Attachment 1

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations

City of White Bear Lake, Ramsey County, Minnesota

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USING ECOLOGY TO RESTORE LAND AND WATER
NATURAL SHORE

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I. INTRODUCTION

The Vadnais Lake Area Water Management Organization (VLAWMO) retained the services of Natural Shore Technologies to classify plant community types and to provide management recommendations for the wetland system located in the Rotary Nature Preserve, White Bear Lake. This Preserve is a 36 acre city park located north of Birch Lake, between Birch Lake Boulevard North and White Bear Parkway (Appendix A, Figure 1). Collectively through a strong partnership, the City of White Bear Lake, VLAWMO, and Rotary Club volunteers have done an excellent job in restoring and maintaining the Preserve's natural resources and infrastructure.

This Preserve has a rich history and is a local destination for walkers, hikers, birders, and other outdoor enthusiasts. Popular trails and a boardwalk over the wetland provide easy access to plant and wildlife viewing. A link to naturalist observations can be found here: iNaturalist. A log pavilion is also available for neighborhood gatherings. In 2022, White Bear Lake began an effort to remove invasive woody plant species and restore wetland buffers on the eastern portion of the system adjacent to the walking path (White Bear Lake Plan). This wetland study will build on and complement these restoration efforts, providing guidance on how to effectively preserve and enhance the native plant communities that are present in this unique ecological system.

Fieldwork to conduct wetland plant community assessments took place on three separate occasions between May and October, 2023. The main goal of this effort was to characterize and map existing plant community types throughout the wetland complex. A global positioning system (GPS) was used to delineate distinct vegetation types, and then later, these data sets were compiled to generate maps that clearly describe and georeference the vegetation found in the Rotary Nature Preserve wetland. In addition to defining various native plant communities, emphasis was placed on assessing the distribution of three invasive wetland plant species: reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), and narrowleaf and hybrid cattail (*Typha angustifolia* and *Typha X glauca*).

This study lays out management recommendations for practitioners to use in preserving and improving the plant community types within Rotary Nature Preserve wetland. Specific areas within the wetland are prioritized for management. Key restoration approaches are presented for individual plant community types. Revegetation methods are discussed. Management recommendations are given for the most problematic invasive weed species. Together, this information can be used to improve the ecological quality of the Rotary Nature Preserve wetland ecosystem. These efforts will create exceptional wildlife habitat, but they will also substantially contribute to the enjoyment experienced by the residents that visit this unique park.

II. NATURAL HISTORY/BACKGROUND

Early Inhabitants

The first inhabitants of the White Bear Lake region were the Dakota and Ojibwe Native Americans, who used the land for migratory hunting and harvesting. In an 1825 treaty, the United States government designated the area as Dakota land, but later purchased all Dakota territory east of the Mississippi to open it for European-American settlement.

Pioneering the White Bear Lake region, Joseph and Sarah Freeman, English immigrants arriving in 1853, played a significant role in the area's early settlement. In 1855, additional members of the Freeman family, including Joseph's brother William Freeman, also immigrated to Ramsey County from England. Acquiring expansive farmland, the Freeman family established residences in the vicinity of Birch Lake, adjacent to White Bear Lake. One of the historic family homes became the residence for William Freeman, his wife, and children. As illustrated in Appendix A, Figure 2, William Freeman held property to the north of Birch Lake, encompassing the present Rotary Nature Preserve area.

Historical Public Land Survey

NST conducted a review of the natural history in and around the Rotary Nature Preserve. Notably, Marschner's Map (refer to Appendix A, Figure 3; MN DNR) proved instrumental in reconstructing the presettlement vegetation of the area. Developed by Francis J. Marschner, this map originated from the interpretation and compilation of original vegetation notes spanning the years 1847-1907, documented by land surveyors. These notes detailed the dimensions and species of prominent trees used as bearing trees, accompanied by general descriptions of the physical geography encountered during the surveys. Over time, Marschner's Map has undergone digitization and updates for a more accurate representation of presettlement vegetation. According to Marschner's Map, the land within the Rotary Nature Preserve was historically classified as Oak Openings and Barrens. Adjacent areas, including Wet Prairie and Big Woods - Hardwoods (oak, maple, basswood, hickory), were also identified through the mapping process.

