prairie and wetland plants have fairly specific moisture requirements and should be seeded on sites with appropriate soil moisture regimes (see Chapter 5 and Appendix B). For example, restorations on low-lying sites with standing water for most of the growing season (seasonally and semi-permanently flooded wetlands) should be sown with marsh plants. Low-lying sites flooded only in spring or after heavy rains and with groundwater always within a few feet of the soil surface (temporary wetlands) should be sown with wet-mesic prairie plants. Upland prairie plants are appropriate for seeding on sites not influenced by groundwater or flooding.

Hand collecting is necessary for obtaining seed of most prairie and wetland species.

Wetland restorations are complicated because the natural hydrology of sites have often been altered through ditching, tiling or filling and must be restored before seeding. Restoration of wetland hydrology often requires complex engineering, extensive earthmoving and state and federal permits. Consulting with a biologist from the Nebraska Game and Parks Commission, U.S. Fish and Wildlife Service, Ducks Unlimited or other conservation organizations is recommended before undertaking a wetland restoration.

We believe that past herbicide use at a restoration site usually has little influence on establishing seeded species. Atrazine, a broadleaf and grass herbicide commonly applied to cornfields in eastern Nebraska, is the exception. We have found that Atrazine might limit seeding growth of native plants for one or possibly more years after its last application. We recommend not applying Atrazine to a restoration site for 2-3 years before seeding.

NEBRASKAland Magazine

Downy gentian, a rare tallgrass prairie species, is a beautiful fall-blooming wildflower. Its seed is not harvestable until October.

Figure 1 (page 9) shows the presettlement distribution of major prairie and wetland types in Nebraska and can be consulted to help determine which plant community type is appropriate for planting on a restoration site. Though this map shows distinct boundaries between community types (e.g. tallgrass prairie and mixed-grass prairie), in reality these transitions are often gradual and sometimes shifting over time in response to climate.

OTHER PLANNING CONSIDERATIONS

Obtaining seed, whether by collection or purchase, is usually the most time-consuming or costly part of the restoration process. Seed cost varies depending on the following factors: 1) size of the restoration, 2) number of species included in the seed mix, 3) seeding rate and 4) whether seed is collected and processed by oneself or purchased. The seed of common prairie species, such as big bluestem or rigid sunflower (*Helianthus pauciflorus*), can usually be collected in large quantities or purchased at reasonable prices. Seed collecting time or cost increase when hard-to-collect or less common species, such as or blue-eyed grass (*Sisyrinchium* spp.) or downy gentian (*Gentiana puberulenta*), are included in the seed mix. We found collecting and processing seed ourselves is more cost efficient than to buy it from a dealer. However, we have made a considerable investment in equipment and staff training, which increases the efficiency of seed harvesting.

There are presently few individuals or companies in Nebraska that collect, grow and sell local ecotype seed. However, several Midwestern seed dealers do sell prairie and wetland seed that may be appropriate for eastern Nebraska. Buying seed mixes is usually

NEBRASKAland Magazine

Seed collecting time or cost increase when hard-to-collect or less common species such as this blue-eyed grass are included in the seed mix.

less expensive than purchasing seed of individual species and making one's own mix. Another point to consider is that many commercial prairie and wetland seed mixes contain seed of horticultural and agronomic native plant cultivars or seed that is not local ecotype seed for eastern Nebraska.

There are several conservation programs including the Nebraska Game and Park Commission's Wild Nebraska Program, the U.S. Fish and Wildlife Service's Partners For Wildlife Program and the Natural Resource Conservations Service's Conservation Reserve Program and Wetland Reserve Program that can provide landowners financial assistance for prairie and wetland restorations. Contact information for these agencies is included in Appendix A.

Timeline

Becoming familiar with prairie or wetland plants before beginning a restoration will prove valuable and increase your enjoyment of the restoration process. Several books on prairie and wetland plants are listed in Appendix A. Visiting a local native prairie or wetland will assist with learning native plants, their growth characteristics and locations on the landscape.

Adequate time must be scheduled for seed collecting and processing, site preparation and planting, which are discussed in Chapters 3-6. For most prairie and wetland restorations seed is collected over an entire growing season, mid-May to late October. Before collecting seed, collecting sites must be located and access permission obtained. Seed is usually processed in late fall and planted in late fall through spring.

For those with little restoration experience, collecting seed for and planting only a small part of a site the first year will allow one to learn the tricks of the trade before jumping headlong into unfamiliar territory. For schoolyard restorations, conducting a partial restoration each year allows subsequent classes to be involved in each aspect of the restoration process. Keeping a written record of each phase of the restoration process, such as seed collection dates and amounts, and planting methods and rates, is a valuable learning process and may increase one's enjoyment of the restoration process.

Becoming familiar with prairie or wetland plants before beginning a restoration will prove valuable.

Chapter 3 - Seed Collecting

Seed Collecting Tips

The seeds of most species planted in restorations in eastern Nebraska can be collected from remnant prairies and wetlands, and occasionally from road right-of-ways. Seed collecting requires a comprehensive knowledge of the plants beyond learning their names and how to identify them. It also requires learning their habitats, locations and seasonal cycles of growth, flowering and seed production. Learning these facts for 100 or so species in a planting is not as an intimidating as it might seem and can be an enjoyable part of the restoration process. Several plant guides for the region are listed in Appendix A.

In eastern Nebraska, the seed-collecting season begins in mid-May when the seeds of early blooming plants such as prairie ragwort (*Senecio plattensis*), pussytoes (*Antennaria* spp.)

A high-diversity mix can include seed of more than 100 species.

and sedges (*Carex* spp.) ripen. Harvest continues through October and into early November when the seeds of the late-blooming wildflowers, such as asters (*Symphyotrichum* spp.) and goldenrods (*Solidago* spp.) ripen. Seed of the dominant warm-season prairie grasses, such as big bluestem and Indiangrass, needed in large quantities for prairie restorations, begin ripening in mid-September.

The seeds of most prairie and wetland plants mature over a 1-2 week period that is fairly consistent from year to year (see Appendix B). For some species, such as spiderworts (*Tradescantia* spp.) and blazing stars (*Liatris* spp.), seeds mature over several weeks.

NEBRASKAland Magazine

Milkweed seeds bursting from their pods in September.

For some species, such as this blazing star, seeds ripen over several weeks. First to ripen are seeds lower on the stem.

Ripening seed should be checked often and harvested when the highest percentage of seed is ripe because the seed of many species begins to fall from the plant soon after ripening. The seeds of New Jersey tea (*Ceanothus* spp.), violets (*Viola* spp.), prairie phlox (*Phlox pilosa*) and a few other prairie species burst from capsules when mature and must be collected immediately upon ripening. Members of the milkweed (*Asclepiadaceae*) and aster (*Asteraceae*) families have wind-blown, dandelion-like seeds that must be collected before they blow away.

Some restorationists recommend collecting only 50 percent of the seed of a given species from a site and less for rare species. Leaving seed at a collection site provides food for wildlife and provides plants an opportunity to reproduce. As a general rule, we collect as much seed as possible for each species needed in a restoration, though limiting the amount we take from each site. Excess seed is used to plant a heavier seed mix. Seed of aggressive native

species (listed in Appendix B), such as Maximillian sunflower (*Helianthus maximilianii*), sawtooth sunflower (*Helianthus grosseserratus*) and Canada goldenrod (*Solidago canadensis*),

NEBRASKAland Magazine

Seed of aggressive native species, such as this sawtooth sunflower, that spread rapidly in a restoration can be collected in limited quantities.

that spread rapidly in a restoration can be collected in limited quantities.

Care must be taken to avoid collecting seed of agronomic and horticultural cultivars that have been planted in many areas of the state. This is generally not a problem when collecting from remnant prairies and wetlands. However, many road right-of-ways have been seeded with horticultural and agronomic cultivars of native wildflowers, such as purple coneflower (*Echinacea* spp.) and blanket flower (*Gaillardia pulchella*), and native grasses, such as eastern gamma grass (*Tripsacum dactyloides*) and big bluestem. Most Conservation Reserve Program (CRP) fields also have been planted with agronomic and horticultural cultivars of native grasses and wildflowers.

It is necessary that seed collectors know when seeds are ripe for harvest and the difference between seed capable of germination and seed that won't germinate. Prairie cordgrass (*Spartina pectinata*), side-oats grama (*Bouteloua curtipendula*) and sedges (Carex spp.) are examples of species that often produce normal healthy looking seed heads that are empty of seed. Significant time and effort can be lost collecting sterile seeds or empty seed heads.

Restorationists use the following indicators to judge when seeds are ripe (not all of these conditions must be present simultaneously in all species to indicate ripeness):

- Ripe seeds are plump and hard, unripe seed is generally soft or milky.
- Earliest formed seeds are starting to drop from the plant.
- Seedpods and seed coats are changing colors – usually from green to a darker hue.
- Seedpods or capsules are starting to open.

Ripe Canada milkvetch pods containing seeds. If the pods have not been attacked by insects the seeds may be visible or make a rattle sound when shaken.

- Stems are dry and no longer nourished by the roots and leaves.

Two general stages of seed development with which collectors should be familiar are the milky stage and the dough stage. If when squeezed between the fingers the seed consists of a milky pulp, the seed is not yet ripe and will not mature into a viable seed if picked at this stage. If the seed is doughy, mealy or hard when squeezed between the fingers, it will generally mature into a viable seed if picked at this stage. In general, the longer the seed is allowed to mature or harden the greater the chance of it being viable. The seeds of many species, such as prairie clovers (*Dalea* spp.) and grasses, are well hidden by bracts and chaff and not easily found. Bracts and chaff are often papery and light in these species while seeds are more solid and have smooth hard surfaces.

A shriveled flower head or seed head/ fruit or the presence of a small entry hole in the seed head might indicate insect damage to the

Including as little as a handfull of leafy spurge or other aggressive weed seed in a seed mix could spell trouble for a restoration.

Seed Testing

Seed of native plants can be tested for viability and purity at seed laboratories such as the Nebraska Department of Agriculture Seed Testing Lab in Lincoln. Tests are conducted on an individual species basis. The Pure Live Seed (PLS) can be calculated by multiplying the bulk seed weight by its purity percentage and germination percentage (viability). PLS values must be provided for any native seed sold in Nebraska. Seed testing is fairly expensive, around $80 per test, but it is the only way to closely estimate the amount of live seed being planted in a restoration.

We believe it unnecessary to know the approximate amount of live seed being planted in a restoration and, therefore, we have done little seed testing. Testing all the seed we collect and plant would be cost prohibitive. We reason that if seeds are plump and ripe when collected, most will be viable and that having some bad seed in a mix will not affect our restoration results. Following are viability tests results from seed that we collected from central Platte River valley prairies during the severe drought summer of 2002: rosinweed (*Silphium integrifolium*) 93%, common evening primrose (*Oenothera villosa*) 88%, stiff sunflower 86%, Illinois bundleflower (*Desmanthus illinoensis*) 78%, wild licorice (*Glycyrrhiza lepidota*) 75%, Maximillian sunflower 72%, big bluestem 86% and Indiangrass 91%. These test results, though from a severe drought period, are not to imply that native plants always produce a high percentage of viable seed. Many native species may not have good seed production in a given year.

seeds. Insect infested seed heads generally produce little viable seed. Infestations often affect entire populations. The seed heads of prairie cordgrass and the seed pods of Canada milkvetch (*Astragalus canadensis*) and wild indigo (*Baptisia* spp.) are often infested by insects, turning a promising looking seed harvest to bust. Drought can also drastically affect the seed yield of many prairie and wetland species. Many species, such as Indiangrass and big bluestem, might still flower during dry years, but produce little viable seed. Late rains in previously dry summers may cause many plants to flower later than normal and produce viable seed.

For all methods of seed collecting, thoroughly scouting an area for troublesome weed species is important. Including as little as a handful of leafy spurge (*Euphorbia esula*) or other aggressive weed seed in a seed mix could spell trouble for a restoration. This is especially true when machine-harvesting seed, which does not allow for the kind of close inspection of vegetation that is possible with hand collecting.

Seed collectors should always obtain permission from landowners when collecting seed on private property and from roads departments when collecting from road right-of-ways. It is also important to inform adjacent private landowners when collecting from road right-of-ways because many will be curious as to what is going on. Seed collecting is not allowed on most public lands, such as state parks and wildlife management areas, without permission of the managing agency.

Hand Collecting

For prairie and wetland restorations of less than a few acres, the seed of all species can be collected in sufficient quantities by hand. Even for larger restorations we collect the majority of the forb, sedge and non-dominant grass seed by hand. We machine-harvest seed of the dominant prairie warm-season grasses and seed of several other prairie and wetland species.

A necessary step in collecting porcupine grass and needle-and-thread is cutting the long awns from the seeds. If not done, the awns twist while drying and tangle the seeds together.

When hand collecting, the seed heads, capsules or fruits of most grasses, sedges and wildflowers can be grasped and easily pulled

Taping fingers protects them from cuts and abrasions while seed collecting.

PPRI's 2000 seed collecting crew with plastic milk jugs. From left to right, Kristy Lee, Mike Bullerman, Jason Johnson and Jon Soper.

from the stems. Taping fingers protects them from cuts and abrasions. We prefer veterinary tape, available at most farm stores, because it adheres well yet allows flexible finger movement. Prickly seed heads and heads that don't detach easily from the stem can be clipped with pruning shears or knives. Short, serrated-edged knife blades work well for this. The seed heads of many grasses, such as prairie cordgrass and slender wheatgrass (*Elymus trachycaulus*), can be swept together by the handful and clipped.

We belt plastic detergent and milk jugs with the tops cut off to our waist for seed storage, freeing both hands for collecting. Two- to five-gallon plastic buckets work well for larger quantities of seed. We keep the seed of most species separate while collecting.

Mechanical seed strippers

Mechanical seed strippers are an effective method for collecting large quantities of seed for many species. The stripper consists of a nylon-bristled brush about 5 feet in length powered by a gasoline engine. Both brush and engine are mounted on a chassis with road worthy tires. The spinning brush dislodges seeds and seed heads and deposits them in a hopper located behind. Seed strippers are somewhat inefficient in that some seed is thrown forward by the brush and misses the bin. Some restorationists view inefficiency as positive in that it ensures that some seed remains on the collection site. We pull our seed strippers with 4-wheel all-terrain vehicles (ATV), but pickup trucks or tractors can also be used.

The strippers are useful only when relatively large patches of target plants are available and free of unwanted weed seed, such as that of smooth brome. In prairies we use them for collecting seed of warm-season grasses, Virginia wildrye (*Elymus virginicus*), Canada wildrye, western wheatgrass (*E. smithii*), sedges,

Collecting the seed of warm-season grasses using a seed stripper designed by Prairie Habitats, Inc.

prairie clovers, leadplant and other species. In wetlands we use them for collecting seeds of bulrushes (*Schoenoplectus* spp.), spikerushes (*Eleocharis* spp.), rushes (*Juncus* spp.), plains coreopsis (*Coreopsis tinctoria*) and other species. Frequently, seed of several species can be harvested at one time with a stripper. Brush strippers are not effective for harvesting species such as prairie cordgrass, whose seed or seed heads do not readily detach from the plant.

We use two models of pull-behind seed strippers, one sold by Prairie Habitats Inc. of Argyle, Manitoba, (204 467-9371) the other developed by Ned Groelz of Arvada, Colorado, (303 424-3162). Both models can be purchased for $7,000 to $8,000. The brush height and direction of spin can be changed on both models. On Prairie Habitat's model the brush is raised or lowered by a hand-operated hydraulic pump operated when the machine is stopped. The Groelz model has an automatic hydraulic system that raises and lowers the brush. This machine has chassis-mounted controls, easily reachable from the ATV, which turns the brush on or off and adjusts brush height and direction of spin. When using the Groelz machine, patches of weeds can be avoided by stopping or raising the brush. The brush height can be easily adjusted when patches of desirable seed heads of different heights are encountered. The Groelz machine also has a durable, road-worthy suspension and tires and can be pulled with a pickup to collecting sites at normal road speeds.

We use a counterclockwise brush spin direction for collecting seeds of middle height to tall species and a clockwise spin direction for shorter species. We recommend experimenting with brush height, spin direction and spin speed to see which works best for target species.

COMBINES

Combines are more efficient at harvesting seed than seed strippers. For example, for every acre of warm-season grass seed harvested by stripper, we can plant 4-5 acres of prairie. Whereas, for every acre of grass seed harvested by combine, we can plant about 10 acres of prairie. The efficiency of combines must be weighed against their cost, high maintenance and transportation concerns.

New combines can cost over $100,000 and are unaffordable for most restorationists. Older, used combines can be purchased for as little as $1,000. Older combines commonly have mechanical breakdowns while harvesting.

Chris Helzer/The Nature Conservancy

The Nature Conservancy's 1974 Massey Ferguson 510 combine with a grain head harvesting warm-season grasses.

When combining, having a good mechanic handy can save time and headaches. Combines can be driven on back roads to nearby collecting sites, but they must be trailered for longer trips.

Combines designed for grain harvesting can be easily modified for harvesting prairie and wetland plant seed. We use two combine types - a 1974 Massey Ferguson 510 and a 1975 Allis Chalmers Gleaner K, both with grainheads. Grainheads consist of a cutting sickle and reel to cut seed heads. Combines use a combination of a hammermill (the cylinder), air and screens to clean the seed once harvested by the cutting or stripper head. Generally, when harvesting grass

U.S. Fish and Wildlife Service

Massey Ferguson 8560 combine with a rice head harvesting Canada wildrye seed.

seed, the cylinder should be set relatively tight with a small space between the rasp bars and the concave, and the air kept to a minimum to prevent seed from blowing out the back. When using a grainhead the screens should be adjusted to allow the most seed to pass through while keeping the most stems and leaves out.

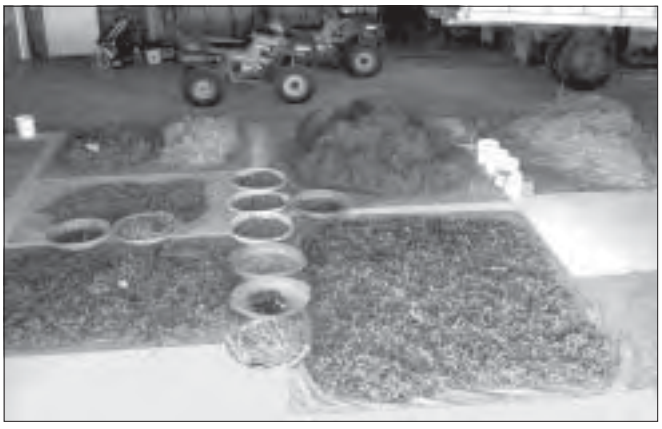
The USFWS in Kearney, Nebraska, harvests native seed with a 1993 Massey Ferguson 8560 combine and a rice head. Rice heads are more efficient at harvesting native seed than grainheads, but they are also more expensive, costing around $15,000 new. Used rice heads can likely be purchased for less. Rice heads were designed to harvest wild rice, which matures over several weeks. Rotating cylinder-mounted teeth catch the seed heads and strip mature seed. It's similar to catching seed heads between the fingers, squeezing and pulling to free seeds. Rice heads leave most of the stems and leaves unstripped providing nesting cover for birds or fuel for prescribed burning the following spring. When using a rice head, most of the screens can be removed because very few stems are harvested and the seed requires little or no cleaning.

Augering grass seed out of the combine is often difficult when using either grainheads or rice heads. The fluffy seed often "bridges" in the bin and will not feed into the auger located at the bottom of the bin. Building a plywood floor in the bin and simply shoveling the seed out is one way to avoid this problem. Another method is to place a 12-inch or larger diameter PVC pipe vertically into the bin. As grass seed comes into the bin it fills in around the pipe. To auger seed out of the bin the pipe is removed and seed pushed down the resulting hole to the auger below.

We can combine 20-30 acres of prairie grass on days with only minor breakdowns, producing 80-150 barrels (32 gallon capacity) of seed. When combining a vegetatively diverse prairie in mid-September for grass seed, we can harvest seed of up to 40 additional native species. We also combine seed of wildryes, wheatgrasses, sedges, leadplant and other prairie plants as well as wetland sedges, bulrushes, spikerushes and large-fruit bur-reed (*Sparganium eurycarpum*). As with seed strippers, caution must be taken when combining to avoid harvesting weed seeds such as those of smooth brome or musk thistle.

Woodward Flail-vac Seed Stripper

The Woodward Flail-vac Seed Stripper made by Ag-renewal, Inc. of Weatherford, Oklahoma, (800 658-1446) is a popular seed-harvesting machine among many restorationists.



Drying seeds of prairie plants.

Drying stripper- or combine-harvested grass seed outdoors is an option.

It consists of a 6- or 12-foot hydraulic stripper brush and hopper that mounts on a tractor's front-end loader. A 4-foot brush model is also designed for mounting on the front of a 4-wheeler. The fast spinning brush creates a vacuum pulling the seed heads into the bristles, dislodging seeds and depositing them into the hopper.

Seed Drying

Seed of prairie and wetland plants must be dried shortly after collecting to prevent molding and to prepare it for storage. Packard (1997) writes that seed should be dried to a 5-15 percent moisture content. If seeds are not dried to this extent they are susceptible to molding and loss to microorganisms. The cell walls of seeds will break down and their enzymes will become inactive if dried below 5 percent moisture content.