Ecological Land Classification

In 1993, the MN DNR and the US Forest Service developed an ecological classification system for ecological mapping and landscape classification (MN DNR). Ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The system uses associations of biotic and environmental factors,

including climate, geology, topography, soils, hydrology, and vegetation and builds upon the natural history information contained in Marschner's Map.

Rotary Nature Preserve is located within the Eastern Broadleaf Forest province, the Minnesota and NE Iowa Morainal section, and the St. Paul-Baldwin Plains and Moraines subsection. Detailed information regarding these classifications can be found in Appendix B.

Ramsey County Soil Survey

According to the Ramsey County Soil Survey, a variety of upland and wetland soil types have been mapped within the Rotary Nature Preserve property boundary (Appendix A, Figure 4). Soils located within wetland portions of the site are lacustrine soils and are composed of hydric soils including poorly drained Bluffton loam, Dundas loam and saturated Aquolls and Histosols (Ramsey County). The surrounding upland and islands consist of well drained Hayden and Nessel series soils. Appendix C contains descriptions of the soil types.

National Wetland Inventory

The National Wetland Inventory was established to conduct a nationwide inventory of wetlands to provide biologists and others with information on the distribution and type of wetlands to aid in conservation efforts. A classification system was developed to differentiate distribution and type of wetlands (U.S. Fish & Wildlife). The wetland classification codes correspond to various wetland site characteristics. All of the wetlands within the Preserve are freshwater emergent wetlands varying only by their water regime. See Appendix A, Figure 5 for the wetland inventory map of Rotary Nature Preserve, as well as Appendix D for descriptions of the various wetland types.

Review of Aerial Photography

Prior to conducting field work, NST staff reviewed available historic aerial photographs in order to gain an understanding of how the site has changed over the past seventy-five years. NST staff reviewed historic aerial photographs available between 1940 and 2022. Below is a general summary of the observations. Appendix A, Figure 6 contains several representative aerial photographs from this timeline (Ramsey County).

1940: The Rotary Nature Preserve property, both wetland and upland, is clearly identifiable in the 1940 aerial photograph. There is clear evidence of ditching and drainage within the center wetland portion of the property. The site appears relatively dry with very little visual evidence of standing surface water. The upland and drier regions mostly bordering the east and west edges of the property are in agriculture, most likely hay or small grains. There appears to be a farmstead west of the current park property. The present oak woodland in the northwest corner

of the property is clearly visible and is the only substantial woodland cover. Birch Lake Boulevard is the only road near the site.

1953: Little had changed within the Rotary Nature Preserve boundaries. The large wetland complex remained fully vegetated with primarily herbaceous plant cover. Only a small area of open water was observed in the southern border area near the lake outlet. The surrounding uplands remained in agricultural production.

1974: Agriculture and farming practices changed drastically between 1953 and 1974. Past crop fields appear to be fallow or possibly in hay fields. Evergreen tree rows were planted near the west center of the property and increased shrub and tree cover is evident at the wetland margins. The farmstead to the west was removed or destroyed. Extensive ditching and excavation work is evident on the northwest boundary near the position of the current White Bear Parkway alignment. The wetland complex seems to have a higher water elevation during the time of the photo. Increased development within the watershed is evident with the addition of single family homes around Birch Lake.

1985: Many changes occurred in this area since the last available photo in 1974. Many adjacent properties were sold and developed for single family homes. Agriculture is no longer evident. White Bear Parkway was constructed and hiking trails are evident on both the west and east sides of the site. Although the ditch system remained throughout the wetland, there is still evidence of pools of standing water and extensive herbaceous wetland plant cover. The woodland canopy cover has expanded.

1991: There was increased watershed development between 1985 and 1991. A commercial building project increased impervious surfaces on both northeast and southwest of the surrounding area. The Rotary Nature Preserve parking lot was evident. Wetland surface water was evident and a ditch connection to the wetland on the western property border (Golden Pond).

2003: Continued watershed development is evident with the addition of a large housing development and road (Golden Pond Lane) on the western boundary of the property. Development on the parkland is evident: restroom facility, log building and trail system. Amur maple shrubs along the north and east portions of the property are discernible, along with a signature of purple loosestrife within the wetland.

2011: Upland and wetland boundaries are stable with little change. Wetland vegetation composition was favoring wetter species (e.g., cattail). Increased woody plant cover is evident in the upland areas with considerable growth of amur maple. A boardwalk was installed in the middle of the property to connect the east and west trails. The center upland park area appears consistent with a mesic prairie signature.

2019: Few changes appear within the upland and wetland boundaries. Upland woody vegetation continues to expand with the addition of planted tamarack trees and the invasion of

common buckthorn. Wetland surface water continues to be apparent with pockets of open water throughout the entire main wetland complex.

2023: The expansion of amur maple throughout the north and eastern sections of the property is clearly evident. Water levels appear low with many exposed mudflat areas. Numerous wildlife trails zigzag through the wetland vegetation.

Elevation Base Map

The elevation within Rotary Nature Preserve ranges from 918' in the lowest parts of the wetland, to 934' on the eastern edge where the pavilion is located (Appendix A, Figure 7; Ramsey County). Road building and wetland ditching were likely the most substantial disturbances affecting land elevations within Rotary Nature Preserve. Although ditching in the wetland was evident in the aerial imagery, these elevation changes did not appear in the elevation base map.

Hydrology

Appendix A, Figure 8 details inlet and outlet pipes for the Rotary Park wetland. This current investigation primarily focused on wetland vegetation classification and management recommendations, and did not assess the hydrology of the wetland system. However, the critical importance of hydrology is acknowledged in shaping and maintaining wetland ecosystems. Watershed inputs play a significant role in influencing wetland plant communities, and effective stormwater management is imperative for sustaining the health and resilience of this wetland system. For instance, VLAWMO's efforts in assessing the feasibility of watershed best management practices being implemented along Birch Lake Boulevard, just to the south of the Rotary Park wetland, is a critical measure that works towards preserving the ecological integrity of this system. Also, routine maintenance of inlet and outlet pipes is important in sustaining favorable wetland hydrology.

III. METHODS

Plant Surveys

Natural Shore staff conducted plant surveys of the Rotary Nature Preserve wetland during May-October, 2023. The main goal was to identify and map wetland plant cover types. During these field surveys, ecologists completed a meander type survey throughout the project area, collecting data on native and invasive plant species cover, vegetation cover type, and various site characteristics. A GPS unit was used to map the boundaries of identified plant community

types. When possible, the MNDNR's Field Guide to Native Plant Communities of Minnesota Eastern Broadleaf Forest Province (MN DNR 2005) was used to classify native plant cover types. One additional sedge meadow sub-type was formulated in order to better describe a unique native cover type within the wetland. In addition, three wetland cover types were formulated that describe the presence and abundance of the most common invasive non-native species in the wetland. Although classifying wetland plant communities was the main focus of the survey, upland plant communities were also identified within Rotary Park.

Restoration Prioritization and Management

As plant community types were identified and mapped in the field, ecologists assessed the restoration potential of each area, keeping notes on characteristics that would help in formulating management recommendations. Special emphasis was placed on invasive species abundance within stands dominated by native plants. The perceived difficulty in conducting various management tasks (e.g., mechanical and chemical control) associated with the identified plant communities was also assessed by experienced restoration ecologists in the field. Proximity to pathways and view angles in relation to the location of native plant cover types were also noted in the assessments.

IV. RESULTS

The 36 acre nature preserve was surveyed and eleven unique plant cover types were identified: seven wetland and four upland communities. The entire site was then mapped to determine the distribution of these cover types (Appendix A, Figure 9). Six communities were identified using MN DNR's native plant community classifications. Descriptive cover types were formulated for the five remaining areas that did not fit within the native plant community classifications. Appendix F contains the MN DNR's detailed information on each native plant community. Table 1 provides a breakdown of plant community type by area.