We spread seed of most species on tarps, plastic barrel lids or cardboard laid on shed or garage floors to dry. Elevated wire mesh-bottomed trays also work well and allow for better air movement around seed. Drying areas should be well ventilated. Doors and windows should be open and fans used if needed to increase air movement. Turning most seed every day or two will facilitate even drying. The seed of most species will be adequately dried in 1-2 weeks. Seeds enclosed in fleshy fruits, such as those of roses (*Rosa* spp.) and false Solomon's seal (*Smilacina stellata*), will require longer drying time.

Larger quantities of stripper- or combine-harvested grass seed can be spread on plastic sheeting or tarps to a depth of about eight inches for drying. Large well-ventilated barns or sheds work well for this, or the seed can be dried outdoors as long as it is covered with plastic sheeting before rain. This seed needs to be turned daily with scoop shovels to facilitate drying. Seed that is damp or has green stems or leaves in it needs turning more frequently. Damp conditions could cause decomposition and subsequent heating, which can kill seed or cause combustion.

We also dry grass seed in 4x4x8-foot plywood boxes with 1-foot diameter perforated pipe in the bottom connected to a grain-drying fan. Up to 40 barrels of grass seed can be dried in a day using the boxes. The drying boxes can be mounted on a trailer and transported to the harvesting site and loaded directly from the combine or stripper. Once seed is dry, one side of the box, held in place by clamps, is dropped for easy unloading.

Chris Helzer/The Nature Conservancy

Plywood seed drying box connected to a grain drying fan.

Production Plots

Native grasses, sedges and wildflowers grown using agricultural methods in single species production plots, where they have sufficient water and no competition, produce far more seed than wild grown plants. Seed grown in production plots can be used in restorations or wildlife plantings. Unlike conventional crops that are mostly annuals, most native plants grown in production plots are perennials that do not require replanting each year.

Chris Helzer/The Nature Conservancy

Foxglove penstemon seed production plot at the Nature Conservancy's Platte River Preserve.

Larger-scale native seed production operations require irrigation systems, farm equipment and much labor. The Nature Conservancy, on its Kankakee Sands Preserve in Indiana, grows 110 wildflower species in single-species production plots on 123 acres and five warm-season grass species on 65 acres. Wetland plants are grown in shallow ponds. They use a center pivot to irrigate, herbicides and manual labor to control weeds. They produce far more seed each year than is required to plant 500 restoration acres.

Gayfeather production plot at The Nature Conservancy's Kankakee Sands Preserve in Indiana.

In 2002-03, the Nebraska Game and Parks Commission planted 1.5 acres of prairie cordgrass and 0.5 acres of slender wheatgrass (*Elymus trachycaulus*) production plots using 8,000 greenhouse grown seedlings and 0.5 acres of native legume production plots from seed on the Cornhusker Wildlife Management Area west of Grand Island. We use gravity-flow to irrigate the plots from a well that pumps nearly 1,000 gallons per minute. We control weeds on the site using pre-emergent and post-emergent herbicides and some manual weeding. The plots should produce some seed in the fall of 2003 and be in full production by 2004.

The Nature Conservancy has planted 30 native wildflower and grass species in production plots on 2 acres on its Platte River Preserve in Hall County. A traveling sprinkler system with a 100-foot spray radius attached to a typical outdoor spigot is used to irrigate plots. Weeds are controlled through rototilling, mowing, hoeing and pre-emergent herbicide spraying. Some seed producers place plastic weed barriers between plant rows used in combination with underground drip-irrigation systems. This method greatly reduces the amount of hand weeding and herbicide spraying needed.

It is important to consider the seed source when first planting production plots. Many restorationists prefer local ecotype seed and will not purchase seed that originates outside the region.

CHAPTER 4 - SEED PROCESSING AND STORAGE

Most hand-collected species require some threshing to dislodge and separate seeds from capsules or seed heads. Most stripper- and combined-harvested seed requires no processing before planting. When broadcast planting, this seed requires only minor cleaning after threshing to remove larger pieces of stem and chaff. When drill-planting, seed needs to be fairly clean to pass through the drill.

Small quantities of seed can be threshed by hand. One method is to place seed heads or capsules on newspapers and use a rolling pin or steel pipe to break them open. Rubbing seed heads against 1/8- to 1/2-inch mesh hardware screen also works. The threshed seeds can then be sifted over the screens to remove larger pieces of chaff and stem.

Homemade hammermill consisting of a modified heavy-duty Grasshopper lawn mower conveyor fan run by a gas engine.

Chris Helzer/The Nature Conservancy

Threshed seeds can be sifted over screen to remove large pieces of chaff and stem.

Larger quantities of seed can be threshed with hammermills that use spinning fan blades or small, finger-like paddles to separate seed from pods or heads. One of our hammermills is a modified heavy-duty Grasshopper lawnmower conveyor fan run by a gas engine. Seed heads

Speed King Hammermill model 615.

are vacuumed through flexible plastic tubing into the spinning fan blades, dislodging the seeds and depositing seed and chaff into a hopper.

We also use another homemade hammermill similar to the Speed King Hammermill, model 615, sold by the Winona Attrition Mill Company of Winona, Minnesota, (507 452-2716). With this machine, seed heads are fed down through a metal throat into

NEBRASKAland Magazine

Seed pods of ground-plum.

spinning, plastic, finger-like hammers that dislodge the seed from the head. Screens located below the hammers keep the plant material from leaving the threshing area until reduced in size. A variety of screen sizes can be used with this machine. Smaller mesh sizes work best for smaller seed and larger mesh sizes for larger seeds. Smaller mesh sizes will keep the seed in the threshing area longer producing cleaner seed. Seed heads sometimes must be hammermilled several times before most seed is dislodged.

We do little seed cleaning after hammermilling (threshing) because most medium-sized chaff will pass through broadcast planters. After hammermilling, we screen the seed of some species, such as prairie cordgrass and leadplant, to remove the larger pieces of stem and chaff. A small amount of seed and chaff is placed on the screens and shaken vigorously. The seed falls through the screen into a barrel or bucket located below. The chaff is taken off the screen and the process repeated. We vary mesh size in accordance with seed size when cleaning seed. We use old fanning mill screens, but hardware cloth screen secured to wooden frames also works well.

Many restorationists and seed dealers clean seed using fanning mills, which use

Seed capsules of shell-leaf penstemon.

vibration, gravity, pressure and moving air to separate the heavier seed from the lighter chaff. Fanning mills are commercially available in many sizes and models. The least expensive models sell for about $500. Older fanning mills

Seed heads of purple coneflower.

sometimes can be purchased inexpensively at farm auctions.

After processing, seed must be stored until planted. We usually complete seed processing in late November and plant from December through April. After drying, we store

stripper- or combine-harvested warm-season grass seed in piles in a shed until planted. Seed of other species is stored in paper sacks or plastic buckets and barrels. The USFWS in Kearney mixes their forb and grass seed in the fall and bags it for storage.

It is essential that stored seed is kept in a dry, unheated space, such as a garage or shed. We have experienced little damage to stored

Seed heads of longbeard hawkweed.

seed from rodents or insects, but seed should be checked occasionally to prevent this from happening. Mice often reside in our grass seed piles, and occasionally chew holes in seed storage bags. We have also had problems with cats defecating in our grass seed. Rodent and cat proof seed cages built with 2x4s and wire mesh can be used to store seed piles and containers.

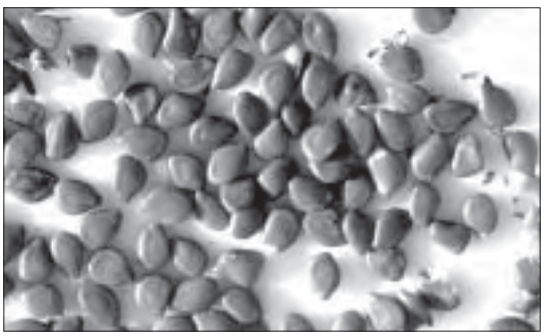
As a rule of thumb, when storing seed for the short-term, the sum of the storage temperature and relative humidity should be kept below 100. For example, if the storage temp is 70 degrees Fahrenheit, the relative humidity should be less than 30 percent. Also, the relatively humidity should never exceed 75 percent, and the lower the better. We have had good restoration results using seed that has been stored for more than a year.

Processing, screening and mixing seed is dusty work. The fine dust can cause allergic reactions and irritate the soft tissues of the eyes, nose and mouth. If mice are present in the seed, the feces can carry diseases – most notably Hanta virus. We strongly advise using high-quality facial dust masks or respirator masks and goggles when working with seed.

Seed Treatment

In the wild, native plant seeds germinate sporadically over time, an adaptation that increases the species' chances of survival. The seed germination rates of most prairie and wetland species will be enhanced by undergoing moist-cold stratification - exposure to moist conditions and cold temperatures (<40 degrees Fahrenheit) for a period of 10-120 days. Other treatments often recommended to enhance seed germination of native plant species include the following: 1) sowing fresh seed, 2) warm-moist stratification, 3) cold-dry stratification, 4) scarification, 5) inoculation of legumes, and 6) light treatment (Beimborn and Lasca 1999 and Packard 1997). We believe special seed treatment is generally not needed for successful restorations. Several of our more successful restorations were planted in late fall or early winter. This exposes the seed to rain, snow, cold temperatures and freeze/thaw cycles providing for cold-moist stratification. In greenhouse tests we found that the seed of most prairie plants over-wintered in an unheated shed successfully germinates the following spring.

Hard-coated seeds, such as those of legumes and roses, require physical breaking of the seed coat prior to germination. This



Chris Helzer/The Nature Conservancy

Hard-coated seeds of Illinois bundleflower.

process, known as scarification, allows the embryo to imbibe water. We believe that hammermilling seed causes some scratching of the seed coat and we do no further scarification. In greenhouse tests we found that sandpapered (scarified) purple prairie-clover

Hand scarifying legume seeds.

(*Dalea purpurea*) and white prairie-clover (*D. candida*) seeds germinated at similar rates to our hammermilled seeds. If seeds are not hammermilled, scarification may increase germination rates for some species with hard-coated seeds. Commercial scarifying machines are available. A homemade model can be built by lining the bottom of an old furniture drawer with number 40 grit, adhesive-backed sandpaper. Place a small amount of seed in the drawer and sand for a minute or two with moderate pressure using a hand sander with number 60-grit sandpaper.

Some restorationists recommend early summer seeding, immediately after collecting, of spring-flowering plants such as prairie dog-toothed violet (*Erythronium mesochoreum*), cool-season grasses and sedges to increase germination rates. We have not tried this method. Many of our restoration sites are farmed the year before planting, making summer seeding impractical. The seed of early flowering species could be collected the summer following the initial seeding and then overseeded.

Greenhouse Propagation of Plants

Seedlings of prairie and wetland plants grown under greenhouse conditions without competition from other plants develop quickly and some species (e.g. prairie clovers) may flower the first year when transplanted into the wild. Growing greenhouse plants is labor intensive. Local ecotype seedlings of some prairie and wetland plants may be available from native plant nurseries, selling for about $2 to $4 apiece.

Small backyard or schoolyard restorations can be planted entirely with greenhouse grown or purchased seedlings. Planting larger restorations entirely with greenhouse grown seedlings is generally not practical or recommended. Seedlings can be used to supplement highly visible areas of sown prairie restorations, such as near trails, where rapid plant establishment is desired. For species that are difficult to establish from seed, seedlings can be used as supplements in restorations. We have used greenhouse-grown seedlings to reintroduce porcupine grass (*Hesperostipa*

Chris Helzer/The Nature Conservancy

Our 8x24-foot solar greenhouse required about $1,500 in materials.

Greenhouse Propagation of Plants

spartea) into a remnant prairie and a prairie restoration in central Nebraska. At both sites, the relatively few planted individuals successfully reproduced, forming larger populations. Many wetland plants spread prolifically from seed and vegetatively. Planting relatively few greenhouse grown seedlings of these species may enhance wetland restorations.

Cone-tainers with grass seedlings.

Using recycled Filon panels, our 8x24-foot solar greenhouse required about $1,500 in additional materials. It has a cobble floor, and insulated plywood walls and roof.

We begin planting seeds in plastic flats or 5 ½-inch or 8 ¼-inch deep plastic Cone-tainers in late January. A Cone-tainer catalog is

Planting production plots with greenhouse grown seedlings.

available from Stuewe and Sons, Inc., 1-800-553-5331 or www. Steuwe.com. At 100 cells per square foot, the 5 ½-inch Cone-tainers make efficient use of greenhouse space. We fill Cone-tainers to within an inch of the top with Vaughan's BP25 bedding mix and then slightly compress the mix. We then place 4-5 seeds in each Cone-tainer and cover them with about 1/8 inch of bedding mix. The seeds and young plants will require watering every few days for several weeks. When temperatures warm and seedling growth rates increase daily watering will be required. Plants started in plastic flats can be transplanted to Cone-tainers after a few weeks growth.

We use a propane heater in winter months to maintain a greenhouse temperature above freezing. On warm days, the greenhouse needs adequate ventilation to prevent overheating. When seedlings reach a few inches in height and appear "strong" we move them outdoors for sun and wind hardening.

Seedlings are transplanted into production plots or restorations beginning in mid-May. Plants can be over-wintered in Cone-tainers or flats and transplanted outside during their second year of growth.

When transplanting into sandy or soft soils, we use a large knife blade or trowel for making the planting holes. In harder soils, we have used dibble bars or electric drills with bulb planting bits for making holes. Various drill bit diameters are available to match the diameter of Cone-tainers. Where possible, water transplanted seedlings every few days for the first few weeks after planting and then occasionally thereafter.

Candle anemone seedling freshly pulled from a Cone-tainer.

Chapter 5 - Seed Mixing and Mixes

Designing the seed mix is a key step in all prairie and wetland restorations. We design separate seed mixes for each plant community type at a restoration site. For example, for Rainwater Basin restorations we design a tallgrass prairie mix for uplands bordering wetlands, a wet-mesic prairie mix for moist lowlands and a marsh mix for deep-watered areas. For river valley restorations we sow level bottoms with a wet-mesic prairie mix, swales with a marsh mix and sand ridges with a sand-prairie mix.

Soil type at a restoration site must be considered when designing seed mixes. The species composition of specific plant community types often varies depending on soil type. For example, tallgrass prairies in areas of Jefferson County along the Little Blue River have loamy sand soils formed from underlying Dakota Sandstone. On these sites grow many plants also found on tallgrass prairies with clay and loam soils, but also sand-adapted species, such as small-flowered fameflower (*Talinum parviflorum*). Including sand-adapted species in seed mixes for tallgrass prairie restorations on loam and clay soils would not be appropriate.

The geographic range of native plant species must also be considered when designing seed mixes for restorations as the distribution of many species is limited in the state. For example, many tallgrass prairie plants, such as white wild indigo (*Baptisia alba*) and prairie coreopsis (*Coreopsis palmata*), naturally occur only in the wetter regions of southeastern Nebraska. Planting these species in a tallgrass prairie restoration in northeastern Nebraska would not be appropriate.

We develop our seed mixes in late fall after seed processing and before planting. Areas are marked on a shed floor for each needed seed mix (e.g. Rainwater Basin marsh mix, Rainwater Basin wet-mesic mix or northeastern Nebraska tallgrass prairie mix). We pour seed of wildflowers, sedges and non-dominant grasses into each pile in the amount needed for each restoration. We call this our "forb mix." Rings can also be built of scrap lumber to corral the seed. When all the seed is poured into piles, it is thoroughly mixed with grain shovels and then stored in barrels or bags. Mixing the seed of about 200 species for several hundred acres of restoration takes about a day.

Seed mix for a restoration.

For prairie restorations we mix the stripper- or combine-harvested warm-season grass with the forb mix just prior to planting. Our upland prairie (e.g. tallgrass prairie, sand prairie and mixed-grass prairie) and wet-mesic prairie seed mixes contain 10-15 gallons of

Why a high diversity prairie restoration?

Before Euroamerican settlement, hundreds of species of native plants grew in eastern Nebraska's prairies. Restorationists trying to recreate these plant communities should plant as many appropriate species as possible because the greater the plant diversity the greater the ecological benefits. These include greater habitat and animal diversity.

Vegetatively diverse prairie restorations containing plants with varying seasons of growth, seed type and structural characteristics will provide habitat benefits to many wildlife species, including songbirds, game birds, small mammals and insects. Restorations with a diversity of cool- and warm-season grasses and other nutritious plants will provide high-quality livestock forage throughout the growing season. Diverse restorations will have plants with a variety of root types and rooting depths. This vegetation can utilize soil moisture and nutrients more efficiently than the vegetation of low-diversity grasslands. Diverse grasslands are also more tolerant of drought and resistant to invasion by exotic plants, disease problems and overgrazing than are low-diversity grasslands.

From an aesthetic viewpoint, restorations rich in wildflowers and other plants are more appealing than those with few species. Diverse prairie restorations have a procession of wildflowers that begin blooming in late April and continue blooming through October. High-diversity restorations are also valuable educational and research sites, where students can study the dynamics, function and resilience of native plant communities.

warm-season grass seed (depending on quality and availability of the seed in a given year) to 1-3 gallons of forb mix. We prefer to plant at the higher rate of 2-3 gallons of forb seed per acre when it is available. Lack of collecting time and sites or seed costs usually limit the amount of forb seed included in a seed mix.

We measure seed by volume (gallons) not by weight (pounds) as do many restorationists. About 40-45 percent by weight of our rough-cleaned prairie mixes is pure seed, the remainder is chaff, broken stems and other plant parts. Fifteen gallons of our prairie seed mix (grasses and forbs), a standard seeding rate for one acre, weighs about 10 pounds of which about 4 to 4 ½ pounds is seed, most warm-season grass seed.

Seed mixes for different restorations.

Packard (1997) wrote "when planting a diverse mix of forbs and grasses, most restorationists use a seeding rate of ten pounds per acre with pure, clean seed and as high as thirty to forty pounds per acre with rough-cleaned, wild-collected seed." He also recommends a grass to forb seed ratio of 40:60 for tallgrass prairie restorations. We use much less grass and forb seed and a higher grass to forb ratio than recommended by Packard and other restorationists.

Establishing warm-season grasses in our prairie restorations has never been a problem. They are usually well-established 3 to 5 years after planting on sandy, loamy and clayey soils especially when managed with prescribed fire. They might develop faster if we used higher seeding rates and drill planting. We perceive that an advantage of slower developing grass stands is that plantings stay open longer, providing less competition and more time for wildflowers and other plants to establish. Maintaining restorations in an open weedy condition also prolongs ideal habitat conditions for gamebirds such as ring-necked pheasants and northern bobwhites and many nongame birds.

Though we plant less forb seed in our prairie restorations than Packard and other restorationists recommend, we are generally satisfied with the forb abundance in our restorations. Tallgrass prairies in Nebraska might naturally be more grass-dominated than those in states to the east. However, we do believe that for most wildflowers, sedges and non-dominant grasses the more seed planted the better. Aggressive forbs, such as Maximillian sunflower, sawtooth sunflower and Canada goldenrod, are exceptions. If seeded too heavily in a restoration, these species may limit establishment of less aggressive species.

Appendix B lists all plant species we have seeded in eastern Nebraska restorations, the plant community types for which they are appropriate, seed collecting dates and general comments on their use in restorations. Below, listed by community type are basic seed mixes suitable for planting in eastern Nebraska. Seed mixes for butterfly gardens and grassland wildlife habitat are also included. We recommend planting the prairie (i.e. tallgrass, mixed-grass, sand and wet-mesic prairie) mixes at a rate of 10-15 gallons of stripper- or combine-harvested warm-season grass seed to 1-3 gallons of rough-cleaned forb seed. Planting rates for the other community types are included in the following text.

Tallgrass Prairie

The species listed below are suitable for planting in moderate- and high-diversity prairie restorations on upland sites throughout the tallgrass prairie region of eastern Nebraska (see Figure 1, page 9). If financial or seed-collecting resources preclude planting a high-diversity restoration a moderate-diversity planting will still provide excellent floral displays and wildlife habitat.

Moderate-Diversity Tallgrass Prairie Mix		Moderate-Diversity Tallgrass Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Woolly Yarrow	*Achillea millefolium*	**Illinois Tick-clover**	*Desmodium illinoense*
Leadplant	*Amorpha canescens*	**Purple Coneflower**	*Echinacea angustifolia*
Big Bluestem	*Andropogon gerardii*	**Canada Wildrye**	*Elymus canadensis*
Canada Milkvetch	*Astragalus canadensis*	**Small-flowered Gaura**	*Gaura mollis* (*G. parviflora*)
Side-oats Grama	*Bouteloua curtipendula*	**Maximillian Sunflower**	*Helianthus maximilianii*
Short-beak Sedge	*Carex brevior*	**Stiff Sunflower**	*Helianthus pauciflorus* (*H. rigidus*)
Partridge Pea	*Chamaecrista fasciculata* (*Cassia chamaecrista*)	**Round-head Bush-Clover**	*Lespedeza capitata*
White Prairie-clover	*Dalea candida*	**Dotted Gayfeather**	*Liatris punctata*
Purple Prairie-clover	*Dalea purpurea*		

Moderate-Diversity Tallgrass Prairie Mix		Moderate-Diversity Tallgrass Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Wild Bergamot	*Monarda fistulosa*	**Indiangrass**	*Sorghastrum nutans*
Common Evening Primrose	*Oenothera villosa*	**Prairie Dropseed**	*Sporobolus heterolepis*
Switchgrass	*Panicum virgatum*	**Western Ironweed**	*Vernonia baldwinii*
Upright Prairie Coneflower	*Ratibida columnifera*		
Dwarf Prairie Rose	*Rosa arkansana*		
Black-eyed Susan	*Rudbeckia hirta*		

Add the following species for a high-diversity tallgrass prairie seed mix.

Wild Garlic	*Allium canadense*
Meadow Anemone	*Anemone canadensis*
Candle Anemone	*Anemone cylindrica*
Field Pussytoes	*Antennaria neglecta*
Hemp Dogbane	*Apocynum cannabinum*
White Sage	*Artemisia ludoviciana*
Narrowleaf Milkweed	*Asclepias stenophylla*
Butterfly Weed	*Asclepias tuberosa* ssp. *interior*
Whorled Milkweed	*Asclepias verticillata*
Short Green Milkweed	*Asclepias viridiflora*
Spider Milkweed	*Asclepias viridis*
Ground-plum	*Astragalus crassicarpus*
Plains Wild Indigo	*Baptisia bracteata*
False Boneset	*Brickellia eupatorioides*
Pale Poppy Mallow	*Callirhoe alcaeoides*
Plains Yellow-primrose	*Calylophus serrulatus*
Bicknell's Sedge	*Carex bicknellii*
Redroot New Jersey Tea	*Ceanothus herbaceus*

NEBRASKAland Magazine

Compass-plant.

Little Bluestem	*Schizachyrium scoparium*
Prairie Ragwort	*Senecio plattensis*
Compass-plant	*Silphium laciniatum*
Rosinweed	*Silphium integrifolium*
Canada Goldenrod	*Solidago canadensis*
Missouri Goldenrod	*Solidago missouriensis*
Stiff Goldenrod	*Solidago rigida*

Pale poppy mallow.

High-Diversity Tallgrass Prairie Mix		High-Diversity Tallgrass Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Bastard Toadflax	*Comandra umbellata*	**Scribner's Spring Panicum**	*Panicum oligosanthes*
Prairie Larkspur	*Delphinium carolinianum* (*D. virescens*)	**Silver-leaf Scurf Pea**	*Pediomelum argophyllum* (*Psoralea a.*)
Canada Tick-clover	*Desmodium canadense*	**Prairie Turnip**	*Pediomelum esculentum* (*Psoralea e.*)
Flowering Spurge	*Euphorbia corollata*		
Downy Gentian	*Gentiana puberulenta*		
Wild Licorice	*Glycyrrhiza lepidota*		
False Sunflower	*Heliopsis helianthoides*		
Porcupine Grass	*Hesperostipa spartea* (*Stipa s.*)		
Longbeard Hawkweed	*Hieracium longipilum*		
Inland Rush	*Juncus interior*		
Junegrass	*Koeleria macrantha* (*K. pyramidata*)		
Rough Gayfeather	*Liatris aspera*		
Grooved Yellow Flax	*Linum sulcatum*		
Prairie Trefoil	*Lotus unifoliolatus* (*L. purshianus*)		
Wild Four-o'clock	*Mirabilis nyctaginea*		
False Gromwell	*Onosmodium molle*		
Violet Wood Sorrel	*Oxalis violacea*		

NEBRASKAland Magazine

Dwarf prairie rose.

Purple coneflower.

Shell-leaf Penstemon	*Penstemon grandiflorus*
Prairie Phlox	*Phlox pilosa* ssp. *fulgida*
Prairie Cinquefoil	*Potentilla arguta*
Slender-flower Scurfpea	*Psoralidium tenuiflorum* (*Psoralea tenuiflora*)
Prairie Blue-eyed Grass	*Sisyrinchium campestre*
Late Goldenrod	*Solidago gigantea*
Prairie Wedgegrass	*Sphenopholis obtusata*
Tall Dropseed	*Sporobolus compositus* (*S. asper*)
Heath Aster	*Symphyotrichum ericoides* (*Aster e.*)
Smooth Blue Aster	*Symphyotrichum laeve* (*Aster laevis*)
American Germander	*Teucrium canadense*
Purple Meadow Rue	*Thalictrum dasycarpum*
Long-bracted Spiderwort	*Tradescantia bracteata*
Prairie Violet	*Viola pedatifida*
Golden Alexander	*Zizia aurea*

Mixed-grass Prairie

The species listed below are suitable for planting a moderate-diversity prairie restoration on upland sites with clay, loam or fine sandy loam soils within the mixed-grass prairie region of central Nebraska (see Figure 1).

Mixed-grass Prairie Mix		Mixed-grass Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Woolly Yarrow	*Achillea millefolium*	**False Boneset**	*Brickellia eupatorioides*
Leadplant	*Amorpha canescens*	**Plains Yellow-primrose**	*Calylophus serrulatus*
Big Bluestem	*Andropogon gerardii*	**Short-beak Sedge**	*Carex brevior*
Candle Anemone	*Anemone cylindrica*	**Sun Sedge**	*Carex heliophila*
Field Pussytoes	*Antennaria neglecta*	**Wavy-leaved Thistle**	*Cirsium undulatum*
Purple Three-awn	*Aristida purpurea*	**Bastard Toadflax**	*Comandra umbellata*
White Sage	*Artemisia ludoviciana*	**White Prairie-clover**	*Dalea candida*
Narrowleaf Milkweed	*Asclepias stenophylla*	**Purple Prairie-clover**	*Dalea purpurea*
Whorled Milkweed	*Asclepias verticillata*	**Purple Coneflower**	*Echinacea angustifolia*
Short Green Milkweed	*Asclepias viridiflora*	**Western Wheatgrass**	*Elymus smithii* (*Agropyron s.*)
Spider Milkweed	*Asclepias viridis*	**Six-weeks Fescue**	*Festuca octoflora*
Ground-plum	*Astragalus crassicarpus*	**Scarlet Gaura**	*Gaura coccinea*
		Small-flowered Gaura	*Gaura mollis* (*G. parviflora*)
		Maximillian Sunflower	*Helianthus maximilianii*
		Stiff Sunflower	*Helianthus pauciflorus* (*H. rigidus*)
		Needle-and-thread	*Hesperostipa comata* (*Stipa c.*)
		Inland Rush	*Juncus interior*
		Junegrass	*Koeleria macrantha* (*K. pyramidata*)
		Showy Vetchling	*Lathyrus polymorphus*
		Round-head Bush-clover	*Lespedeza capitata*
		Dotted Gayfeather	*Liatris punctata*
		Prairie Trefoil	*Lotus unifoliolatus* (*L. purshianus*)
		Skeleton Plant	*Lygodesmia juncea*
		Cutleaf Ironplant	Machaeranthera pinnatifida (*Haplopappus spinulosus*)
		Sensitive Briar	*Mimosa quadrivalvis* (*Schrankia nuttallii*)
		Wild Four-o'clock	*Mirabilis nyctaginea*
		Plains Muhly	*Muhlenbergia cuspidata*
		False Gromwell	*Onosmodium molle*
		Purple Locoweed	*Oxytropis lambertii*
		Scribner's Spring Panicum	*Panicum oligosanthes*
		Silver-leaf Scurf Pea	*Pediomelum argophyllum* (*Psoralea a.*)
Missouri Milkvetch	*Astragalus missouriensis*		
Side-oats Grama	*Bouteloua curtipendula*		
Blue Grama	*Bouteloua gracilis*		

Purple locoweed.

Mixed-grass Prairie Mix		Mixed-grass Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Prairie Turnip	*Pediomelum esculentum* (*Psoralea e.*)	**Shell-leaf Penstemon**	*Penstemon grandiflorus*
White Beardtongue	*Penstemon albidus*	**Prairie Cinquefoil**	*Potentilla arguta*
		Slender-flower Scurfpea	*Psoralidium tenuiflorum* (*Psoralea t.*)
		Upright Prairie Coneflower	*Ratibida columnifera*
		Dwarf Prairie Rose	*Rosa arkansana*
		Little Bluestem	*Schizachyrium scoparium*
		Prairie Ragwort	*Senecio plattensis*
		Missouri Goldenrod	*Solidago missouriensis*
		Soft Goldenrod	*Solidago mollis*
		Stiff Goldenrod	*Solidago rigida*
		Indiangrass	*Sorghastrum nutans*
		Tall Dropseed	*Sporobolus compositus* (*S. asper*)
		Heath Aster	Symphyotrichum ericoides (*Aster e.*)
		Aromatic Aster	*Symphyotrichum oblongifolium* (*Aster o.*)
		Long-bracted Spiderwort	*Tradescantia bracteata*

Sensitive briar.

Sand Prairie

The species listed below are suitable for planting a moderate-diversity prairie on sandy upland soils and dry, sandy river bottom soils in eastern Nebraska and on sand dunes in the eastern portion of the Nebraska Sandhills.

Sand Prairie Mix		Sand Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Leadplant	*Amorpha canescens*	**False Boneset**	*Brickellia eupatorioides*
Big Bluestem	*Andropogon gerardii*	**Prairie Sand Reed**	*Calamovilfa longifolia*
Sand Bluestem	*Andropogon hallii*	**Sun Sedge**	*Carex heliophila*
Western Sagewort	*Artemisia campestris*	**Redroot New Jersey Tea**	*Ceanothus herbaceus*
White Sage	*Artemisia ludoviciana*	**Platte Thistle**	*Cirsium canescens*
Wooly Milkweed	*Asclepias lanuginosa*	**Rocky Mountain Bee Plant**	*Cleome serrulata*
Narrowleaf Milkweed	*Asclepias stenophylla*	**Bastard Toadflax**	*Comandra umbellata*
Short Green Milkweed	*Asclepias viridiflora*	**Texas Croton**	*Croton texensis*
Side-oats Grama	*Bouteloua curtipendula*	**Great Plains Flatsedge**	*Cyperus lupulinus*
Hairy Grama	*Bouteloua hirsuta*	**Sand Flatsedge**	*Cyperus schweinitzii*

Sand Prairie Mix		Sand Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Purple Prairie-clover	*Dalea purpurea*	**Fourpoint Evening-primrose**	*Oenothera rhombipetala*
Silky Prairie-clover	*Dalea villosa*	**False Gromwell**	*Onosmodium molle*
Purple Lovegrass	*Eragrostis spectabilis*	**Scribner's Spring Panicum**	*Panicum oligosanthes*
Sand Lovegrass	*Eragrostis trichodes*	**Switchgrass**	*Panicum virgatum*
Annual Wild Buckwheat	*Eriogonum annuum*	**Slender Paspalum**	*Paspalum setaceum*
Large Cottonweed	*Froelichia floridana*	**White Beardtongue**	*Penstemon albidus*
		Narrow Beardtongue	*Penstemon angustifolius*
		Slender Beardtongue	*Penstemon gracilis*
		Shell-leaf Penstemon	*Penstemon grandiflorus*
		Lemon Scurf Pea	*Psoralidium lanceolatum* (*Psoralea l.*)
		Dwarf Prairie Rose	*Rosa arkansana*
		Wild Begonia	*Rumex venosus*
		Little Bluestem	*Schizachyrium scoparium*
		Prairie Ragwort	*Senecio plattensis*
		Missouri Goldenrod	*Solidago missouriensis*
		Soft Goldenrod	*Solidago mollis*
		Stiff Goldenrod	*Solidago rigida*
		Sand Dropseed	*Sporobolus cryptandrus*
		Aromatic Aster	*Symphyotrichum oblongifolium* (*Aster o.*)
		Prairie Spiderwort	*Tradescantia occidentalis*
		Soapweed	*Yucca glauca*

Prairie spiderwort.

Stiff Sunflower *Helianthus pauciflorus* (*H. rigidus*)
Petioled Sunflower *Helianthus petiolaris*
Needle-and-thread *Hesperostipa comata* (*Stipa c.*)
Hairy Golden-aster *Heterotheca villosa* (*Chrysopsis villosa*)
Junegrass *Koeleria macrantha* (*K. pyramidata*)
Showy Vetchling *Lathyrus polymorphus*
Round-head Bush-clover *Lespedeza capitata*
Plains Gayfeather *Liatris squarrosa* var. *hirsuta*
Hairy Puccoon *Lithospermum caroliniense*
Fringed Puccoon *Lithospermum incisum*
Prairie Trefoil *Lotus unifoliolatus* (*L. purshianus*)
Skeleton Plant *Lygodesmia juncea*
Cutleaf Ironplant *Machaeranthera pinnatifida* (*Haplopappus spinulosus*)
Pale Four-o'clock *Mirabilis albida* (including *M. hirsuta*)
Sand Muhly *Muhlenbergia pungens*

Showy vetchling.

Wet-Mesic Prairie

The species listed below are suitable for planting a moderate-diversity wet-mesic prairie restoration on moist lowlands (temporarily flooded wetlands) on stream and river terraces and floodplains in eastern Nebraska. The water table at these sites should remain within a few feet of the soil surface for most of the growing season. Surface water can be present at the sites during late winter and spring and after heavy rains. This list contains species that can be planted on loamy sand to somewhat clayey soils. River valleys such as those of the Platte and Loup rivers often contain low wet swales and dry sand ridges. If swales contain standing water for much of the growing season they should be seeded with marsh plants. Dry sand ridges should be seeded with the sand prairie mix.

Wet-mesic Prairie Mix		Wet-mesic Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Wild Garlic	*Allium canadense*	**Canada Tick-clover**	*Desmodium canadense*
Big Bluestem	*Andropogon gerardii*	**Bald Spikerush**	*Eleocharis erythropoda*
Meadow Anemone	*Anemone canadensis*	**Common Spikerush**	*Eleocharis palustris* (*E. macrostachya*)
Swamp Milkweed	*Asclepias incarnata*		
Showy Milkweed	*Asclepias speciosa*		
Prairie Milkweed	*Asclepias sullivantii*		
Blue Joint	*Calamagrostis canadensis*		
Northern Reedgrass	*Calamagrostis stricta*		
Short-beak Sedge	*Carex brevior*		
Woolly Sedge	*Carex pellita* (*C. lanuginosa*)		

Meadow anemone.

Sawbeak Sedge	*Carex stipata*
Fox Sedge	*Carex vulpinoidea*
Common Water-hemlock	*Cicuta maculata*
Illinois Bundleflower	*Desmanthus illinoensis*

Wild garlic.

Canada Wildrye	*Elymus canadensis*
Western Wheatgrass	*Elymus smithii* (*Agropyron s.*)
Slender Wheatgrass	*Elymus trachycaulus* (*Agropyron caninum*)
Virginia Wildrye	*Elymus virginicus*
Cinnamon Willow Herb	*Epilobium coloratum*
Spotted Joe Pye Weed	*Eupatorium maculatum*
Common Boneset	*Eupatorium perfoliatum*

Wet-mesic Prairie Mix		Wet-mesic Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Hairy Fimbry	*Fimbristylis puberula*	**Golden-glow**	*Rudbeckia laciniata*
Yellow Avens	*Geum aleppicum*	**Little Bluestem**	*Schizachyrium scoparium*
Wild Licorice	*Glycyrrhiza lepidota*	**Three-square Bulrush**	*Schoenoplectus pungens* (*Scirpus p.*)
Sneezeweed	*Helenium autumnale*	**Marsh Skullcap**	*Scutellaria galericulata*
Sawtooth Sunflower	*Helianthus grosseserratus*	**Rosinweed**	*Silphium integrifolium*
Maximillian Sunflower	*Helianthus maximilianii*	**Cup Plant**	*Silphium perfoliatum*
		Compass-plant	*Silphium laciniatum*
		Canada Goldenrod	*Solidago canadensis*
		Late Goldenrod	*Solidago gigantea*
		Indiangrass	*Sorghastrum nutans*
		Prairie Cordgrass	*Spartina pectinata*
		Prairie Wedgegrass	*Sphenopholis obtusata*
		Sand Dropseed	*Sporobolus cryptandrus*

Lanceleaf gayfeather in a Platte River meadow.

Jerusalem Artichoke	*Helianthus tuberosus*
False Sunflower	*Heliopsis helianthoides*
Yellow Star Grass	*Hypoxis hirsuta*
Dudley's Rush	*Juncus dudleyi*
Torrey's Rush	*Juncus torreyi*
Lanceleaf Gayfeather	*Liatris lancifolia*
Great Blue Lobelia	*Lobelia siphilitica*
Pale Spiked Lobelia	*Lobelia spicata*
Common Water Horehound	*Lycopus americanus*
Western Water Horehound	*Lycopus asper*
Fringed Yellow-loosestrife	*Lysimachia ciliata*
Tufted Yellow-loosestrife	*Lysimachia thyrsiflora*
Winged Loosestrife	*Lythrum alatum*
Field Mint	*Mentha arvensis*
Switchgrass	*Panicum virgatum*
Foxglove Penstemon	*Penstemon digitalis*
Self-heal	*Prunella vulgaris*
Virginia Mountain-mint	*Pycnanthemum virginianum*
Black-eyed Susan	*Rudbeckia hirta*

NEBRASKAland Magazine

New England aster.

Common Hedge Nettle	*Stachys pilosa* (*S. palustris*)
Panicled Aster	*Symphyotrichum lanceolatum* (*Aster simplex*)
New England Aster	*Symphyotrichum novae-angliae* (*Aster n.*)
Willowleaf Aster	*Symphyotrichum praealtum* (*Aster praealtus*)
American Germander	*Teucrium canadense*
Purple Meadow Rue	*Thalictrum dasycarpum*
Blue Vervain	*Verbena hastata*

Rainwater Basin Wet-mesic Prairie

The species listed below are suitable for planting a low-diversity wet-mesic prairie restoration on moist lowlands (temporarily flooded wetlands) within the Rainwater Basin region of south-central Nebraska. These wetlands often occur as zones bordering deeper-watered marshes (seasonally and semi-permanently flooded wetlands) and as isolated wetlands. The list contains mostly perennial species. Most annuals found in Rainwater Basin wetlands will likely appear in restorations from seeds in the soil and will not require seeding.

Sedge and grass seed make up the bulk of the seed mix we use to restore this community type. We stripper-harvest the seeds of many species on this list. We broadcast plant the seed mix for this community type at a rate of 5-7 gallons per acre.

Species included on the list are also appropriate for planting other playa-like wetlands in eastern Nebraska such as those found in the Todd Valley of Saunders County. Uplands bordering Rainwater Basin wetlands should be planted with an appropriate tallgrass prairie or mixed-grass prairie seed mix.

Rainwater Basin Wet-mesic Prairie Mix		Rainwater Basin Wet-mesic Prairie Mix	
Common Name	**Species**	**Common Name**	**Species**
Woolly Yarrow	*Achillea millefolium*	**Heavy Sedge**	*Carex gravida*
Swamp Milkweed	*Asclepias incarnata*	**Smooth-cone Sedge**	*Carex laeviconica*
White Boltonia	*Boltonia asteroides*	**Woolly Sedge**	*Carex pellita* (*C. lanuginosa*)
Short-beak Sedge	*Carex brevior*	**Fox Sedge**	*Carex vulpinoidea*
		Golden Coreopsis	*Coreopsis tinctoria*
		Common Spikerush	*Eleocharis palustris* (*E.macrostachya*)
		Western Wheatgrass	*Elymus smithii* (*Agropyron s.*)
		Virginia Wildrye	*Elymus virginicus*
		Foxtail Barley	*Hordeum jubatum*
		Rice Cutgrass	*Leersia oryzoides*
		Switchgrass	*Panicum virgatum*
		Wedgeleaf fog-fruit	*Phyla cuneifolia* (*Lippia c.*)
		Plains Bluegrass	*Poa arida*
		Norwegian Cinquefoil	*Potentilla norvegica*
		Prairie Cordgrass	*Spartina pectinata*
		Heath Aster	*Symphyotrichum ericoides* (*Aster e.*)
		Panicled Aster	*Symphyotrichum lanceolatum* (Aster simplex)
		American Germander	*Teucrium canadense*
		Western Ironweed	*Vernonia fasciculata*

Prairie cordgrass (tall), sedges, rice cutgrass and western ironweed in a Rainwater Basin wet-mesic prairie.

Freshwater Marsh

The species listed below are suitable for planting in deeper-watered marshes (seasonal and semi-permanently flooded wetlands) within stream and river floodplains in eastern Nebraska. The list contains mostly perennial species. Most annuals found in these marshes will likely appear from seeds in the soil and will not require planting. Most species on the list are heavy seed producers that will be utilized as a food source by waterfowl.

We stripper-harvest and hand collect seeds of species used in restoration of this community type. The seed mix is dense, containing mostly seed with little chaff. These wetlands are usually too wet for machine planting so we usually hand broadcast the seeds, often from ATVs, at a rate of about 1-2 gallons per acre.