Plant Community Areas	SF	Acre
WMn82b1 - Sedge Meadow Bluejoint Subtype	24,178	0.6
WMn82b2 - Sedge Meadow Lake Sedge Subtype	31,993	0.7
WMn82b5 - Sedge Meadow Woolgrass Subtype	24,517	0.6
MRn93 - Northern Bulrush-spike Rush Marsh	43,998	1.0
RCG Meadow	173,290	4.0
RCG/PL Meadow	158,114	3.6
RCG/PL/CT Meadow	436,919	10.0
WFs55 - Southern Wet Aspen Forest	79,529	1.8
WFs55 - Southern Dry-mesic Oak (maple) Woodland	206,015	4.7
AMW - Amur Maple Woodland	226,445	5.2
UPs23 - Southern Mesic Prairie	55,280	1.3
Existing Restoration Areas	22,593	0.5
Total:	**1,482,871**	**34.0**

Table 1. Breakdown of plant community types by area.

Wetland Plant Communities

The predominant native wetland community found throughout the 20.5 acre wetland is Sedge Meadow (WMn82b). The WMn82b community type is a subset of the Northern Wet Meadow/Carr classification (WMn82) and contains four subtypes that describe the dominant graminoid species. Within these areas, two of the four subtypes were found to be dominated by either Canada bluejoint (*Calamagrostis canadensis*) or lake sedge (*Carex lacustris*). A third sedge meadow subtype was developed to describe a unique sedge meadow dominated by woolgrass (*Scirpus cyperinus*). This cover type exhibited similar features to the other sedge meadows, however Canada bluejoint (*Calamagrostis canadensis*) and lake sedge (*Carex lacustris*) were relatively minor components.

> **WMn82b - Sedge Meadow:** Open wetlands with abundant broad-leaved graminoids, and shrub cover typically <25%. The invasive species common reed grass *(Phragmites australis)* and reed canary grass *(Phalaris arundinacea)* have become increasingly abundant in this community type over the past several decades. WMn82b is divided into four subtypes, based on dominant graminoid species. Only the subtypes found at Rotary Nature Preserve are included below.
>
> **WMn82b1 - Bluejoint (*Calamagrostis canadensis)* Subtype (0.6 ac)**
> **Mn82b4 - Lake Sedge (*Carex lacustris or Carex spp.)* Subtype (0.7 ac)**
> **WMn82b5 - Woolgrass (*Scirpus cyperinus)* Subtype (0.6 ac)**

Deeper pockets (< 918’ elevation) within the sedges meadows that tend to have standing water during normal precipitation years, supported emergent vegetation and were categorized by Northern Bulrush/Spike Rush Marshes (MRn93).

> **MRn93 - Northern Bulrush/Spike Rush Marsh (1.0 ac):** Emergent marsh communities where standing water is present most of the year, providing conditions favorable to hydrophytic plants. These areas are typically dominated by bulrushes or spike-rushes. Submersed aquatic vegetation may also be present. Small patches of native broad-leaved cattail (*Typha latifolia*) were also observed.

The main ecological threat to the Rotary Park wetland is the widespread distribution of invasive species, specifically reed canary grass, purple loosestrife, and narrowleaf and hybrid cattail. Combined, the three invasive species dominated 17.6 acres or 86% of the wetland. Each of these species outcompete and displace native vegetation and have the ability to form large, dense monocultures. Areas with the highest concentrations of these invasive species were the most degraded by having low (<10%) native plant diversity and cover. Native plant community classification was not feasible. Because of this, three classifications were created to accurately describe invasive species cover. A reed canary grass (RCG) monoculture, typically identified at

elevations > 920’ and dominated wetland-upland edges. In the deeper portions of the wetland (< 920’), two invasive plant classifications were used to describe the plant communities. RCG/PL is used to describe a meadow dominated by reed canary grass, but also supports an abundance of purple loosestrife. RCG/PL/CT describes a meadow with a similar distribution of reed canary grass, purple loosestrife, and invasive cattail. The wetland north of White Bear Parkway was classified as having all three problematic invasive species, as well as <5% *Phragmites spp.* *Phragmites spp.* were not noted in the wetland area south of White Bear Parkway.