Freshwater Marsh Mix		Freshwater Marsh Mix	
Common Name	**Species**	**Common Name**	**Species**
Common Water Plantain	*Alisma subcordatum* (including *A. triviale*)	**Orange Jewelweed**	*Impatiens capensis*
Swamp Milkweed	*Asclepias incarnata*	**Rice Cutgrass**	*Leersia oryzoides*
Nodding Bur-marigold	*Bidens cernua*	**Short-beak Arrowhead**	*Sagittaria brevirostra*
Common Beggar-tick	*Bidens frondosa*	**Thick-stalk Arrowhead**	*Sagittaria calycina*
False Nettle	*Boehmeria cylindrica*	**Common Arrowhead**	*Sagittaria latifolia*
Emory's Sedge	*Carex emoryi*	**Hard-stem Bulrush**	*Schoenoplectus acutus* (*Scirpus a.*)
Bottlebrush Sedge	*Carex hystericina*	**Three-square Bulrush**	*Schoenoplectus pungens* (*Scirpus p.*)
Bald Spikerush	*Eleocharis erythropoda*	**Soft-stem Bulrush**	*Schoenoplectus tabernaemontani* (*Scirpus validus*)
Common Spikerush	*Eleocharis palustris* (*E.macrostachya*)	**Pale Bulrush**	*Scirpus pallidus*
Spotted Joe Pye Weed	*Eupatorium maculatum*	**Large-fruit Bur-reed**	*Sparganium eurycarpum*
Common Boneset	*Eupatorium perfoliatum*		
Tall Manna Grass	*Glyceria grandis*		

NEBRASKAland Magazine

Arrowhead.

Rainwater Basin Marsh

The species listed below are suitable for planting in deepwater zones (seasonal and semi-permanently flooded wetlands) of Rainwater Basin wetlands. The list contains mostly perennial species. Most annuals found in these marshes will likely appear from seeds in the soil and will not require planting. Most species on the list are heavy seed producers that will be utilized as a food source by waterfowl.

We stripper-harvest and hand collect seeds of species used in restoration of this community type. The seed mix is dense, containing mostly seed with little chaff. These wetlands are usually too wet for machine planting so we usually hand broadcast the seeds, often from ATVs, at a rate of about 1-2 gallons per acre. Species included on the list are also appropriate for planting other playa-like wetlands in eastern Nebraska such as those found in the Todd Valley of Saunders County.

Rainwater Basin Marsh Mix		Rainwater Basin Marsh Mix	
Common Name	**Species**	**Common Name**	**Species**
Common Water Plantain	*Alisma subcordatum* (including *A. triviale*)	**Short-beak Arrowhead**	*Sagittaria brevirostra*
Swamp Milkweed	*Asclepias incarnata*	**Thick-stalk Arrowhead**	*Sagittaria calycina*
Smooth-cone Sedge	*Carex laeviconica*	**Grassleaf Arrowhead**	*Sagittaria graminea*
Golden Coreopsis	*Coreopsis tinctoria*	**Common Arrowhead**	*Sagittaria latifolia*
Common Spikerush	*Eleocharis palustris* (*E.macrostachya*)	**Stiff Arrowhead**	*Sagittaria rigida*
Rice Cutgrass	*Leersia oryzoides*	**Slender Bulrush**	*Schoenoplectus heterochaetus* (*Scirpus h.*)
		Large-fruit Bur-reed	*Sparganium eurycarpum*

NEBRASKAland Magazine

Swamp milkweed.

Saline Wetland

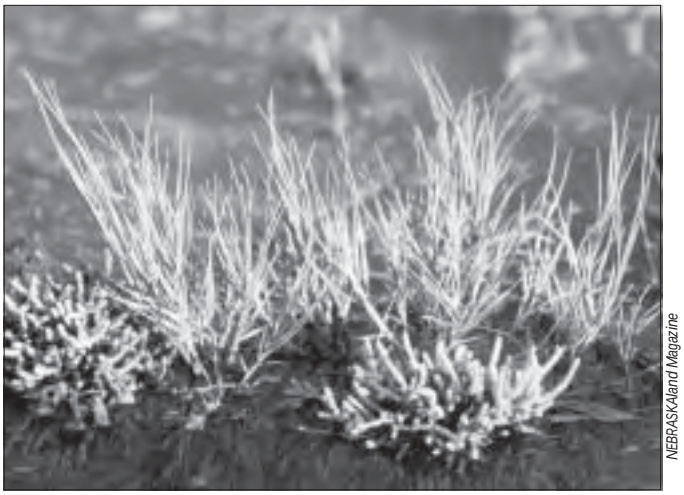
The species listed below are suitable for planting in saline wetlands within the floodplains of Salt Creek and its tributaries in Lancaster and southern Saunders counties. Few plant species can grow on the highly saline, clay soils of these wetlands and therefore a low-diversity seed mix is appropriate. This mix includes both perennial and annual species.

Salt flats, areas with standing water in spring that dry in summer leaving surface salt crusts, are extremely harsh growing environments for most species. Only the most salt-tolerant species – saltwort (*Salicornia rubra*), seablite (*Suaeda calceoliformis*), saltgrass (*Distichlis spicata*), silver orach (*Atriplex argentea*) and saline saltbush (*A. dioica*) – should be planted on salt flats. For wetlands artificially deepened by dikes or dams that contain standing water through most the growing season we recommend seeding only saltmarsh bulrush (*Bolboschoenus maritimus*).

The seed of most species on the list can be stripper-harvested in abundance. The exception is prairie cordgrass whose seed heads cannot be dislodged by the stripper brush. However, prairie cordgrass seed can be hand collected or combined in large quantities. Seed for saltwort and seablite, low-growing annuals, can be hand collected by pulling the entire plant when the stems are dry in late summer and early fall. The plants can then be hammermilled to dislodge the seed. Saltwort is an endangered plant in Nebraska and a permit from the Nebraska Game and Parks Commission is required prior to collecting its seed. Saltgrass, a dominant plant in most saline wetlands, rarely produces viable seed in the wild. We machine broadcast the seed mix for this community type at a rate of about 7 gallons per acre.

Saline Wetland Mix

Common Name	Species
Silver Orach	*Atriplex argentea*
Saltmarsh Spearscale	*Atriplex dioica* (*A. subspicata*)
Saltmarsh Bulrush	*Bolboschoenus maritimus* (*Scirpus m.*)
Short-beak Sedge	*Carex brevior*
Inland Salt Grass	*Distichlis spicata* var. *stricta*
Western Wheatgrass	*Elymus smithii* (*Agropyron s.*)
Foxtail Barley	*Hordeum jubatum*
Annual Marsh-elder	*Iva annua*
Plains Bluegrass	*Poa arida*
Saltwort	*Salicornia rubra*
Prairie Cordgrass	*Spartina pectinata*
Sea Blite	*Suaeda calceoliformis* (*S. depressa*)
Saltmarsh Aster	*Symphyotrichum subulatum* (*Aster subulatus*)



NEBRASKAland Magazine

Saltwort, foreground, and inland salt grass.

Butterfly Garden

The species listed below are easy-to-grow wildflowers, which are good nectar producers and suitable for planting in a backyard or schoolyard butterfly garden. The list contains a combination of species that will provide blooms throughout the growing season. The wildflowers will also attract other insects, such as bees, wasps, flies and beetles.

Butterfly Garden Mix		Butterfly Garden Mix	
Common Name	**Species**	**Common Name**	**Species**
Woolly Yarrow	*Achillea millefolium*	**Round-head Bush-clover**	*Lespedeza capitata*
Leadplant	*Amorpha canescens*	**Rough Gayfeather**	*Liatris aspera*
Swamp Milkweed	*Asclepias incarnata*	**Dotted Gayfeather**	*Liatris punctata*
Showy Milkweed	*Asclepias speciosa*	**Thickspike Gayfeather**	*Liatris pycnostachya*
Prairie Milkweed	*Asclepias sullivantii*	**Cardinal Flower**	*Lobelia cardinalis*
Common Milkweed	*Asclepias syriaca*	**Great Blue Lobelia**	*Lobelia siphilitica*
Butterfly Weed	*Asclepias tuberosa* ssp. *Interior*	**Wild Bergamot**	*Monarda fistulosa*
Whorled Milkweed	*Asclepias verticillata*	**Common Evening Primrose**	*Oenothera villosa*
Plains Yellow-primrose	*Calylophus serrulatus*	**Foxglove Penstemon**	*Penstemon digitalis*
Rocky Mountain Bee Plant	*Cleome serrulata*	**Shell-leaf Penstemon**	*Penstemon grandiflorus*
White Prairie-clover	*Dalea candida*	**Prairie Phlox**	*Phlox pilosa* ssp. *fulgida*
Purple Prairie-clover	*Dalea purpurea*	**Obedient Plant**	*Physostegia virginiana*
Purple Coneflower	*Echinacea angustifolia*	**Prairie Cinquefoil**	*Potentilla arguta*
Tall Boneset	*Eupatorium altissimum*	**Upright Prairie Coneflower**	*Ratibida columnifera*
Stiff Sunflower	*Helianthus pauciflorus* (*H. rigidus*)	**Black-eyed Susan**	*Rudbeckia hirta*
		Pitcher's Sage	*Salvia azurea*
		Prairie Ragwort	*Senecio plattensis*
		Rosinweed	*Silphium integrifolium*
		Compass-plant	*Silphium laciniatum*
		Missouri Goldenrod	*Solidago missouriensis*
		Stiff Goldenrod	*Solidago rigida*
		Heath Aster	*Symphyotrichum ericoides* (*Aster e.*)
		Smooth Blue Aster	*Symphyotrichum laeve* (*Aster laevis*)
		Panicled Aster	*Symphyotrichum lanceolatum* (*Aster simplex*)
		New England Aster	*Symphyotrichum novae-angliae (Aster n.)*
		Aromatic Aster	*Symphyotrichum oblongifolium* (*Aster o.*)
		Purple Meadow Rue	*Thalictrum dasycarpum*
		Hoary Vervain	*Verbena stricta*
		Common Ironweed	*Vernonia baldwinii*

Regal fritillary butterfly on showy milkweed.

Wildlife Habitat

The seed mix listed below is designed to provide year-round habitat for game birds and a variety of other wildlife. The mix includes cool-season grasses and sedges and legumes to provide nesting and brood-rearing habitat for game birds. Annual and perennial legumes, sunflowers and a variety of cool- and warm-season grasses will provide forage for deer and other wildlife. Heavy seed-bearing plants, especially sunflowers and legumes, will provide a fall and winter food source for game birds, songbirds and small mammals. Warm-season grasses and tall-stemmed wildflowers, such as common evening primrose and Canada milkvetch, will provide winter roosting and loafing cover for game birds.

We recommend seeding no more than one gallon per acre of rough-cleaned Canada wildrye and Virginia wildrye seed and no more than 10 gallons per acre of rough-cleaned warm-season grass seed. Using lower grass seeding rates will reduce competition for forbs and maintain plantings in an early successional, weedy state, preferred by game birds, for a longer period.

Wildlife Habitat Mix		Wildlife Habitat Mix	
Common Name	**Species**	**Common Name**	**Species**
Leadplant	*Amorpha canescens*	**Prairie Trefoil**	*Lotus unifoliolatus* (*L. purshianus*)
Canada Milkvetch	Astragalus canadensis	**Wild Bergamot**	*Monarda fistulosa*
Side-oats Grama	*Bouteloua curtipendula*	**Common Evening Primrose**	*Oenothera villosa*
Short-beak Sedge	*Carex brevior*	**Switchgrass**	*Panicum virgatum*
Partridge Pea	*Chamaecrista fasciculata* (*Cassia chamaecrista*)	**Slender-flower Scurfpea**	*Psoralidium tenuiflorum* (*Psoralea t.*)
White Prairie-clover	*Dalea candida*	**Dwarf Prairie Rose**	*Rosa arkansana*
Purple Prairie-clover	*Dalea purpurea*	**Little Bluestem**	*Schizachyrium scoparium*
Illinois Bundleflower	*Desmanthus illinoensis*	**Rosinweed**	*Silphium integrifolium*
Canada Tick-clover	*Desmodium canadense*	**Compass-plant**	*Silphium laciniatum*
Ilinois Tick-clover	*Desmodium illinoense*	**Cup-plant**	*Silphium perfoliatum*
Canada Wildrye	*Elymus canadensis*	**Indiangrass**	*Sorghastrum nutans*
Western Wheatgrass	*Elymus smithii* (*Agropyron s.*)		
Slender Wheatgrass	*Elymus trachycaulus* (*Agropyron caninum*)		
Virginia Wildrye	*Elymus virginicus*		
Small-flowered Gaura	*Gaura mollis* (*G. parviflora*)		
Wild Licorice	*Glycyrrhiza lepidota*		
Sawtooth Sunflower	*Helianthus grosseserratus*		
Maximillian Sunflower	*Helianthus maximilianii*		
Stiff Sunflower	*Helianthus pauciflorus* (*H. rigidus*)		
Jerusalem Artichoke	*Helianthus tuberosus*		
Porcupine Grass	*Hesperostipa spartea* (*Stipa s.*)		
Junegrass	*Koeleria macrantha* (*K. pyramidata*)		
Round-head Bush-clover	*Lespedeza capitata*		

NEBRASKAland Magazine

Canada milkvetch.

Chapter 6 - Planting

Seed Bed Preparation

Most of our restorations are sown on cropland, primarily soybean fields and cornfields. Crop fields provide good seedbeds requiring little site preparation prior to planting. Packard (1997) expressed concern about the residual effects of cropland herbicides on seed germination and seedling establishment of planted species. Atrazine, commonly applied to eastern Nebraska cornfields, is the only herbicide in our region likely to have residual effects on restoration plantings. These effects should last no more than a few years. We recommend not applying Atrazine to a field for 2-3 years before it is seeded as a restoration.

We believe residual stubble in crop fields protects the soil and planted seed from erosion. If corn stubble is over a foot high it may interfere with planting and require shredding or disking. In ridge-tilled fields, the ridges need to be disked before planting. If not leveled, these ridges will persist for years, making walking or driving in the restored field difficult. If planting in late spring or early summer and weeds have become prominent in a field a light disking may be required prior to planting to set weeds back. Disking depth should be less than two inches to prevent additional weed seeds from being brought to the soil surface.

When seeding into noncropland situations, such as old fields and pastures, aggressive perennial weeds, such as smooth brome (*Bromus inermis*), tall wheatgrass (*Thinopyrum poticum*), reed canary grass (*Phalaris arundiancea*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*) and purple loosestrife (*Lythrum salicaria*), if present, will require control prior to planting. If not controlled, these perennial weeds will compete with seeded plants and could jeopardize a restoration's success. Consult with someone knowledgeable about weed control, such as a county weed agent, if you have questions about the best method of weed control.

Hand sowing into corn stubble.

If aggressive perennial weeds occupy only small areas in a restoration site, spot spraying with an appropriate herbicide may be sufficient for control. If these weeds populate large areas control might take several years and require extensive herbicide application. Often smooth brome, tall wheatgrass or reed canary grass dominate entire fields. If these sites have been previously farmed, cropping them for a few years

may be the most effective means of weed control.

Herbicide application is most effective when plants are actively transporting carbohydrates into their root system. This is the time herbicides will also be most efficiently transported into the roots. Mid-fall application of Glyphosate (Roundup), when temperatures are warmer than 60 degrees Fahrenheit, is often an effective method of killing many exotic cool-season grasses. One herbicide application sometimes will not be sufficient to kill aggressive weeds. After spraying in the fall, fields should be checked in the spring to see if the treatment was effective in killing weeds. If not, an additional spring herbicide application might be required before planting. Resprouts from seeds in the soil is a persistent problem after herbicide control of certain perennial weeds, especially tall wheatgrass, leafy spurge and reed canary grass. Follow-up spot spraying is often required to control resprouts.

Reed canary grass is a pervasive, difficult to eradicate, exotic plant in eastern Nebraska wetlands. Though top-killed by herbicides, it often resprouts from its extensive rhizomes (underground lateral stems) or re-emerges from seed. Before seeding reed canary grass-infested wetlands, we frequently excavate 4-6 inches of topsoil to remove the species' rhizomes and seed bank. Though extremely expensive, this process is not a guarantee that reed canary grass will not reappear in a few years.

Restoration sites with excess plant litter, such as idled fields, may require prescribed burning or shallow disking or harrowing prior to planting to reduce litter and expose soil to promote good seed-to-soil contact, especially when broadcast seeding. Some restorationists pack the soil with cultipackers or corrugated cast-iron field rollers before drill planting and after broadcast planting. Packard (1997) wrote "Next to adequate perennial weed control, soil packing is the most important factor in a restoration seeding. A well-packed soil eliminates air passages that can dry out and kill a newly emerging seedling before it ever appears above ground. By creating a crust at the soil surface, it prevents moisture that lies deeper in the soil from evaporating, keeping it just below the surface, where it is most needed by the seeds. It also ensures good seed-to-soil contact, which is vital to the germination of native species." We have done very little soil packing at our restoration sites. We believe that most farmed soils have been well packed by the tires of farm machinery and do not require further packing. This might not be true for sites recently deeply disked or plowed.

An effective seedbed preparation for small-scale plantings is scraping and removal of existing sod, which creates a firm relatively weed-free seedbed. However, this method may make it more difficult to incorporate seed into the soil.

RESTORING WETLAND HYDROLOGY

Restoring hydrology is a critical first step in many wetland restorations. Sufficient water must be present to maintain wetland soils and plant communities and provide for the needs of wildlife. Hydrologic restoration design must allow for natural seasonal and yearly fluctuations in water levels.

Restoring wetland hydrology on crop fields often requires filling ditches and water

In lowland areas, such as the Platte River valley, excavating fill material can create a shallow water wetland that can be seeded to a marsh or wet-mesic prairie community.

storage pits, removing underground drain tile, excavating fill material, removing dikes to re-establish water flow or building dikes and water control structures to store water or to keep water off neighboring lands. A creative individual with a tractor and earthmover can accomplish some small-scale projects. Professional engineers and contractors will likely be needed for larger projects. Contacting the NGPC, USFWS, NRCS or Army Corps of Engineers (Appendix A) is recommended prior to beginning any earthmoving in or near a wetland to see if technical and financial assistance may be available and to obtain necessary permits.

On our Platte River valley restorations we commonly excavate off-channel swales previously filled to facilitate farming. These shallow, meandering swales are excavated to varying depths with gentle side slopes. Some areas hold water only when river levels and connected groundwater levels are high; other areas hold water most of the year. These wetlands provide habitat for many aquatic plants, as well as shorebirds, waterfowl and sandhill cranes in the central Platte River valley.

We often use excavated spoil to create sand ridges similar to high sandbars and low sand dunes that occurred at the sites before they were farmed. These shallow-sloped ridges, one to six feet high, are located near the excavated wetlands to limit earthmoving costs, but far enough away so they will not interrupt surface water flow into the wetlands. The ridges are seeded with sand-adapted species, increasing the site's overall plant diversity.

Prior to seeding Rainwater Basin wetlands, we commonly excavate silt washed into the basins from adjacent cropland. This silt is frequently up to 18 inches thick and overlies the original topsoil (A horizon). The topsoil in Rainwater Basin wetlands is about 6 inches thick and overlays the water-holding clay lens (B horizon). When present, a thick silt layer, lying above the water-holding clay, remains saturated throughout the growing season, never allowing the wetlands to dry completely. These constantly saturated conditions promote the growth of cattails (*Typha* spp.), river bulrush (*Bolboschoenus fluviatilis*), reed canary grass and other aggressive plants that dominate many basins at the expense of other wetland plants more beneficial to wildlife. Prescribed fire, grazing, disking and herbicide spraying, sometimes used in combination, can be used to reduce the abundance of these species and the organic matter buildup they cause prior to planting.

PLANTING

We have had success planting prairie and wetland restorations from October through late May. However, we believe fall (late October) to midwinter (late January) planting provides seeds the greatest chance to germinate and grow. Exposure to winter elements fulfills the cold, moist-seed stratification needs of most species. Early planting also allows young seedlings to benefit from spring and early summer rainfall.

Plantings in drought years often develop at a slower rate. To overcome the potential shortfalls in one growing season, Kurtz (2001) sometimes seeds over two growing seasons, planting half the seed the first fall, and overseeding the other half, without tillage, the following fall.

Restorationists use two primary methods of planting: drilling and broadcasting. We hand broadcast small restorations of less than a few acres, and when volunteers are available, we hand broadcast restorations up to 50 acres. We machine broadcast all other restorations.

Chris Helzer/The Nature Conservancy

Boy Scout volunteer prairie planters.

Organization is key to using volunteers for planting. We divide restorations into one-acre blocks, marking the corners of each acre with pin flags. An acre is approximately 64 yards (or long paces) on a side. Volunteers are divided into two-person teams with each team assigned several acres to plant. For prairie restorations, one volunteer is responsible for planting forb seed, and the other person plants warm-season grass seed. The seed needed for each acre is distributed to volunteers in five-gallon buckets.

We instruct volunteers to mark transects with flags on opposite sides of each acre (transects should run perpendicular to wind direction). The distance between transects depends on wind speed and distance they can throw seed on that day, usually 3 to 10 yards. Planting on days with moderate to high winds will reduce planting time. The volunteer teams walk the transect lines sowing seed as they go. Once a transect has been walked, the volunteers pull the flags marking that transect and use them to mark the next transect. Volunteers must learn to ration seed so they can complete a full acre of planting.