RCG - Reed Canary Grass Meadow (4.0 ac)

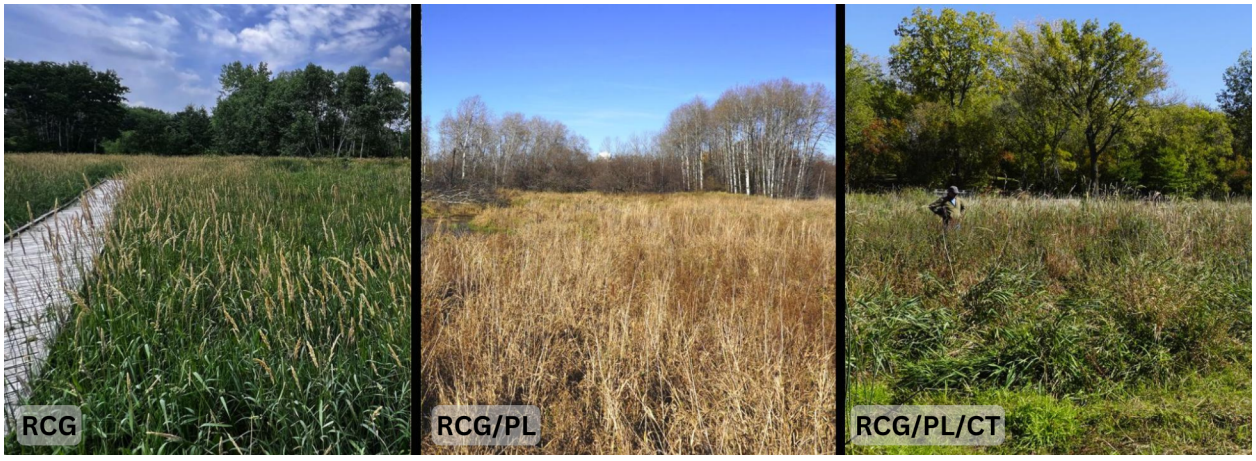
Reed canary grass	>95% cover
Native plant species	<5% cover

RCG/PL - Reed Canary Grass/Purple Loosestrife Meadow (3.6 ac)

Reed canary grass	60-80% cover
Purple loosestrife	20-40% cover
Invasive cattail	<5% cover
Native plant species	<10% cover

RCG/PL/CT - Reed Canary Grass/Purple Loosestrife/Cattail Meadow (10.0 ac)

Reed canary grass	20-40% cover
Purple loosestrife	20-40% cover
Invasive cattail	20-40% cover
Native plant species	<10% cover



The Distribution of High Quality Wetland Areas

High quality sedge meadow and bulrush-spike rush marsh communities provide exceptional habitat quality and ecological integrity in the Rotary Nature Preserve wetland complex. They represent 14% of the total wetland area - 9.2% Sedge Meadow (WMn82b) and 4.8%

Bulrush-Spike Rush Marsh (MRn93). Given this relatively low percentage, preserving and enhancing these areas are imperative. The high quality sedge meadows and bulrush-spike rush marshes were concentrated in the southern and central portions of the wetland (Appendix A, Figure 10). In contrast, the northern portion of the wetland lacked these higher quality areas. Both WMn82b1 and MRn93 plant communities exist along the boardwalk, making this highly visible area quite desirable for restoration and management. Also, RCG areas close to the walking pathways on the east side of the wetland also provide highly visible restoration opportunities.

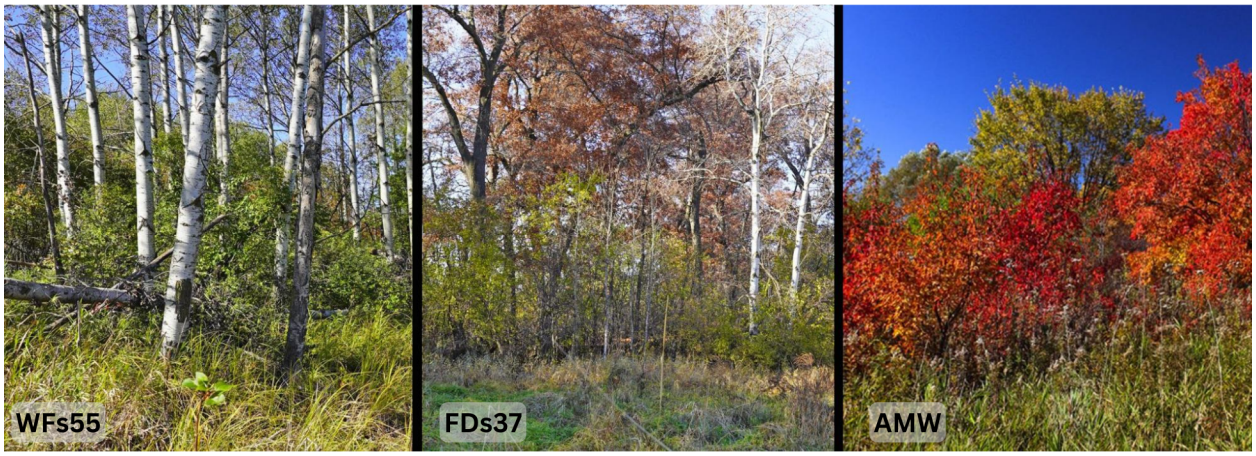
Upland Communities

Although wetland plant communities make up the majority of the Preserve, four upland plant community types were identified. The native woodlands identified are southern wet aspen forest (WFs55) and southern dry-mesic oak (maple) woodland (FDs37). A third woodland cover type was created for areas infested with amur maple that subsequently displaced much of the native vegetation, making it difficult to classify as a native plant community. Much of the woodland communities also have a component of non-native, invasive shrubs such as common buckthorn (*Rhamnus cathartica*), tartarian honeysuckle (*Lonicera tatarica*), and amur maple (*Acer ginnala*).

WFs55 - Southern Wet Aspen Forest (1.8 ac): Wet to wet mesic forests on slightly raised “islands” in large open wet meadows and in transition zones between wet meadows and adjacent forested uplands. Present mostly on level to gently rolling outwash plains.

FDs37 - Southern Dry-Mesic Oak (Maple) Woodland (4.7 ac): Dry-mesic hardwood forests occurring most often on thin, wind-deposited silt on crests and upper slopes dominated by northern red oak, white oak, and basswood.

AMW - Amur Maple Woodland (5.1 ac): Amur maple is a non-native, invasive large shrub or small tree that was imported to the US from Asia. A woodland infested with amur maple displaces native trees, shrubs, and herbaceous plants through allelopathic chemicals that limit growth and reproduction in other plants.



A southern mesic prairie (UPs23) was identified in the west-central area of the park. This plant community is unique in comparison to the communities found elsewhere in the park and is also bordered by walking trails, making it high profile. The prairie represents only 1.4 acres of the 36 acre parkland. From the available historical records, It is unclear if this area was seeded with prairie species or if it can be considered a prairie remnant. However, it is evident from historical photos that this section of land was intensively hayed prior to park acquisition.

> **UPs23 - Southern Mesic Prairie (1.3 ac):** Grass-dominated but forb-rich herbaceous communities on somewhat poorly drained to well-drained loam soils.

V. MANAGEMENT NOTES AND RECOMMENDATIONS

Efficient and sustainable wetland management hinges on a multifaceted approach and often involves strong agency and citizen partnerships. Preserving and encouraging the expansion of remnant stands of native vegetation is imperative for maintaining the biodiversity and ecological

health of the Rotary Nature Preserve wetland. Below, we summarize strategic invasive weed control that includes implementing a host of efficient and economical management approaches and a sitewide prioritization scheme. With this wetland, it is reasonable to implement both active and passive ecological restoration. Moreover, we recommend establishing a monitoring and adaptive management framework that would allow for real-time adjustments based on plant community response and evolving site conditions. Additionally, there is the opportunity to conduct restoration activities close to pathways and boardwalks that allows for easy access and observation. This facilitates educational opportunities and also promotes community engagement and support for the wetland restoration and conservation efforts.

Strategic Invasive Species Control

Reed Canary Grass

In the Rotary Park wetland, controlling reed canary grass involves a combination of mechanical and chemical control. Mechanical control primarily focuses on mowing or cutting during the early stages of growth, in spring, before seed production. This helps weaken the plant and reduces seed production. Chemical control involves the use of a glyphosate type herbicide (labeled for aquatic use) either being sprayed or applied by wicking leaves. Targeting this invasive grass species during the latter part of the growing season (August or later in Minnesota) is optimal. This is when herbicides are most efficiently translocated into the root systems (Reinhardt and Galatowitsch 2004). Integrating these strategies in a coordinated and adaptive management plan is essential for effective long-term control of reed canary grass. Regular monitoring and adjustments to the control plan based on response indicators are crucial for successful management. Additionally, quickly establishing a native plant cover through planting and reseeding can work to inhibit reed canary grass growth.