Hand broadcast seeding from an ATV is much faster than broadcasting while walking and works well for seeding wetlands where muddy soils prevent use of mechanical seeders. We do not perceive the uneven seed distribution sometimes resulting from hand broadcasting as detrimental. Those areas receiving little seed may provide space for less aggressive species to establish free of competition. Seeding gaps in restorations usually fill as restorations develop and species spread via rhizomes and seed production.

There are several types of mechanical broadcast seeders. The simplest are the strap-to-chest, hand-cranked machines. More efficient are the pull-type fertilizer spreaders, such as those made by E-ZEE Flow and John

Filling an E-ZEE Flow granular fertilizer spreader with prairie seed mix.

Deere, with wheel-driven agitators in the seed bin and adjustable openings in the bottom through which the seed falls. More advanced yet are the tractor-pulled or three-point hitch-mounted fertilizers spreaders, such as those made by Vicon, which sell for about $3,000.

The Vicon spreader has an aggressive agitator, which breaks plant stems and keeps trash from bridging. An oscillating arm and

U.S. Fish and Wildlife Service

Tractor-mounted Vicon spreader.

deflectors distribute seed over a 16-foot wide band.

Staff at the USFWS office in Kearney also use an ATV-mounted, Truax "Seed Slinger" for broadcast planting. It has picker wheels and an agitator that works well with fluffy and trashy seed. It can throw the seed in a 10-foot wide band on each side of the spreader. They strap extra seed bags to the ATV to increase the speed of seeding. They also drag a piece of chainlink fence weighted with bricks behind the ATV to cover the seed with a shallow layer of soil.

Seed drills are tractor-pulled implements with a series of small discs that create furrows in the soil. Seed is metered out from top-mounted bins through tubes into the furrows. The soil then falls back into the furrow and is packed by rubber press wheels. Seed drills range in price from $5,000 to $10,000. Popular among restorationists are several models made by the Truax Company of Minneapolis, Minnesota.

U.S. Fish and Wildlife Service

ATV-mounted Truax "Seed Slinger."

Local NRCS offices maintain lists of rental drills, as well as custom seed planters.

Some restorationists prefer seed drills to broadcast planters for the following reasons: 1) drills provide even seed distribution, 2) planting depth of drills is adjustable and 3) drills plant seed in the soil and the soil is packed, increasing germination rates. Disadvantages of drills include the following: 1) drills may plant many small seeds too deep for successful germination, 2) only highly cleaned seed can be used in drills,

rough-cleaned seed will not pass through a drill, 3) seeds are planted in rows giving restorations an artificial look for several years, 4) drilling is slow compared to broadcast seeding and 5) drills are heavy, difficult to transport and have many parts that require frequent maintenance and repair.

We plant most of our restorations with E-ZEE Flow fertilizer spreaders pulled by ATVs. Used E-ZEE Flows can often be purchased at farm auctions for less than $100. The spreader's planting width is 10-12 feet and under good conditions we can plant about 10 acres per spreader per hour with these machines. The spreaders provide even seed distribution and work well even on windy days.

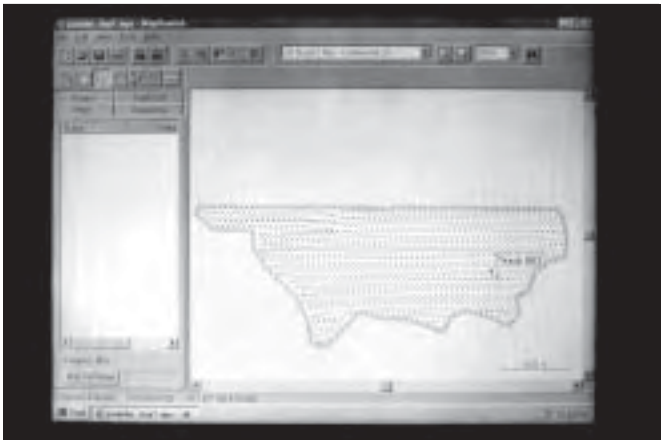
When broadcast seeding, restorationists sometimes mix the seed with an inert carrier, such as sand or vermiculite, to add bulk for easier spreading and to make it easier to see where they have planted. We have found this

Fertilizer spreaders are efficient planters and do not require a tractor.

unnecessary using fertilizer spreaders as we can usually follow tire marks, especially when planting in snow. We sometimes use an ATV-mounted Global Positioning System (GPS) when planting to display the path traveled and identify planting gaps. We also determine acres planted with the GPS.

Broadcast spreaders must be calibrated to distribute the desired amount of seed per

An ATV-mounted Global Positioning System (GPS) unit can be used to record the planting path.



GPS spatial data can be downloaded onto a computer and integrated with other GIS image files, such as aerial photos.

acre. We mark off a few acres and test plant it with given amount of seed and adjust bin openings as needed. When planting different seed mixes, for example tallgrass prairie and wet-mesic prairie mixes, at a restoration site we overlap the mixes in a 20- to 40-foot band in the transition zone. This ensures that the appropriate species are seeded in the often difficult to determine transition zone between community types. On central Platte River valley restorations, we typically broadcast a wet meadow seed mix over the entire site and then overseed wet swales and drier sandy ridges with marsh and sand prairies mixes, respectively.

After broadcast seeding, Kurtz (2001) recommends a light harrowing and cultipacking of the soil to promote better seed-to-soil contact and to prevent soil erosion. We occasionally harrow fields with harder soils after planting to promote better seed-to-soil contact. However, for most plantings we rely on the elements (e.g. rain and frost action) to work the seed into the soil. Where feasible, a light harrowing or raking of small restorations, covering the seeds with less than ¼ inch of soil, may enhance seed-to-soil contact and subsequent germination rates. Packard (1997) wrote that different-sized seeds will survive best at various depths. As a rule of thumb, he recommends covering seed with a layer of soil equal to twice its thickness. He also warns that covering seeds with ½ inch of soil may prevent many species from germinating.

Pulling a harrow behind the E-ZEE Flow marks planter progress and incorporates some of the seed deeper into the soil.

We have never planted cover crops, such as oats or rye, in our restorations. Annual weeds sprout quickly in most restorations, providing adequate cover to prevent soil erosion and partial shading of seedlings to prevent sun scalding. Packard (1997) wrote that adding a protective mulch of straw or sawdust to a planting conserves soils moisture, reduces soil erosion and increases germination especially during dry periods, but also that the mulching is not practical for larger restorations. We have never mulched any of our plantings.

Interseeding

Interseeding is the process of sowing seeds directly into existing perennial vegetation. Restorationists often interseed native plants into degraded plant communities to improve their plant composition and diversity. Reducing the existing plant cover to promote good seed-to-soil contact and decrease competition for seeded species is key to successful interseeding. Densely sodded areas can be lightly disked or harrowed to expose bare soil. Grazing an area just after seeding may also help work seed into the soil. Sites infested with smooth brome, Kentucky bluegrass or other exotic cool-season grasses might require spring burning or heavy spring grazing for 2 or 3 years or herbicide application to reduce these species' abundance before planting.

We have successfully broadcast seeded sunflowers, rosinweed, Illinois bundleflower and a few other hardy native wildflowers into a degraded Platte River valley wet meadow. After seeding, we used late spring and early summer grazing for several years to reduce the vigor of existing cool- and warm-season grasses and give the seeded species a competitive chance. Mowing interseeded sites to a height of 6 to 12 inches may also reduce the vigor of existing vegetation and help establish seedlings.

Chapter 7 - Post-Planting Management

Restoration Development

Prairie and wetland restorations don't become fields of blooming wildflowers overnight. They take several years to develop following the natural process of succession. Patience is a virtue for a restorationist and restoration site owner.

Annual weeds sprouted from seeds in the soil dominate prairie and wetland restorations during the first summer after planting. Annual sunflower (*Helianthus annuus*), pigweeds (*Amaranthus* spp.), giant ragweed (*Ambrosia trifida*), common ragweed (*A. artemisiifolia*), mare's tail (*Conyza canadensis*), foxtails (*Setaria* spp.), kochia (*Kochia scoparia*) and lamb's quarter (*Chenopodium album*) are the most common annual weeds in eastern Nebraska restorations. The canopy of giant ragweed, annual sunflower and kochia often exceeds six feet in height. The robust weed growth the first year after planting is often nourished by excess soil nitrogen remaining from cropping. Hidden among the annual weeds are seedlings of prairie or wetland plants.

In a typical, non-drought year, seeded plants can begin sprouting in mid-April. First-year prairie plants put most of their energy into root development and have limited above-ground growth. Few prairie species tiller their first year. Most remain single-stemmed plants and only a few species will flower. For example, first year rosinweed plants remain few-leafed rosettes about 6 inches tall. First year prairie clover plants can reach about a foot tall with occasional blooms. Big bluestem and Indiangrass plants mostly remain few-leaved clumps up to 6-inches tall, though some plants may flower their first year.

The second year after planting, some annual weeds, such as annual sunflower and foxtails, have less robust growth and are diminished in abundance. Mare's tail is frequently the dominant annual weed in our second-year plantings. Seeded plants are now more visible. Canada wildrye and annual and biennial forbs such as black-eyed Susan (*Rudbeckia hirta*), partridge pea (*Chamaecrista fasciculata*) and common evening primrose (*Oenothera villosa*) may be abundant. Stiff sunflower, goldenrods and other colony-forming plants are beginning to send up multiple stems from rhizomes.

Chris Helzer/The Nature Conservancy

First season prairie forb seedlings in a relatively weed-free backyard planting.

In years 3 to 5 of a restoration, annual weeds are greatly diminished and warm-season grasses and other prairie perennials are often dominant. These perennials are beginning to reproduce and spread via seed and vegetatively filling gaps in

the restoration. Populations of butterfly milkweed (*Asclepias tuberosa*), sedges and other erratic-starting or slow-developing species may still be sparse and consist of small plants.

In years 5 to 10 of a restoration annual weeds are mostly gone. The restoration begins to stabilize and develop the structure and plant composition of a remnant prairie. Many slow-developing plants are visible for the first time. By year ten, most prairie species are growing in their preferred soil type and microenvironment, but even after 10 years a restoration can still reflect conditions from its early years. For example, a portion of a 1992 Platte River valley restoration that flooded in 1993 still maintains a plant species composition distinct from the unflooded portion. Several acres of a central Nebraska tallgrass prairie restoration planted in 1983 with an abundance of Indiangrass seed in the seed mix is still dominated by Indiangrass, while other areas of the restoration are dominated by several grass species. Twenty years after planting this restoration supports 80 of the approximately 100 prairie species planted.

Irrigation

Though the seeds of many prairie and wetland plants are well adapted to withstand drought they will not germinate and grow without sufficient moisture. Limited rainfall in the spring and early summer after planting can reduce the long-term plant diversity and abundance of a restoration. Severe, multi-year drought can cause the failure of restorations on dryer upland sites.

In years of normal precipitation, irrigation of first-year restorations is generally not needed. For most of our restorations irrigation is not feasible because of lack of a water source or irrigation system and pumping costs. Where irrigation is feasible, such as in a backyard, schoolyard or larger areas where irrigation systems are in place, watering during dry periods will likely improve germination rates and seedling establishment. Packard (1997) recommends watering prairie restorations 1 to 2 inches every three days for the first month after planting and as necessary the second month. For eastern Nebraska, watering restorations once a week in the first month or two after planting and during dry periods afterwards is likely sufficient.

Mowing Annual Weeds

Though annual weeds are prolific in restorations the first few years after planting, we believe, in most cases, sufficient sunlight and moisture is still available for establishment of prairie seedlings and the presence of annual weeds has only minor influence on restoration results. Other restorationists believe annual

Annual weeds in a first year restoration.

weeds compete with prairie seedlings for sunlight and moisture and impede their establishment. They recommend mowing restorations the first summer after planting to limit annual weed growth. In the wetter and more fertile areas of the tallgrass prairie region east of Nebraska weed growth is likely more prolific and might be more detrimental to restoration establishment.

Futhermore Kurtz (2001) wrote, "Without mowing to control competition, easily established species such as big bluestem, black-

eyed Susan, saw-toothed sunflower, and gray-headed coneflower [*Ratibida pinnata*] may eventually dominate [a tallgrass prairie restoration]. This can create a community with low species diversity and long-term instability. In the end, mowing encourages higher species diversity, more spaces are filled, and a more stable plant community results. This post-seeding weed control is the most important part of a successful establishment, especially in a dry year when available moisture may be a limiting factor."

Mowing may be cost prohibitive for larger restorations. However, for small restorations, or patches of larger restorations where annual weeds are especially tall or dense, mowing might be feasible and enhance seedling establishment. The presence of annual weeds often concerns neighbors and mowing may alleviate their worries. The benefits of mowing must be weighed against its affects on wildlife. Both mowing and shredding can kill pheasants and other grassland nesting birds, as well as mammals, such as deer fawns.

If you decide to mow, mow first-year restorations when most weeds are about two feet tall. Mow them to a height of about one foot. Mowing when weeds are taller, especially with a sicklebar mower, can lay down a dense thatch layer that shades prairie seedlings. Repeat mowing if weeds again reach two feet in height. Mowing with sicklebar mowers is faster than using shedder mowers, but the rotary action of the shedders is beneficial in that it breaks up thatch. For most restorations, mowing annual weeds will be unnecessary by the second year after planting. Noxious weeds, such as leafy spurge and musk thistle, should be controlled immediately when they appear in a restoration (see Invasive Exotic Plants - A Special Challenge, below).

Annual weeds thrive when soils contain high nutrient levels. Therefore, restorations should not be fertilized. Most native plant species do well on nutrient-poor soils and can more effectively compete with annual weeds under such conditions.

Natural Disturbance in Prairie Ecosystems

Before Euroamerican settlement, Midwestern prairie ecosystems were greatly influenced by natural disturbances including fire, grazing by bison and other ungulates,

Tom Bragg

Prior to settlement, bison were the major native grazer in Midwestern grasslands; their grazing behavior was influenced by fire.

drought and flooding. Periodic disturbance kept the prairies and wetlands diverse and robust. Since settlement, the roving bison herds and sweeping wildfires have disappeared from the prairie landscape and most of eastern Nebraska's remnant and restored prairies and wetlands are relatively small and isolated. The disturbance necessary to maintain healthy plant communities must now be provided through active management – primarily prescribed burning, controlled grazing, haying and sometimes tree cutting and herbicide application.

Without periodic disturbance, such as fire or grazing, eastern Nebraska's prairies and wetlands accumulate excess litter and deteriorate over time when native plants are

shaded out and exotic plants and shrubs and trees invade. Carefully planned and timed management of prairies and wetlands can reduce litter, control invasive plants and produce diverse habitat conditions for native plants and animals ranging from tall, dense stands to short, open stands. Altering the location, timing and intensity of disturbance (i.e. haying, grazing or burning) from year to year is key to managing most plant communities in eastern Nebraska for biodiversity.

The growth and reproductive cycles of various prairie and wetland plants span the entire growing season from March through mid-November. For example, the pasque flower (*Anenome patens*) begins growth in March and sets seed by late May. Downy gentian begins growth in June but does not flower until early September. Disturbance at a particular time in the growing season will generally have short-term, negative effects on plants that are actively growing, flowering or setting seed at that time and benefit species that are inactive. For example, mid-summer (July) burning, grazing or haying weakens warm-season plants that are then actively growing and flowering and reduces competition for cool-season species. Exotic cool-season grasses now dominate many mid-summer hayed meadows in Nebraska.

Conducting a prescribed burn on a remnant prairie.

Nebraska's prairie flora includes relatively few annuals and biennials, such as partridge pea and common evening primrose that flower and set seed only once before dying. Most prairie plants are perennials, some living for decades. They flower and set seed over many years. Management practices that promote a tall, dense vegetative cover, such as rest, light grazing or spring burning, favor taller perennials. Continual use of these practices over many years will reduce the diversity and abundance of annuals, biennials and short-statured perennials within a prairie. These species are favored by disturbances that produce a shorter vegetative cover, such as season-long grazing, multiple haying and summer burning. To maximize species diversity, it is critical to provide a disturbance regime that benefits long- and short-lived plants.

Prescribed Fire

Fire has a rejuvenating effect on prairies. By removing litter and blackening the soil surface, fire increases subsoil temperatures, and thus stimulates soil microbial activity leading to increased nutrient availability for prairie plants. Warmer soil temperatures also lengthen the growing season for most prairie and wetland plants while shortening it for exotic cool-season plants, such as smooth brome and tall wheatgrass.

Eastern Nebraska prairie and wetland restorations can sometimes be burned in the second year after planting if sufficient litter (fuel) is present. Removing dense foxtail and other annual weed litter that shades desirable seedlings is the primary reason for burning young restorations.

Most prescribed burning of Midwestern prairies and wetlands is conducted in spring (mid-March to mid-May) when the growing points of most native plants are still protected below ground. Burning young restorations in March and early April might prevent damage to

early developing cool-season natives, such as sedges and pale poppy mallow (*Callirhoe alcaeoides*), though most native perennials will resprout after fire.

Established restorations, older than five years, can be burned on a three- to four-year rotation. Restorations infested with aggressive exotic cool-season grasses, such as smooth brome and Kentucky bluegrass, should be burned in late April to mid-May when these species are vigorously growing. Severe infestations may require several years of consecutive spring burning or herbicide application to reduce the exotics' populations.

Spring burning promotes the growth of native warm-season grasses. If practiced too frequently warm-season grass stands become dense and can crowd out other native plants. Altering the season and changing the frequency of burning will prevent domination by certain plants and loss of plant diversity. Occasional grazing or haying in addition to burning will add variety to the disturbance regime and diversify vegetative structure and habitats.

Spring burning stimulates tillering, flowering and seed production in warm-season grasses and other prairie plants and is recommended for years when prairies are to be harvested for seed. Resting a site from grazing or haying for a year prior to burning allows fuels to accumulate and plants to store nutrients needed for good seed production. Seed production of some prairie species, such as prairie clovers, may be reduced following a fire. This is dependent on timing of the burn and amount of rainfall received after the burn.

Invasion by both native and exotic shrubs and trees can lead to degradation of prairies and wetlands primarily by shading out native plants. Before settlement, competition with native grasses, wildfires and browsing by deer and elk limited the spread of woody species, such as eastern red cedar (*Juniperus virginiana*), honey locust (*Gleditsia triacanthos*), rough dogwood (*Cornus drummondii*), smooth

Eastern red cedar stand after a prescribed fire.

sumac (*Rhus glabra*), green ash (*Fraxinus pennsylvanica*) and cottonwood (*Populus deltoides*) into prairies and wetlands. With settlement came wildfire control and changes in grazing regimes allowing the spread of woody species. This was exacerbated by the introduction of invasive exotic shrubs and trees, such as black locust (*Robinia pseudoacacia*), Osage orange (*Maculara pomifera*), Siberian elm (*Ulmus pumila*), Russian olive (*Elaeagnus angustifolia*) and white mulberry (*Morus alba*).

Cutting cedars is necessary in some situations.

Eastern red cedar, a prolific coniferous invader of prairies, is easily controlled with prescribed fire when grass fuels are adequate and the trees are less than six to eight feet tall. Once top-killed, eastern red cedars, like most conifers, will not resprout. Deciduous shrubs and trees, such as smooth sumac, Siberian elm, honey locust and cottonwood, though top-killed and weakened, usually resprout after a fire. Control of deciduous species is often best accomplished through the combined use of prescribed burning (summer burning appears most effective on woody plants), grazing, cutting and herbicide spraying. The more robust growth of native plants following fire may slow shrub and tree reinvasion of prairies and wetlands.

Only those with professional training should lead prescribed burns. The Natural Resource Conservation Service and other conservation organizations offer prescribed fire training in areas of the state. Local fire departments require that burn permits be obtained before conducting a prescribed burn.

Grazing

Controlled grazing is a valuable prairie and wetland management tool providing many options for regulating the location, intensity and season of disturbance. Like prescribed fire, cattle grazing can be used to reduce litter, limit exotic cool-season grasses and create habitat diversity. Grazing restorations can generally begin three to five years after planting when seeded plants are well established and provide an adequate forage base. In some cases, younger restorations can be grazed for short periods to control foxtail growth. Grazing restorations in years three to 10 after planting may be especially important for creating openings in the grass matrix that allows other plant species to establish.

We use both short-duration grazing at moderate to high-stocking rates and season-long grazing at low-stocking rates as management practices on our prairie and wetland restorations. Season-long grazing at low stocking rates allows cattle to select their preferred forage, generally the dominant warm-season grasses, especially on recently burned sites, reducing competition for other plant species. Short-duration grazing at moderate to high stocking rates at specific times of the growing season can be used to the benefit or detriment of certain plant groups. For example, grazing in the spring or fall for several continuous years will benefit warm-season species and weaken cool-season species including exotic species. As with prescribed fire, occasional variation in the frequency, timing and intensity of grazing over time will produce a more diverse plant community. Use of electric fence allows grazing to be restricted to specific areas of a prairie or wetland, if watering sites are available in those areas.

Cattle grazing a recently burned prairie on the Platte River bluffs of central Nebraska.

Season-long grazing at moderate to high-stocking rates should generally be avoided unless practiced only occasionally to meet specific management objectives. Local Natural Resource Conservation Service staff can assist landowners in determining the appropriate stocking rates for their restorations.