Purple Loosestrife

The management of purple loosestrife often employs a combination of chemical and biological control strategies to mitigate its impact on natural ecosystems. Chemical control involves the application of herbicides when the plant is actively growing, typically in mid to late summer (July 1 - September 1) when it is in full bloom. Treating during this time will reduce the cover of purple loosestrife and minimize seed production. This approach is especially productive when targeting small patches of loosestrife (< 100 plants) or outlier (individual) plants within a stand of native vegetation. For additional information on chemical control, please visit the MN DNR website: DNR - herbicide control

To enhance the long-term control of purple loosestrife and minimize environmental impact, biological control insects are being used to manage this invasive species. This approach involves the introduction of specialized herbivores, such as *Galerucella* beetles, which selectively feed on purple loosestrife. These biocontrol agents can help to suppress the plant's growth over time, providing a sustainable, ecological solution to managing this noxious weed over a large scale. Since the 1990s, the MN DNR has been actively releasing loosestrife leaf eating beetles throughout the state (see DNR Biological Control). In systems where populations are low, beetle stocking may be used as an effective management tool.

For the Rotary Nature Preserve wetland, assessing the possibility of integrating both chemical and biological control measures in a comprehensive management plan may lead to an effective and environmentally friendly approach to combating the spread of purple loosestrife. Regular monitoring and adaptive management are essential components of this integrated strategy to ensure ongoing success in controlling this invasive wetland species.

Narrowleaf and Hybrid Cattail

As with reed canary grass, a combination of chemical and mechanical control measures are suggested for the management of Narrowleaf Cattail (*Typha angustifolia*) and Hybrid Cattail (*Typha x glauca*) in the Rotary Park wetland. Fortunately, the invasive cattail infestations in this system consist of patches with sparse to moderate plant cover. Hence, it seems plausible to use a mechanical “cut and flood” technique to kill or severely set back cattail in this system. Cattail with cut stems that have been under the water for an extended period of time tend to have a high rate of mortality. We recommend using this management tool to treat outlier plants and patches less than 1,000 SF in size.

Herbicides, when applied carefully, can be used to target these cattail species while minimizing harm to native vegetation. The use of aquatic-approved herbicides, such as glyphosate-based formulations, can effectively suppress cattail growth, particularly in areas where mechanical control may be impractical. It is recommended that a combination of spraying, leaf wicking, and cutting-stem treatment be used for cattail control in the Rotary Nature Preserve wetland. When using glyphosate, we recommend treating cattail later in the growing season (August - October). For additional information on the chemical control of invasive cattails, check out the Board of Soil and Water Resources invasive species control information here: BWSR - cattail control.

Prescribed Fire

Fire is a natural disturbance and plays a crucial role in shaping sedge meadow wetlands by influencing vegetation composition, nutrient cycling, and habitat structure. Fire may facilitate the dominance of fire-adapted plant species and help maintain the open character of sedge meadows, preventing encroachment by woody vegetation. Although fire is an important wetland management tool, we recommend delaying the use of fire in the Rotary Park wetland until there is an established and large-scale effort to control invasive species. Fire should not be thought of as an all-encompassing tool that will significantly reduce the abundance and cover of invasive species. Conversely, in some situations, fire could actually stimulate weed abundance by opening up bare soil areas. This is especially a concern in restored wetlands where reed canary grass has been dominant and actively controlled, e.g., Spring Peeper Meadow at the U of MN Landscape Arboretum (Julia Bohnen, pers. comm.).