Prescribed burning can be incorporated into grazing systems when adequate fuels are available, usually after periods of rest or light grazing. Exotic cool-season grasses can be effectively set back by spring burning followed by several weeks of moderate to heavy cattle grazing. Prescribed burning in combination with grazing can also be used to produce a diverse and somewhat random disturbance regime. For example, one to several smaller

NEBRASKAland Magazine

Hayed central Platte River valley meadow.

units of a pasture, perhaps totaling one-third to one-fourth of the total area, can be burned. After allowing a few weeks for regrowth, cattle are grazed in the pasture at light to moderate stocking rates. Grazing will be concentrated on the fresh regrowth of burned areas, providing these areas with additional intense disturbance and unburned areas with little additional disturbance. The following year different areas can be burned, usually those areas with the heaviest litter accumulation.

Grazing some prairies and wetlands is not always feasible because of their small size or lack of watering facilities or fencing. Prescribed burning and haying may be more feasible forms of management for these sites. These management practices differ from grazing in that they generally remove all the vegetative cover from a site at one time. Some ecologists recommend against burning or haying entire prairies or wetlands at once as this may be detrimental to the sites' insect populations, especially if a prairie or wetland is isolated with little chance of insect recolonization from nearby sites.

Monitoring and Record Keeping

Monitoring and record keeping are important for documenting vegetative changes in a restoration and to provide information to guide management decisions. For all restorations we recommend recording which species were seeded and in what amounts, as well as seeding date and method. We also recommend the following monitoring activities be conducted on an annual basis: 1) record all plant species found in the restoration, 2) draw maps of noxious weed, other invasive exotic plant and woody plant infestations, 3) record general observations such as which plants are dominant and which are rare, vegetation structure and amount of litter and 4) take photographs of the restoration from fixed photo points. Photo points can be permanently marked with fence posts and the photos taken from the top of the posts.

Conservationists and scientists often undertake more detailed, statistically valid forms of restoration monitoring. Packard (1997) discusses in detail quantitative restoration monitoring techniques. We use plot-wise Floristic Quality Assessment (FQA) for restoration monitoring. We believe FQA is a simple, consistent and statistically valid method for judging the floristic quality of restorations and remnant plant communities and for detecting change in the floristic quality of these communities over time.

The foundation of FQA is based on the concept of species conservatism. Each Nebraska plant species has been assigned a coefficient of conservatism (**C**) ranging from 0-10 (Rolfsmeier and Steinauer 2003) based on the methodology and philosophy of Swink and Wilhelm (1994) and Taft et al. (1997). The coefficients of

Invasive Exotic Plants - a Special Challenge

Of the approximately 1,950 plants found in the wild in Nebraska, at least 470 are exotic (non-native) plants introduced from other continents or other regions in North America. Most of Nebraska's exotic plants such as alfalfa and garden phlox don't compete well with native vegetation and therefore do not persist in remnant or restored plant communities. However, some exotics successfully invade native plant communities and restorations. Once established, these exotics might outcompete, hybridize with, or spread disease to native plants, change natural fire frequencies and intensities, or even alter soil chemistry. The annual weeds that dominate restorations in their initial years include both exotic and native species. These annual weeds are usually displaced a few years after planting by native perennials and generally do not concern us.

Nebraska currently lists seven noxious weed species that the state has mandated for control. These are leafy spurge, plumeless thistle (*Carduus acanthoides*), Canada thistle (*Cirsium arvense*), musk thistle, spotted knapweed (*Centaurea biebersteinii*), diffuse knapweed (*C. diffusa*) and purple loosestrife (*Lythrum salicaria*). All are exotics that pose serious ecological threats to remnant and restored plant communities. Purple loosestrife is a wetland species. The others occupy more upland habitats. Planting restorations on sites with extensive and persistent noxious weed problems is discouraged.

In addition to noxious weeds, several other exotic plants, mostly perennials, pose serious ecological threats to eastern Nebraska prairies, including sericea lespedeza (*Lespedeza cuneata)*, crown vetch (*Coronilla varia*), ox-eye daisy (*Leucanthemum vulgare*), tall fescue (*Lolium arundinaceum*), smooth brome, Garrison creeping foxtail (*Alopecurus arundinaceus*) and tall wheatgrass. Other invasive exotics of eastern Nebraska wetlands include reed canary grass, narrow-leaved cattail (*Typha angustifolia*) and the non-native variety of common reed (*Phragmites australis*). Though not mandated by law, these weeds should be promptly controlled when they first appear at a restoration. Certain native species, such as river bulrush (*Bolboschoenus fluviatilis*) and eastern red cedar, can exhibit an aggressive nature in a plant community when no longer subjected to natural processes such as fire and grazing.

The presence of invasive exotic plants complicates management of remnant and restored plant communities, as management that benefits native species may also benefit exotics. In addition, methods to control exotics can be detrimental to native plants and wildlife. Hand-pulling, grazing, burning or mowing can sometimes keep small populations of certain exotics in check without affecting native species. However, herbicide application is often necessary for controlling invasive exotics and most herbicides will also affect native plants.

Invasive exotic plants are often best controlled through careful spot spraying of herbicides when they first appear at a site and populations are small. When exotics become well established at a site control is more time consuming, costly and detrimental to native plants and wildlife. Restorations should be monitored annually for the presence of aggressive exotic weeds.

conservatism represent two basic ecological tenets: 1) plants differ in their tolerance to disturbance type, frequency and amplitude and 2) plants display varying degrees of fidelity to native habitats. With these principles as a guide, the **C** value applied to each plant represents a relative rank based on the plants observed behavior and pattern of occurrence in Nebraska and our confidence that the plant is dependent on remnant native habitats. Native plant species most successful in heavily disturbed habitats were given a **C** value of 0. Those species with high fidelity to relatively undisturbed native plant communities received a **C** value of 10. All exotic plants were assigned an asterisk (*) and are treated as 0s in calculations for site indices and **FQI** values.

General categories for species assignments are as follows:

1) **C** values of 0-3 were applied to plants that are adapted to severe disturbance (ruderal and ruderal competitive species), found in a wide variety of habitats and have little fidelity to native plant communities. Species in this category include giant ragweed (*Ambrosia trifida*) (**C** = 0), partridge pea (*Chamaecrista fasciculata*) (**C** = 1), sand dropseed (*Sporobolus cryptandrus*) (**C** = 2) and wolfberry (*Symphoricarpos occidentalis*) (**C** = 3).
2) **C** values of 4-6 were applied to plants that are dominant or matrix species of several native plant communities (competitor species) and species that are often expected or have high consistency in a given native plant community. In the contemporary Nebraska landscape these species demonstrate considerable tolerance to light to moderate periods of disturbance and habitat degradation, but may decline with an increase in intensity, duration or frequency of disturbance. Species in this category include Canada wildrye (*Elymus canadensis*) (**C** = 4), big bluestem (*Andropogon gerardii*) (**C** = 5) and purple prairie-clover (*Dalea purpurea*) (**C** = 6).
3) **C** values of 7-10 were applied to plants that are generally slow-growing, longer-lived, perennial plants of late seral native habitats. Species in this category tolerate little disturbance, they often have a high degree of fidelity to a narrow range of ecological parameters and usually persist only in intact natural areas. Species in this category include rough gayfeather (*Liatris aspera*) (**C** = 7), wild rice (*Zizania palustris*) (**C** = 8), small white lady's-slipper (*Cypripedium candidum*) (**C** = 9) and small yellow lady's-slipper (*C. parviflorum*) (**C** = 10).

A few species exhibit varying degrees of conservatism over their statewide range. In such cases, the **C** value assigned reflects that which would be expected most commonly throughout the state.

Plot-wise FQA includes three measures of ecological importance: 1) plant species richness (**n**), 2) mean **C** value and 3) floristic quality index (**FQI**). **FQI** is a weighted index of species richness (**n**), and is the product of the average **C** value and the square root of species richness (**n**) of a surveyed area (**FQI** = mean **C** value*$\sqrt{}$**n**). Using the square root of n in the equation limits the influence of area alone on species richness (Swink and Wilhelm 1994).

Determining the extent and configuration of survey units is important when determining a site's **FQI**. Because **FQI** is a weighted index of species richness; larger survey units and greater inventory efforts will likely result in an increase in species richness or number of conservative species and yield higher **FQI** values (Taft et al. 1997). If the goal is to compare similar plant communities, care should be taken to avoid inclusions of other communities while sampling for FQA. Sites with multiple plant communities (e.g. wetlands with multiple vegetation communities) can be

compared using FQA. We use 100 1x1 m^2 sample plots located with a stratified random design for FQA monitoring of prairie and wetland restorations and remnant prairie communities.

Summary

Prairie and wetland restoration not only provides many ecological benefits, such as habitat for native plants and animals and prevention of soil erosion, but also can be a personally fulfilling activity. However, restoration is not an activity to be tackled on a whim. Seed collecting, processing and planting all take considerable time. Buying seed can be expensive. Once planted, restorations take several years to develop. For those with little patience this may seem like an eternity. Once established, restorations require management - weed control, prescribed burning or grazing - and may fail if not properly cared for. Personal commitment and dedication is key to a successful restoration.

Because of their considerable cost and labor requirements, high-diversity prairie and wetland restorations are most suitable for lands permanently protected with long-term conservation easements or other conservation measures, or by the commitment of a landowner and their family. A Conservation Reserve Program (CRP) field that is under a 10-year contract and likely to be farmed again when the contract expires is not a suitable site for a high-diversity restoration.

Though many ecologists prefer high-diversity restorations, moderate- or low-diversity plantings may be more practical in many circumstances, especially where time and money are limited and the land not permanently protected. For the above-mentioned CRP field, the best planting option would be perhaps a 10- to 20-species mix of native grasses and wildflowers. Such plantings will prevent soil erosion, provide wildlife habitat and other ecological benefits and be aesthetically pleasing. Management of low-diversity plantings can be less complicated than management of higher-diversity plantings.

A quick overview of prairie and wetland restoration techniques that we recommend for eastern Nebraska follows:

1) Whenever possible use local ecotype seed.
2) Limit the amount of grass seed sown in restorations. In general collect or buy as much forb seed as possible, with the exception of certain aggressive species. Rough cleaning of the seed is usually sufficient.
3) Broadcast plant the seed in late fall or winter. If possible, cover the seed with a light layer of soil by harrowing or by dragging a piece of chainlink fence weighted with bricks behind the planter.
4) Where feasible, water plantings the first year if conditions are dry.
5) Annual weed control is optional, but may be necessary where weeds are extremely tall and dense. Mow annual weeds, preferably with a shedder mower, when they reach a height of about two feet.
6) Control all noxious weeds, other aggressive perennial weeds and woody invaders in a restoration when they first appear.
7) Once established, manage restorations with a combination of prescribed fire, grazing or haying.
8) Monitor restorations to measure success and to help direct management.
9) If you have questions regarding a restoration, contact a professional.

Most importantly, enjoy the restoration process and the resulting prairie or wetland. Share this experience with others and learn as much about nature as you possibly can from the restoration.

APPENDIX A - REFERENCE MATERIAL

CONSERVATION AGENCIES & ORGANIZATIONS

Nebraska Game and Parks Commission (District 2 Office)
524 Panzer St., PO Box 508
Bassett, NE 68714-0508
402 684-2921

Nebraska Game and Parks Commission (District 3 Office)
2201 N 13th St.
Norfolk, NE 68701
402 370-3374

Nebraska Game and Parks Commission (District 5 Office)
2200 N 33rd St.
Lincoln, NE 68503-0370
402 471-0641

Nebraska Game and Parks Commission (District 6 Office)
1617 First Ave.
Kearney, NE 68847-5310
308 865-5310

Prairie Plains Resource Institute
1307 L Street
Aurora, NE 68818
(402) 694-5535

Rainwater Basin Joint Venture and **Ducks Unlimited**
2550 North Diers Avenue
Grand Island, NE 68803
(308) 382-8112

The Nature Conservancy (Platte River/Rainwater Basin Field Office)
1228 L Street, Suite 1
Aurora, NE 68818
(402) 694-4191

U.S. Army Corp of Engineers
Wehrspann Field Office
8901 South 154th Street
Omaha, NE 68138
(402) 896-0896

U.S. Army Corp of Engineers
Kearney Field Office
1430 Central Avenue
Kearney, NE 68847
(308) 234-1403

U.S. Fish and Wildlife Service
203 West Second Street
Federal Building
Grand Island,NE 68801
(308) 382-6468

Useful Literature and Publications

Begin with a seed - the Riveredge guide to growing Wisconsin prairie plants. 1999. Editors: Beimborn, J. and J. Lasca. Riveredge Nature Center. Newburg, Wisconsin. 111 p. (Contains information on the moisture, germination and soil type requirements of many tallgrass prairie plants).

Ecological restoration. This journal is published by the Society for Ecological Restoration. It contains articles on a wide diversity of topics related to native plant community restoration. For subscription and membership information contact SER, University of Wisconsin-Madison Arboretum, 1207 Seminole Highway, Madison, WI 53711, (608) 262-9547.
ser@macc.wisc.edu
www.ser.org

Flora of the Great Plains. 1986. Great Plains Flora Association. University Press of Kansas. Lawrence, Kansas 1402 p. (Technical publication, includes keys to and descriptions of the Great Plains flora, no drawings.)

Floristic Quality Assessment in Illinois; a method for assessing vegetation integrity. 1997. Taft, J. B., G. S. Wilhelm, D. M. Ladd, and L. A. Masters. Erigenia 15:3-95. (Contains detailed discussion on the development of Floristic Quality Assessment.)

Going Native – A prairie restoration handbook for Minnesota landowners. 2000. Rebecca Kilde. Minnesota Department of Natural Resources. (General restoration guidelines for the landowner. Available by calling (651) 296-2835.)

Grassland plants of South Dakota and the northern Great Plains. 1999. James R. Johnson and Gary E. Larson. South Dakota State University. 228 p. (A good prairie wildflower and grass field guide for most of Nebraska.)

How to manage small prairie fires. 1982. W.R. Pauly. Dane County Park Commission, Madison, WI. (A valuable guide for conducting small prairie burns. Available from Prairie Nursery, Inc. (www.prairienursery.com) and WildOnes Wild Store (www.for-wild.org)

Native vegetation of Nebraska (map). 1993. Kaul, R. B., and S. B. Rolfsmeier. Conservation and Survey Division, The University of Nebraska, Lincoln, Nebraska, scale 1:1,000,000. (http://csd.unl.edu/csd/pubcatalog/gimc-nebr.htm)

Nebraska florasearch. (A web site of the Nebraska Statewide Arboretum. Contains pictures and brief descriptions of many Nebraska wildflowers.) (Http://citnews.unl.edu/florasearch)

Plants of the Chicago region, 4th edition. 1994. Swink, F. and G. Wilhelm. Indiana Academy of Science, Indianapolis, IN. (Contains information on the development of Floristic Quality Assessment.)

A practical guide to prairie reconstruction. 2001. Carl Kurtz. University of Iowa Press. (A guide to restoration relying on Kurtz' own restoration experience.)

Prairie plants and their environment. 1968. J. E. Weaver. University of Nebraska Press. (A good general overview of prairie ecology.)

Restoring the tallgrass prairie. 1994. Shirley Shirley. University of Iowa Press. (General information on restoration methods. It also contains line drawings of many prairie plants.)

Steyermark's flora of Missouri (volume 1). 1999. G. Yatskievych. Missouri Department of Conservation in cooperation with the Missouri Botanical Garden. Jefferson City, MO. 991 pp. (Contains keys to and descriptions of the monocots of Missouri, with excellent drawings.)

The tallgrass prairie handbook. 1997. Edited by Stephen Packard and C. Mutel. Island Press. (Most detailed restoration book available.)

Tallgrass prairie wildflowers. 1995. Doug Ladd and Frank Oberle. Falcon Press. (Field guide with excellent photos of many eastern Nebraska tallgrass prairie wildflowers.)

Vascular plants of Nebraska. 2003. Steve Rolfsmeier. and Gerry Steinauer. 2003. Unpublished document of the Nebraska Game and Parks Commission. 57 p. (List of the vascular plants of Nebraska. Includes scientific and common names and coefficients of conservatism. Available online at www.ngpc.state.ne.us)

Terrestrial natural communities of Nebraska (version III – June 30, 2003). 2003. Gerry Steinauer and Steve Rolfsmeier. Unpublished document of the Nebraska Game and Parks Commission. 162 p. (Technical descriptions of Nebraska's terrestrial plant communities. Available online at www.ngpc.state.ne.us)

Equipment

Hammermills

Winona Attrition Mill Company, 1009 W. 5th St. Winona, MN 55987. (507) 452-2716.

Fanning mills

Clipper Office Tester Seed Cleaner, 805 S. Decker Drive, P.O. Box 256. Bluffton, IN 46714. (800) 248-8318, (219) 824-3400.

Seed Drills

Truax Company, Inc., 4821 Xerxes Avenue North, Minneapolis, MN 55430. (612) 537-6639. (www.truaxcomp.com)

Seed strippers

Ag-Renewal, Inc. 1710 Airport Road, Weatherford, OK 73096. (800) 658-1446, (580) 772-7059.

Ned Groelz, 308 W Highway 34, Phillips, NE 68865, or Arvada, Colorado, (303) 424-3162.

Prairie Habitats, Inc. P.O. Box 1, Argyle, Manitoba, Canada ROC OBO. (204) 467-9371. (prairiehabitats.com)

Appendix B - Plant List

Plant species (listed by family) used by the authors in eastern Nebraska prairie and wetland restorations. Includes common name; scientific name; plant type preceded by abbreviations for annual (A), biennial (B) and perennial (P); seed collection dates; habitats suitable for planting (tg = tallgrass prairie, mg = mixed-grass prairie, san = sand prairie, wm = wet-mesic prairie, rbwm = rainwater basin wet-mesic prairie, rbmar = rainwater basin marsh, mar = freshwater marsh, sawet = saline wetland); and coefficient of conservatism (C).

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Family - Acanthaceae				
Hairy Ruellia	*Ruellia humilis*	P-FORB	mid sept	tg, southeastern NE	4
	Familiy - Acoraceae				
American Sweet Flag	*Acorus americanus*	P-FORB	late july-aug	mar, *A. calamus* is exotic	7
	Family - Agavaceae				
Soapweed	*Yucca glauca*	SHRUB	early aug-oct	san	4
	Family - Alismataceae				
Common Water Plantain	*Alisma subcordatum* (incl. *A. triviale*)	P-FORB	mid aug-mid sept	rbmar, mar	4
Upright Burhead	*Echinodorus berteroi* (*E. rostratus*)	A-FORB	sept	mar, far southeastern NE	6
Short-beak Arrowhead	*Sagittaria brevirostra*	P-FORB	mid to late july	mar, rbmar	5
Thick-stalk Arrowhead	*Sagittaria calycina*	A-FORB	mid to late july	mar, rbmar	3
Arum-leaf Arrowhead	*Sagittaria cuneata*	P-FORB	mid to late july	mar, sandy soils	5
Grassleaf Arrowhead	*Sagittaria graminea*	P-FORB	mid to late july	mar, rbmar	7
Common Arrowhead	*Sagittaria latifolia*	P-FORB	mid to late july	mar, rbmar	5
Stiff Arrowhead	*Sagittaria rigida*	P-FORB	mid to late july	mar, rbmar	7
	Family - Alliaceae				
Wild Garlic	*Allium canadense*	P-FORB	mid to late july	tg, wm, bulblets or seeds	3
Plains Onion	*Allium perdulce*	P-FORB	mid to late may	mg	6
White Wild Onion	*Allium textile*	P-FORB	mid june	tg, mg	6
	Family - Amaranthaceae				
Large Cottonweed	*Froelichia floridana*	A-FORB	mid aug	san	4
	Family - Apiaceae				
Common Water-hemlock	*Cicuta maculata*	P-FORB	late aug-oct	wm, highly toxic if ingested	5
Rattlesnake Master	*Eryngium yuccifolium*	P-FORB	sept	tg, far southeastern NE	9
Prairie Parsley	*Polytaenia nuttallii*	P-FORB	late june	wm	8
Canada Sanicle	*Sanicula canadensis*	B-FORB	aug-sept	tg, woodland edge	3
Hemlock Water-parsley	*Sium suave*	P-FORB	sept-oct	wm, mar	7
Golden Alexander	*Zizia aurea*	B-FORB	early aug	tg, wm	6
	Family - Apocynaceae				
Hemp Dogbane	*Apocynum cannabinum*	P-FORB	lat aug-late sept	tg, wm, rbwm	2

Common Name	Species	Plant Type	Collection Date	Habitats	C
Family - Asclepiadaceae					
Prairie Milkweed	*Asclepias sullivantii*	P-FORB	sept	wm	7
Common Milkweed	*Asclepias syriaca*	P-FORB	mid aug-oct	tg, mg, san, wm	1
Butterfly Weed	*Asclepias tuberosa* ssp. *interior*	P-FORB	sept-oct	tg, mg	6
Whorled Milkweed	*Asclepias verticillata*	P-FORB	aug-oct	tg, mg, san	3
Short Green Milkweed	*Asclepias viridiflora*	P-FORB	mid aug-oct	tg, mg, san	6
Spider Milkweed	*Asclepias viridis*	P-FORB	sept-oct	tg, mg	4
Family - Asteraceae					
Woolly Yarrow	*Achillea millefolium*	P-FORB	aug-sept	tg, mg, san, wm, rbmw	2
Field Pussytoes	*Antennaria neglecta*	P-FORB	mid may	tg, mg, san	1
Pale Indian Plantain	*Arnoglossum atriplicifolium* (*Cacalia*)	P-FORB	mid july	tg, wm	6
Prairie Indian Plantain	*Arnoglossum plantagineum* (*Cacalia*)	P-FORB	mid july	tg, wm, southeastern NE	7
Western Sagewort	*Artemisia campestris*	B-FORB	oct	mg, san	4
White Sage	*Artemisia ludoviciana*	P-FORB	mid to late oct	tg, mg, san, wm	4
Nodding Bur-marigold	*Bidens cernua*	A-FORB	oct	mar	3
Tickseed Sunflower	*Bidens coronata*	A-FORB	oct	mar	4
Common Beggar-tick	*Bidens frondosa*	A-FORB	oct	mar	1
Coreopsis Beggar-tick	*Bidens polylepis*	A-FORB	oct	mar	4
White Boltonia	*Boltonia asteroides*	P-FORB	mid oct	rbwm	3
False Boneset	*Brickellia eupatorioides*	P-FORB	sept-oct	tg, mg, san	3
Tall Thistle	*Cirsium altissimum*	P-FORB	sept	tg, mg	1
Platte Thistle	*Cirsium canescens*	B-FORB	aug	wm	4
Flodman's thistle	*Cirsium flodmanii*	P-FORB	mid july-aug	tg, wm	4
Wavy-Leaved Thistle	*Cirsium undulatum*	P-FORB	aug	mg, san	4
Prairie Coreopsis	*Coreopsis palmata*	P-FORB	early to mid aug	tg, southeastern NE	8
Golden Coreopsis	*Coreopsis tinctoria*	A-FORB	mid aug-sept	rbwm, rbmar	1
Dandelion Hawks-beard	*Crepis runcinata*	P-FORB	early june	wm, central Platte Valley	5
Purple Coneflower	*Echinacea angustifolia*	P-FORB	late july-sept	tg, mg	5
Marsh Fleabane	*Erigeron philadelphicus*	B-FORB	late june	wm	3
Daisy Fleabane	*Erigeron strigosus*	A-FORB	mid to late june	tg, mg, wm	2
Tall Boneset	*Eupatorium altissimum*	P-FORB	oct	tg,wm, southeastern NE	3
Spotted Joe Pye Weed	*Eupatorium maculatum*	P-FORB	early to mid sept	wm, mar	6
Common Boneset	*Eupatorium perfoliatum*	P-FORB	late sept-oct	wm, mar	5
Late Boneset	*Eupatorium serotinum*	P-FORB	mid to late oct	tg, southeastern NE	4
Viscid Goldentop	*Euthamia gymnospermoides*	P-FORB	mid oct-nov	san, wm	4
Blanket Flower	*Gaillardia pulchella*	P-FORB	late july-early aug	mg, rare species	5
Sneezeweed	*Helenium autumnale*	P-FORB	mid sept-oct	wm	6
Sawtooth Sunflower	*Helianthus grosseserratus*	P-FORB	late sept-early oct	wm, rbwm, aggressive	4
Hairy Sunflower	*Helianthus hirsutus*	P-FORB	sept	tg, woodland edge	6
Maximillian Sunflower	*Helianthus maximilianii*	P-FORB	mid sept	tg,mg,wm, aggressive	4
Stiff Sunflower	*Helianthus pauciflorus* (*H. rigidus*)	P-FORB	early sept	tg, mg, san	5
Petioled Sunflower	*Helianthus petiolaris*	A-FORB	mid sept	mg, san	2
Jerusalem Artichoke	*Helianthus tuberosus*	P-FORB	late sept	tg, wm, rbwm	4
False Sunflower	*Heliopsis helianthoides*	P-FORB	mid aug-sept	tg, wm	4
Hairy Golden-aster	*Heterotheca villosa* (*Chrysopsis villosa*)	P-FORB	july-aug	san	4
Longbeard Hawkweed	*Hieracium longipilum*	P-FORB	july-aug	tg	6
Annual Marsh-elder	*Iva annua*	A-FORB	late sept-early oct	wm, rbwm, sawm	1
Wild Lettuce	*Lactuca canadensis*	B-FORB	aug-sept	tg, mg	2
Western Wild Lettuce	*Lactuca ludoviciana*	B-FORB	late july-early sept	tg, mg	3
Showy Blue Lettuce	*Lactuca tatarica* (*L. oblongifolia*)	P-FORB	mid july	tg, mg	0
Rough Gayfeather	*Liatris aspera*	P-FORB	sept	tg, mg, san	5
Lanceleaf Gayfeather	*Liatris lancifolia*	P-FORB	late aug-mid sept	wm, central & northeast NE	8
Dotted Gayfeather	*Liatris punctata*	P-FORB	late sept-early oct	tg, mg	5
Thickspike Gayfeather	*Liatris pycnostachya*	P-FORB	early sept	tg, southeastern NE	7
Plains Gayfeather	*Liatris squarrosa* var. *glabrata*	P-FORB	late aug-early sept	mg, san, central NE	5

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Asteraceae - continued				
Plains Gayfeather	*Liatris squarrosa* var. *hirsuta*	P-FORB	late aug-early sept	tg, southeastern NE	7
Skeleton Plant	*Lygodesmia juncea*	P-FORB	late july-early aug	tg, mg, san	4
Cutleaf Ironplant	*Machaeranthera pinnatifida* (*Haplopappus spinulosus*)	P-FORB	late june	mg, san	4
Wavyleaf Prairie-dandelion	*Nothocalis cuspidata* (*Microseris cuspidata*)	P-FORB	early june	tg, mg	6
Rough Rattlesnake-root	*Prenanthes aspera*	P-FORB	mid sept-oct	tg, mg, san	7
Old Field Balsam	*Pseudognaphalium obtusifolium* (*Gnaphalium obtusifolium*)	B-FORB	mid to late oct	tg, mg	3
Upright Prairie Coneflower	*Ratibida columnifera*	P-FORB	aug	tg, mg, san	3
Grayhead Prairie Coneflower	*Ratibida pinnata*	P-FORB	late aug	tg	3
Black-eyed Susan	*Rudbeckia hirta*	B-FORB	late july-aug	tg, wm	3
Golden-glow	*Rudbeckia laciniata*	P-FORB	sept	wm	4
Prairie Ragwort	*Senecio plattensis*	B-FORB	late may-early june	tg, mg, san, wm	5
Rosinweed	*Silphium integrifolium*	P-FORB	late aug-sept	tg, mg, wm	4
Compass-plant	*Silphium laciniatum*	P-FORB	late aug-sept	tg, wm	5
Cup-plant	*Silphium perfoliatum*	P-FORB	late aug-sept	tg, wm, woodland edge	4
Canada Goldenrod	*Solidago canadensis*	P-FORB	oct	tg, wm	2
Late Goldenrod	*Solidago gigantea*	P-FORB	oct	tg, wm	3
Missouri Goldenrod	*Solidago missouriensis*	P-FORB	oct	tg, mg, san	5
Soft Goldenrod	*Solidago mollis*	P-FORB	oct	tg, mg	4
Gray Goldenrod	*Solidago nemoralis*	P-FORB	oct	tg	4
Stiff Goldenrod	*Solidago rigida*	P-FORB	oct	tg, mg, san	3
Showy-wand Goldenrod	*Solidago speciosa*	P-FORB	oct	tg	7
Heath Aster	*Symphyotrichum ericoides* (*Aster ericoides*)	P-FORB	oct	tg, mg, san, wm, rbwm	3
Smooth Blue Aster	*Symphyotrichum laeve* (*Aster laevis*)	P-FORB	late oct	tg	5
Panicled Aster	*Symphyotrichum lanceolatum* (*Aster simplex*)	P-FORB	mid to late oct	tg, wm, rbwm	2
New England Aster	*Symphyotrichum novae-angliae* (*Aster novae-angliae*)	P-FORB	mid to late oct	wm	4
Aromatic Aster	*Symphyotrichum oblongifolium* (*Aster oblongifolium*)	P-FORB	mid to late oct	tg, mg, san	5
Azure Aster	*Symphyotrichum oolentangiense* (*Aster oolentangiense*)	P-FORB	mid to late oct	tg, southeastern NE	7
Willowleaf Aster	*Symphyotrichum praealtum* (*Aster praealtus*)	P-FORB	mid to late oct	wm, rbwm	5
Silky Aster	*Symphyotrichum sericeum* (*Aster sericeus*)	P-FORB	mid to late oct	tg	7
Saltmarsh Aster	*Symphyotrichum subulatum* (*Aster subulatus*)	A-FORB	mid sept-oct	sawet	0
Rayless Greenthread	*Thelesperma megapotamicum*	P-FORB	aug	mg	4
Common Ironweed	*Vernonia baldwinii*	P-FORB	sept-oct	tg, wm	3
Western Ironweed	*Vernonia fasciculata*	P-FORB	sept-oct	wm, rbwm	4
	Family - Balsaminaceae				
Orange Jewelweed	*Impatiens capensis*	A-FORB	july-aug	mar, ripe capsules explode	4
	Family - Boraginaceae				
Hoary Puccoon	*Lithospermum canescens*	P-FORB	aug	tg	5
Hairy Puccoon	*Lithospermum caroliniense*	P-FORB	aug	san	6
Fringed Puccoon	*Lithospermum incisum*	P-FORB	aug	tg, mg, san	5
False Gromwell	*Onosmodium molle*	P-FORB	late june-oct	tg, mg, san	4

Appendix B - Plant List

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Family - Cactaceae				
Plains Pincushion Cactus	*Coryphantha vivipara*	P-FORB	aug	mg, san	6
Plains Prickly Pear	*Opuntia tortispina* (*O. macrorhiza*)	P-FORB	early sept	mg, san	4
	Family - Campanulaceae				
Cardinal Flower	*Lobelia cardinalis*	P-FORB	sept	wm, rare, central Platte Valley	6
Great Blue Lobelia	*Lobelia siphilitica*	P-FORB	sept	wm	6
Pale Spiked Lobelia	*Lobelia spicata*	P-FORB	mid july-mid aug	tg, wm	6
Venus' Looking Glass	*Triodanis perfoliata*	A-FORB	mid july	tg, mg, san, wm	2
	Family - Capparaceae				
Rocky Mountain Bee Plant	*Cleome serrulata*	A-FORB	sept	san	0
	Family - Caprifoliaceae				
Wolfberry	*Symphoricarpos occidentalis*	SHRUB	late sept-oct	tg, mg	2
Coralberry	*Symphoricarpos orbiculatus*	SHRUB	late sept-oct	tg, southeastern NE	2
Horse-gentian	*Triosteum perfoliatum*	P-FORB	mid sept	tg	5
	Family - Caryophyllaceae				
Sleepy Catchfly	*Silene antirrhina*	A-FORB	mid june	tg, mg, wm	2
	Family - Chenopodiaceae				
Silver Orach	*Atriplex argentea*	A-FORB	aug-sept	sawet	4
Saltmarsh Spearscale	*Atriplex dioica* (*A. subspicata*)	A-FORB	aug-sept	sawet	5
Winged-pigweed	*Cycloloma atriplicifolium*	A-FORB	sept	san	2
Saltwort	*Salicornia rubra*	A-FORB	july-oct	sawet, collect dried stems	8
Sea Blite	*Suaeda calceoliformis* (*S. depressa*)	A-FORB	aug-oct	sawet, collect dried stems	5
	Family - Clusiaceae				
Canada St. John's Wort	*Hypericum majus*	A-FORB	mid sept	wm	6
	Family - Commelinaceae				
Long-bracted Spiderwort	*Tradescantia bracteata*	P-FORB	late june-early july	tg, mg, wm	5
Prairie Spiderwort	*Tradescantia occidentalis*	P-FORB	late june-mid july	san	5
	Family - Convallariaceae				
Starry False Solomon's Seal	*Smilacina stellata*	P-FORB	late june-july	tg, wm	4
	Family - Crassulaceae				
Ditch Stonecrop	*Penthorum sedoides*	P-FORB	mid sept	mar	4
	Family - Cyperaceae				
River Bulrush	*Bolboschoenus fluviatilis* (*Scirpus f.*)	P-SEDGE	mid july-sept	mar, may be aggresive especially in rbmar	3
Saltmarsh Bulrush	*Bolboschoenus maritimus* (*Scirpus m.*)	P-SEDGE	mid july-sept	mar, sawet, wear gloves	5
Golden Sedge	*Carex aurea*	P-SEDGE	mid june	wm, western Platte Valley	7
Bicknell's Sedge	*Carex bicknellii*	P-SEDGE	mid june	tg, wm	6
Common Wood Sedge	*Carex blanda*	P-SEDGE	mid june	wm	2

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Cyperaceae - continued				
Yellowfruit Sedge	*Carex brachyglossa* (*C. annectens*)	P-SEDGE	mid june	wm, far southeastern NE	7
Short-beak Sedge	*Carex brevior*	P-SEDGE	mid june	tg, mg, san, wm, rbwm	3
Bush's Sedge	*Carex bushii*	P-SEDGE	mid june	tg, far southeastern NE	6
Bearded Sedge	*Carex comosa*	P-SEDGE	mid june	mar	5
Crawe's Sedge	*Carex crawei*	P-SEDGE	mid june	wm, Platte and Loup valleys	6
Crested Sedge	*Carex cristatella*	P-SEDGE	july	wm	5
Davis' Sedge	*Carex davisii*	P-SEDGE	mid june	tg, wm, southeastern NE	4
Needleleaf Sedge	*Carex eleocharis*	P-SEDGE	mid june	mg, san, wm, central NE	1
Emory's Sedge	*Carex emoryi*	P-SEDGE	early june	wm, mar	5
Frank's Sedge	*Carex frankii*	P-SEDGE	june	wm, mar, far southeastern NE	7
Hale's Meadow Sedge	*Carex granularis*	P-SEDGE	mid june	wm	6
Heavy Sedge	*Carex gravida*	P-SEDGE	mid to late june	tg, mg, san, wm, rbwm, mar, rbmar	4
Sun Sedge	*Carex heliophila*	P-SEDGE	mid may	mg, san	5
Shoreline Sedge	*Carex hyalinolepis*	P-SEDGE	mid june	mar	7
Bottlebrush Sedge	*Carex hystericina*	P-SEDGE	july-aug	mar	5
Prairie Star Sedge	*Carex interior*	P-SEDGE	june	wm, northcentral NE	7
Ripgut Sedge	*Carex lacustris*	P-SEDGE	mid june	wm, northern NE	6
Smooth-cone Sedge	*Carex laeviconica*	P-SEDGE	mid june	wm, rbwm, mar, rbmar	4
Mead's Sedge	*Carex meadii*	P-SEDGE	mid june	tg,wm, eastern 1/4 of NE	6
Midland Sedge	*Carex mesochorea*	P-SEDGE	mid june	tg, wm, southeastern NE	1
Troublesome Sedge	*Carex molesta*	P-SEDGE	mid june	wm	3
Hall's Sedge	*Carex parryana* (*C. hallii*)	P-SEDGE	mid june	wm, central NE	6
Woolly Sedge	*Carex pellita* (*C. lanuginosa*)	P-SEDGE	early to mid june	wm, rbwm	4
Clustered Field Sedge	*Carex praegracilis*	P-SEDGE	early june	wm	4
Sartwell's Sedge	*Carex sartwellii*	P-SEDGE	early june	wm, eastern Platte Valley	6
Pointed Broom Sedge	*Carex scoparia*	P-SEDGE	mid to late june	wm, mar, Loup and Platte	5
Sawbeak Sedge	*Carex stipata*	P-SEDGE	mid june	wm, mar	5
Rigid Sedge	*Carex tetanica*	P-SEDGE	early june	wm, Platte and Loup valleys	7
Fox Sedge	*Carex vulpinoidea*	P-SEDGE	late june-july	wm, rbwm, mar	4
Umbrella Flatsedge	*Cyperus diandrus*	A-SEDGE	mid aug-early sept	wm, mar, wet sandy sites	5
Yellow Nutsedge	*Cyperus esculentus*	P-SEDGE	mid aug-sept	mar	0
Great Plains Flatsedge	*Cyperus lupulinus*	P-SEDGE	aug-sept	mg, san	1
Sand Flatsedge	*Cyperus schweinitzii*	P-SEDGE	late july-sept	san	4
Needle Spikerush	*Eleocharis acicularis*	P-SEDGE	june-sept	rbmar, mar	4
Bog Spikerush	*Eleocharis elliptica*	P-SEDGE	june	wm	7
Bald Spikerush	*Eleocharis erythropoda*	P-SEDGE	june	wm, mar	5
Blunt Spikerush	*Eleocharis obtusa*	A-SEDGE	june	rbwm, rbmar	3
Common Spikerush	*Eleocharis palustris* (*E.macrostachya*)	P-SEDGE	june	wm, rbwm, mar, rbmar	4
Hairy Fimbry	*Fimbristylis puberula*	P-SEDGE	aug	wm	7
Umbrella Grass	*Fuirena simplex*	A-SEDGE	mid sept	wm, mar	6
Hard-stem Bulrush	*Schoenoplectus acutus* (*Scirpus a.*)	P-SEDGE	july-aug	mar	5
Slender Bulrush	*Schoenoplectus heterochaetus* (*Scirpus h.*)	P-SEDGE	early july-aug	rbmar, mar	5
Three-square Bulrush	*Schoenoplectus pungens* (*Scirpus p.*)	P-SEDGE	late june-aug	wm, mar	4
Soft-stem Bulrush	*Schoenoplectus tabernaemontani* (*Scirpus validus*)	P-SEDGE	july-aug	mar	5
Dark Green Rush	*Scirpus atrovirens*	P-SEDGE	july-aug	wm, mar, southeastern NE	5
Pale Bulrush	*Scirpus pallidus*	P-SEDGE	mid aug	wm, mar	5
Rufous Bulrush	*Scirpus pendulus*	P-SEDGE	late june-july	wm	8
Tall Nut-rush	*Scleria triglomerata*	P-SEDGE	mid june	tg, wm, rare species	8
	Family - Eleagnaceae				
Buffaloberry	*Shepherdia argentea*	SHRUB	aug	san sandy river bottoms in central NE	4

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Family - Euphorbiaceae				
Texas Croton	*Croton texensis*	A-FORB	mid oct	san	1
Flowering Spurge	*Euphorbia corollata*	P-FORB	mid sept	tg	3
Snow-on-the-mountain	*Euphorbia marginata*	A-FORB	oct	mg, san, wm	0
	Family - Fabaceae				
Leadplant	*Amorpha canescens*	SHRUB	late aug-oct	tg, mg, san, wm	6
Canada Milkvetch	*Astragalus canadensis*	P-FORB	aug-oct	tg, mg, insects damage pods	5
Ground-plum	*Astragalus crassicarpus*	P-FORB	mid june-mid july	tg, mg, san	7
Missouri Milkvetch	*Astragalus missouriensis*	P-FORB	mid to late june	mg	6
White Wild Indigo	*Baptisia alba* (*B. lactea*)	P-FORB	mid july	tg, insects damage pods	6
Plains Wild Indigo	*Baptisia bracteata*	P-FORB	mid july-aug	tg	5
Partridge Pea	*Chamaecrista fasciculata* (*Cassia chamaecrista*)	A-FORB	aug-sept	tg, mg, san, wm	1
Rattlebox	*Crotalaria sagittalis*	A-FORB	july aug	tg, mg, drier loess hills	2
White Prairie-clover	*Dalea candida*	P-FORB	mid aug-sept	tg, mg, san	6
Hare's-foot Dalea	*Dalea leporina*	A-FORB	oct	mg,san, wm	3
Round-head Prairie-clover	*Dalea multiflora*	P-FORB	late july-sept	mg, tg, far southern NE	7
Purple Prairie-clover	*Dalea purpurea*	P-FORB	mid aug-sept	tg, mg, san	6
Silky Prairie-clover	*Dalea villosa*	P-FORB	mid aug-sept	san	5
Illinois Bundleflower	*Desmanthus illinoensis*	P-FORB	aug-oct	tg, wm	5
Canada Tick-clover	*Desmodium canadense*	P-FORB	aug-sept	tg, mg, wm	5
Hoary Tick-clover	*Desmodium canescens*	P-FORB	sept	tg, mg, wm	5
Illinois Tick-clover	*Desmodium illinoense*	P-FORB	aug-sept	tg, mg, wm	6
Panicled Tick-clover	*Desmodium paniculatum*	P-FORB	sept	tg, wm	5
Wild Licorice	*Glycyrrhiza lepidota*	P-FORB	july-oct	tg, mg, san, wm	4
Showy Vetchling	*Lathyrus polymorphus*	P-FORB	mid july	mg, san	5
Round-head Bush-Clover	*Lespedeza capitata*	P-FORB	sept-oct	tg, mg, san	5
Prairie Trefoil	*Lotus unifoliolatus* (*L. purshianus*)	A-FORB	mid aug-mid sept	tg, mg, san	3
Sensitive Brier	*Mimosa quadrivalvis* (*Schrankia nuttallii*)	P-FORB	sept-oct	tg, mg, san	6
Purple Locoweed	*Oxytropis lambertii*	P-FORB	late june	mg	6
Silver-leaf Scurf Pea	*Pediomelum argophyllum* (*Psoralea a.*)	P-FORB	mid july-aug	tg, mg, san	6
Prairie Turnip	*Pediomelum esculentum* (*Psoralea e.*)	P-FORB	early to mid july	tg, mg	7
Lemon Scurf Pea	*Psoralidium lanceolatum* (*Psoralea l.*)	P-FORB	mid july	san	4
Slender-flower Scurfpea	*Psoralidium tenuiflorum* (*Psoralea tenuiflora*)	P-FORB	late june	tg, mg	5
Wild Senna	*Senna marilandica* (*Cassia marilandica*)	P-FORB	sept	tg, southeastern NE	5
Slick-seed Wild Bean	*Strophostyles leiosperma*	A-VINE	aug-sept	tg, mg	4
American Vetch	*Vicia americana*	P-FORB	june-july	tg, mg	6
	Family - Gentianaceae				
Prairie Gentian	*Eustoma grandiflorum*	A-FORB	sept	wm, central Platte Valley	4
Bottle Gentian	*Gentiana andrewsii*	P-FORB	late sept-oct	wm, rare species	9
Downy Gentian	*Gentiana puberulenta*	P-FORB	mid to late oct	tg, mg	7
	Family - Hypoxidaceae				
Yellow Star Grass	*Hypoxis hirsuta*	P-FORB	early june	wm	7
	Family - Iridaceae				
Prairie Blue-eyed Grass	*Sisyrinchium campestre*	P-FORB	june	tg, mg	4
Meadow Blue-eyed Grass	*Sisyrinchium montanum*	P-FORB	june	wm	5

Common Name	Species	Plant Type	Collection Date	Habitats	C
Family - Juncaceae					
Baltic Rush	*Juncus arcticus* (*J. balticus*)	P-FORB	june	wm, capsules lose seed soon after ripening	6
Short-leaf Rush	*Juncus brachyphyllus*	P-FORB	mid to late june	san	6
Toad Rush	*Juncus bufonius*	A-FORB	mid june	mar, prefers sandy flats	4
Dudley's Rush	*Juncus dudleyi*	P-FORB	june	wm, rbwm	5
Inland Rush	*Juncus interior*	P-FORB	mid june	tg, mg, wm	4
Path Rush	*Juncus tenuis*	P-FORB	late june	wm	2
Torrey's Rush	*Juncus torreyi*	P-FORB	late june-early aug	wm	4
Family - Juncaginaceae					
Alkali Arrowgrass	*Triglochin maritima*	P-FORB	mid june	wm, alkaline soils	5
Family - Lamiaceae					
Rough False-pennyroyal	*Hedeoma hispida*	A-FORB	july	tg, mg, san	1
Common Water Horehound	*Lycopus americanus*	P-FORB	late july-mid sept	wm, mar	4
Western Water Horehound	*Lycopus asper*	P-FORB	sept	wm, mar	5
Field Mint	*Mentha arvensis*	P-FORB	aug-oct	wm	4
Wild Bergamot	*Monarda fistulosa*	P-FORB	mid aug-sept	tg, mg	3
Obedient Plant	*Physostegia virginiana*	P-FORB	late aug-sept	wm	7
Self-heal	*Prunella vulgaris*	P-FORB	late june-mid july	wm	4
Virginia Mountain-mint	*Pycnanthemum virginianum*	P-FORB	mid aug-sept	wm	6
Pitcher's Sage	*Salvia azurea*	P-FORB	aug-oct	tg, southeast NE	6
Marsh Skullcap	*Scutellaria galericulata*	P-FORB	late aug-sept	wm, mar	6
Mad-dog Skullcap	*Scutellaria lateriflora*	P-FORB	late aug-sept	mar	5
Small Skullcap	*Scutellaria parvula*	P-FORB	early july-sept	tg, wm	6
Common Hedge Nettle	*Stachys pilosa* (*S. palustris*)	P-FORB	early aug-sept	wm, mar	5
American Germander	*Teucrium canadense*	P-FORB	mid aug-mid sept	tg, wm, rbwm	4
Family - Liliaceae					
Prairie Dog-toothed Violet	*Erythronium mesochoreum*	P-FORB	mid to late may	tg, wm, southeastern NE	6
Family - Linaceae					
Grooved Yellow Flax	*Linum sulcatum*	A-FORB	late june	mg, san	6
Family - Lythraceae					
Intermediate Toothcup	*Ammannia coccinea*	A-FORB	early sept	mar, rbmar	4
Winged Loosestrife	*Lythrum alatum*	P-FORB	sept	wm	6
Family - Malvaceae					
Pale Poppy Mallow	*Callirhoe alcaeoides*	P-FORB	july	tg, mg, san	5
Purple Poppy Mallow	*Callirhoe involucrata*	P-FORB	july-aug	tg, mg, san	2
Halberd-leaved Rose Mallow	*Hibiscus laevis*	P-FORB	aug-sept	mar	4
Scarlet Globe-mallow	*Sphaeralcea coccinea*	P-FORB	june-aug	mg	4
Family - Myrsinaceae					
Fringed Yellow-loosestrife	*Lysimachia ciliata*	P-FORB	sept-oct	tg, wm	5
Tufted Yellow-loosestrife	*Lysimachia thyrsiflora*	P-FORB	july-early aug	wm, mar	7

Common Name	Species	Plant Type	Collection Date	Habitats	C
Family - Nyctaginaceae					
Pale Four-o'clock	*Mirabilis albida* (including *M. hirsuta*)	P-FORB	mid july-aug	san	5
Narrow-leaf Four-o'clock	*Mirabilis linearis*	P-FORB	mid july-aug	tg, mg, san	4
Wild Four-o'clock	*Mirabilis nyctaginea*	P-FORB	sept	tg, mg, san	1
Family - Onagraceae					
Plains Yellow-primrose	*Calylophus serrulatus*	P-FORB	july-early aug	tg,mg, san	5
Cinnamon Willow Herb	*Epilobium coloratum*	P-FORB	mid sept	wm, rbwm, mar, rbmar	5
Fen Willow Herb	*Epilobium leptophyllum*	P-FORB	late aug-sept	mar	7
Scarlet Gaura	*Gaura coccinea*	P-FORB	july-aug	mg	4
Long-flower Butterfly Plant	*Gaura longiflora*	B-FORB	mid sept	tg, southeastern NE	3
Small-flowered Gaura	*Gaura mollis* (*G. parviflora*)	A-FORB	aug-sept	tg, wm	1
Water Purslane	*Ludwigia palustris*	P-FORB	mid sept	mar	5
Cutleaf Evening-primrose	*Oenothera lacianata*	A-FORB	sept	san	1
Pale Evening-primrose	*Oenothera latifolia*	P-FORB	aug-sept	san	4
Fourpoint Evening-primrose	*Oenothera rhombipetala*	B-FORB	mid aug-oct	san	2
Common Evening Primrose	*Oenothera villosa*	B-FORB	early sept	tg, mg	1
Family - Orchidaceae					
Nodding Ladies'-tresses	*Spiranthes cernua*	P-FORB	oct	tg, wm	6
Early Ladies'-tresses	*Spiranthes vernalis*	P-FORB	oct	tg	8
Family - Oxalidaceae					
Upright Yellow Wood Sorrel	*Oxalis stricta* (*O. dillenii*)	P-FORB	early june	tg, mg, capsules explode	0
Violet Wood Sorrel	*Oxalis violacea*	P-FORB	early june	tg, mg, capsules explode	5
Family - Plantaginaceae					
Woolly Plantain	*Plantago patagonica*	A-FORB	late june-july	mg, san	1
Family - Poaceae					
Ticklegrass	*Agrostis hyemalis*	P-GRASS	mid may-june	rbwm	4
Short-awn Meadow-foxtail	*Alopecurus aequalis*	P-GRASS	june	wm, rbwm, mar, rbmar	6
Big Bluestem	*Andropogon gerardii*	P-GRASS	mid sept-oct	tg, mg, wm	5
Sand Bluestem	*Andropogon hallii*	P-GRASS	mid sept-oct	san	5
Prairie Three-awn	*Aristida oligantha*	A-GRASS	sept	tg	2
Purple Three-awn	*Aristida purpurea*	P-GRASS	sept	mg, san	5
Side-oats Grama	*Bouteloua curtipendula*	P-GRASS	mid aug-sept	tg, mg, san	5
Blue Grama	*Bouteloua gracilis*	P-GRASS	sept-oct	tg, mg, san	4
Hairy Grama	*Bouteloua hirsuta*	P-GRASS	sept-oct	san	6
Blue Joint	*Calamagrostis canadensis*	P-GRASS	july	wm	6
Northern Reedgrass	*Calamagrostis stricta*	P-GRASS	mid june-mid july	wm	6
Prairie Sand Reed	*Calamovilfa longifolia*	P-GRASS	sept-oct	san	5
Inland Saltgrass	*Distichlis spicata* var. *stricta*	P-GRASS	early july	sawet	2
Canada Wildrye	*Elymus canadensis*	P-GRASS	early sept-oct	tg, wm	5
Western Wheatgrass	*Elymus smithii* (*Agropyron s.*)	P-GRASS	mid july-sept	tg, mg, wm, rbwm, sawet	3
Slender Wheatgrass	*Elymus trachycaulus* (*Agropyron caninum*)	P-GRASS	early to mid july	wm	7
Virginia Wildrye	*Elymus virginicus*	P-GRASS	early sept-oct	wm, rbwm	4
Purple Lovegrass	*Eragrostis spectabilis*	P-GRASS	late aug-sept	tg, mg, san	3
Sand Lovegrass	*Eragrostis trichodes*	P-GRASS	late sept-oct	san	5
Six-weeks Fescue	*Festuca octoflora*	A-GRASS	mid june	mg, san	3
Tall Manna Grass	*Glyceria grandis*	P-GRASS	late june-early july	wm, mar	7
Fowl Manna Grass	*Glyceria striata*	P-GRASS	early june	wm, mar	5

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Poaceae - continued				
Needle-and-thread	*Hesperostipa comata* (*Stipa c.*)	P-GRASS	mid june	mg, san, cut awns soon	6
Porcupine Grass	*Hesperostipa spartea* (*Stipa s.*)	P-GRASS	mid june	tg, mg, san, cut awns soon	6
Foxtail Barley	*Hordeum jubatum*	P-GRASS	early july	wm, rbwm, sawet	1
Junegrass	*Koeleria macrantha* (*K. pyramidata*)	P-GRASS	late june-aug	tg, mg, san	6
Rice Cutgrass	*Leersia oryzoides*	P-GRASS	mid sept	wm, rbwm, mar, rbmar	4
Plains Muhly	*Muhlenbergia cuspidata*	P-GRASS	aug-sept	tg, mg, drier tallgrass sites	5
Sand Muhly	*Muhlenbergia pungens*	P-GRASS	aug-sept	san	6
Marsh Muhly	*Muhlenbergia racemosa*	P-GRASS	sept	tg, mg	4
Green Needlegrass	*Nassella viridula* (*Stipa v.*)	P-GRASS	mid june	tg, mg, northern NE	4
Tapered Spring Panicum	*Panicum acuminatum*	P-GRASS	june	wm	6
Slim-leaf Spring Panicum	*Panicum linearifolium* (*Dichanthelium l.*)	P-GRASS	june	tg	7
Scribner's Spring Panicum	*Panicum oligosanthes*	P-GRASS	mid june	tg, mg, san	4
Switchgrass	*Panicum virgatum*	P-GRASS	mid to late sept	tg, mg, san, wm, rbwm	4
Slender Paspalum	*Paspalum setaceum*	A-GRASS	early july-mid aug	san	2
Plains Bluegrass	*Poa arida*	P-GRASS	early july	rbwm, sawet	6
Little Bluestem	*Schizachyrium scoparium*	P-GRASS	late sept	tg, mg, san, wm	4
Indiangrass	*Sorghastrum nutans*	P-GRASS	mid sept-late sept	tg, mg, wm	5
Prairie Cordgrass	*Spartina pectinata*	P-GRASS	sept-oct	wm, rbwm, sawet	5
Prairie Wedgegrass	*Sphenopholis obtusata*	P-GRASS	late june-early july	tg, wm	5
Tall Dropseed	*Sporobolus compositus* (*S. asper*)	P-GRASS	mid sept-oct	tg, mg, san	3
Sand Dropseed	*Sporobolus cryptandrus*	P-GRASS	late aug-sept	san	2
Prairie Dropseed	*Sporobolus heterolepis*	P-GRASS	mid sept	tg	7
False Redtop	*Tridens flavus*	P-GRASS	mid sept-oct	tg, wm, southeastern NE	1
Eastern Gammagrass	*Tripsacum dactyloides*	P-GRASS	mid july	tg, wm, far southeastern NE	7
	Family - Polemoniaceae				
Prairie Phlox	*Phlox pilosa* ssp. *fulgida*	P-FORB	early july	tg	8
	Family - Polygalaceae				
Pink Milkwort	*Polygala sanguinea*	A-FORB	aug-sept	wm, sandy soils	6
White Milkwort	*Polyglala alba*	P-FORB	july-aug	mg	5
	Family - Polygonaceae				
Annual Wild Buckwheat	*Eriogonum annuum*	B-FORB	mid sept-oct	san	3
Swamp Smartweed	*Polygonum coccineum*	P-FORB	july-sept	mar, rbmar, in seed bank	3
Mild Water Pepper	*Polygonum hydropiperoides*	P-FORB	july-sept	mar, rbmar, in seed bank	4
Nodding Smartweed	*Polygonum lapathifolium*	A-FORB	july-sept	mar, rbmar, in seed bank	2
Dotted Smartweed	*Polygonum punctatum*	P-FORB	july-sept	mar, rbmar, in seed bank	4
Wild Begonia	*Rumex venosus*	P-FORB	early to mid june	san	4
	Family - Portulacaceae				
Prairie Fameflower	*Talinum parviflorum*	P-FORB	late june-early july	san	5
Sandhills Fameflower	*Talinum rugospermum*	P-FORB	late june-early july	san	7
	Family - Primulaceae				
Western Rock Jasmine	*Androsace occidentalis*	A-FORB	june	tg,mg,san, likely to establish on its own	1
	Family - Ranunculaceae				
Meadow Anemone	*Anemone canadensis*	P-FORB	mid july	tg, wm	4

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Ranunculaceae - continued				
Carolina Anemone	*Anemone caroliniana*	P-FORB	may	tg, mg, san	7
Candle Anemone	*Anemone cylindrica*	P-FORB	mid july-mid aug	tg, mg, san	4
Pascue flower	*Anemone patens*	P-FORB	may	tg, mg, northern NE	6
Prairie Larkspur	*Delphinium carolinianum* (*D. virescens*)	P-FORB	late june-early july	tg, mg, san	6
Longbeak White Crow's-foot	*Ranunculus longirostris*	P-FORB	june-aug	mar	6
Pennslyvania Buttercup	*Ranunculus pensylvanicus*	A-FORB	july-aug	wm, mar	6
Purple Meadow Rue	*Thalictrum dasycarpum*	P-FORB	mid july-mid aug	tg, wm	4
	Family - Rhamnaceae				
Broadleaf New Jersey Tea	*Ceanothus americanus*	SHRUB	late july-early aug	tg	6
Redroot New Jersey Tea	*Ceanothus herbaceus*	SHRUB	mid june-early july	tg, mg, san	6
	Family - Rosaceae				
Swamp Agrimony	*Agrimonia parviflora*	P-FORB	mid-late sept	wm	5
Woodland Agrimony	*Agrimonia striata*	P-FORB	mid aug	wm	6
Yellow Avens	*Geum aleppicum*	P-FORB	sept	wm	6
White Avens	*Geum canadense*	P-FORB	mid aug-oct	tg, wm	3
Spring Avens	*Geum vernum*	P-FORB	mid aug-oct	wm	5
Prairie Cinquefoil	*Potentilla arguta*	P-FORB	mid july	tg, mg, san, wm	6
Norwegian Cinquefoil	*Potentilla norvegica*	P-FORB	late june-july	wm, rbwm	2
Sand Cherry	*Prunus pumila*	SHRUB	early july	san	6
Dwarf Prairie Rose	*Rosa arkansana*	SHRUB	aug-nov	tg, mg, san	4
Western Wild Rose	*Rosa woodsii*	SHRUB	aug-sept	tg, wm, woodland edge	4
	Family - Rubiaceae				
Buttonbush	*Cephalanthus occidentalis*	SHRUB	sept-oct	wm, mar, far southeastern NE	7
Bluntleaf Bedstraw	*Galium obtusum*	P-FORB	late july	wm	6
	Family - Santalaceae				
Bastard Toadflax	*Comandra umbellata*	P-FORB	early june	tg, mg, san	6
	Family - Scrophulariaceae				
Rough False Foxglove	*Agalinis aspera*	A-FORB	early sept	tg, mg	10
Slender False Foxglove	*Agalinis tenuifolia*	A-FORB	early sept	wm, mar	5
Mullein Foxglove	*Dasistoma macrophylla*	A-FORB	aug-sept	tg, southeastern woody edge	6
Round-leaf Monkey Flower	*Mimulus glabratus*	P-FORB	aug-sept	mar, mudflats and seeps	7
Alleghany Monkey Flower	*Mimulus ringens*	P-FORB	sept	mar	6
White Beardtongue	*Penstemon albidus*	P-FORB	mid aug	mg, san	6
Narrow Beardtongue	*Penstemon angustifolius*	P-FORB	mid aug	san	5
Foxglove Penstemon	*Penstemon digitalis*	P-FORB	mid aug-sept	tg, wm	6
Slender Beardtongue	*Penstemon gracilis*	P-FORB	late july-aug	tg, mg, san	6
Shell-leaf Penstemon	*Penstemon grandiflorus*	P-FORB	late july-aug	tg, mg, san	5
Culver's Root	*Veronicastrum virginicum*	P-FORB	late aug	tg, wm, far eastern NE	9
	Family - Solanaceae				
Clammy Ground Cherry	*Physalis heterophylla*	P-FORB	late aug-sept	san	4
Virginia Ground Cherry	*Physalis virginiana*	P-FORB	sept-oct	tg, mg	6
Carolina Horse-nettle	*Solanum carolinense*	P-FORB	oct	tg, mg	2

Common Name	Species	Plant Type	Collection Date	Habitats	C
	Family - Sparganiaceae				
Large-fruit Bur-reed	*Sparganium eurycarpum*	P-FORB	aug	mar, rbmar	5
	Family - Urticaceae				
False Nettle	*Boehmeria cylindrica*	P-FORB	late sept	wm, mar	6
	Family - Verbenaceae				
Wedgeleaf fog-fruit	*Phyla cuneifolia* (*Lippia cuneifolia*)	P-FORB	mid sept	rbwm, rbmar	4
Northern fog-fruit	*Phyla lanceolata* (*Lippia lanceolata*)	P-FORB	mid sept	wm, mar	3
Blue Vervain	*Verbena hastata*	P-FORB	late sept	wm, mar	4
Hoary Vervain	*Verbena stricta*	P-FORB	later aug-sept	tg, mg, san	2
White Vervain	*Verbena urticifolia*	P-FORB	mid sept	tg, wm	3
	Family - Violaceae				
Prairie Violet	*Viola pedatifida*	P-FORB	mid june-aug	tg, mg	6
Blue Meadow Violet	*Viola pratincola*	P-FORB	mid june-aug	wm	1

Prairie Plains Resource Institute's Four Major Projects:

1 Prairie Restoration

PPRI has been a pioneer of high-diversity prairie and wetland restoration since 1980. Restorations harbor both an abundance and diversity of plant and animal life, and are also a sustainable agricultural resource.

2 Prairie Preserves

PPRI presently owns seven prairie preserves, totaling more than 5200 acres, a solid foundation on which to build an ever-expanding "network of campuses."

3 Education/ SOAR.

All PPRI preserves and many of its restoration projects are educational sites suitable for lifelong learning.

SOAR - The program which best exemplifies PPRI's educational efforts is SOAR (Summer Orientation About Rivers), an annual nature day camp for elementary school children.

Science and resource stewardship - PPRI sites offer educational and work opportunities in many aspects of natural resource management.

4 Platte River Corridor Initiative

The goal of the Platte River Corridor Initiative is to establish a conservation process founded on public participation and local initiative. Its aims include:

- Restoring and protecting the Platte River's native prairies.
- Educating citizens about the Platte's ecosystem.
- Planning with local working groups; assisting people in defining and solving their natural resource issues.

Contribute to the mission of Prairie Plains Resource Institute by becoming a member. Members receive the *Prairie Plains Quarterly* and gain opportunities to participate in unique educational, recreational and volunteer activities in diverse Nebraska landscapes. PPRI is a 501(c)(3) organization. Contributions are tax-deductible to the extent allowed by law.

Membership Categories:

$25 Individual
$35 Family
$50-99 Supporting
$100-499 Contributing
$500-999 Patron
$1000+ Benefactor

1307 L STREET AURORA NE 68818-2126
Phone: (402) 694-5535 cellular (402) 694-9847
ppri@hamilton.net prairieplains.org