Active versus Passive Ecological Restoration

Active restoration involves direct interventions, such as planting and seeding or implementing engineering solutions to accelerate ecosystem recovery. In contrast, passive restoration relies on natural processes to drive recovery, emphasizing the removal of stressors and the promotion of natural regeneration. For instance, in the Rotary Nature Preserve wetland, it may be reasonable to determine if a viable native seed bank exists in certain locations. Once invasive species are controlled, then native plants may have the opportunity to expand without actively seeding or planting. This approach aligns with the principles of allowing ecosystems to rebound at their own pace without extensive human interference. The choice between these strategies depends on factors such as the level of degradation, available resources, and desired outcomes. While active restoration can yield rapid results, it is more costly. But, it does have the important benefit of establishing vegetation that will quickly occupy space and inhibit weed growth. Passive restoration, although less intrusive, may necessitate more time for recovery but can be more resilient in the long run. A judicious combination of these approaches, informed by site-specific conditions, emerges as a promising strategy for achieving successful and sustainable ecological restoration.

Wetland Plant Species to Consider for Restoration

In certain highly degraded areas (see below) that will be intensively managed for invasive plant species, it is reasonable to employ a host of revegetation techniques that will introduce a diversity of aggressive native wetland species. Below is a species list to be used as a starting point in developing revegetation plans for both sedge meadow and emergent marsh habitats in the Rotary Nature Preserve wetland (Table 2). These species have exhibited long-term resilience in restored wetland systems in the presence of invasive reed canary grass, cattail, and purple loosestrife (Bartodziej and Galatowitsch, in press; Dan Shaw, pers. comm.).

Graminoids	**Scientific name**	**Common name**
	Bolboschoenus fluviatilis	River bulrush
	Calamagrostis canadensis	Canada bluejoint
	Carex atherodes	Slough sedge
	Carex lacustris	Lake sedge
	Carex vulpinoidea	Fox sedge
	Carex stricta	Tussock sedge
	Eleocharis spp.	Spikerush

	Schoenoplectus tabernaemontani	Softstem bulrush
	Scirpus cyperinus	Woolgrass
	Spartina pectinata	Prairie cordgrass
Forbs		
	Acorus americanus	Sweet flag
	Asclepias incarnata	Swamp milkweed
	Eutrochium maculatum	Joe-pye weed
	Iris versicolor	Blue flag iris
	Mimulus ringens	Monkey flower
	Sagittaria latifolia	Arrowhead
	Scutellaria galericulata	Marsh skullcap
	Silphium perfoliatum	Cup plant
	Sparganium americanum	Bur-reed
	Verbena hastata	Blue vervain
Pteridophyta		
	Onoclea sensibilis	Sensitive fern
	Thelypteris palustris	Northern marsh fern

Table 2. Wetland species to consider for restoration.

Restoration and Management Prioritization

For the Rotary Nature Preserve wetland, we recommend implementing a restoration prioritization scheme that takes into account: 1) the preservation and expansion of remnant patches of native vegetation, 2) the distribution and abundance of invasive weed species cover, 3) the ease and potential effectiveness of management, and 4) the logistics related to public engagement opportunities. Below, we outline a broad approach that optimizes the use of limited resources, maximizes the overall impact of restoration activities, and fosters the sustained functionality of this wetland system. This is a starting point for developing a long-term management plan. Additionally, we believe that the viability of a management plan, in part, is determined by integrating education and public outreach into the prioritization scheme. This

ensures that restoration efforts actively engage and educate local communities, creating a more informed and committed constituency for ongoing conservation efforts.

1) **Control Outlier Weeds within High Quality Wetland Areas**
    a) Goal: minimize the expansion of invasive weed species within stands
    b) Target WMn82b and MRn93 stands
    c) Spot mow (weed whip) early in the growing season to reduce seed production
    d) Cut small patches of invasive cattail below the water
    e) Wick individual plants with herbicide in late summer-early fall when treatment is most effective

2) **Treat the Perimeter of High Quality Wet Meadow Areas**
    a) Goal: Expand the coverage of native wet meadow areas
    b) Target RCG/PL and RCG/PL/CT areas around WMn82b stands
    c) Treat adjoining outer bands of invasive weeds with glyphosate type herbicide
    d) This approach has proven to be successful in wetland areas on the MN Arboretum Campus (Julia Bohnen, pers. comm.)
    e) Closely monitor treated areas to determine if native species recolonize these bands without seeding or planting (passive restoration)
    f) If native plant establishment does not take place, develop and implement a revegetation plan for the treated areas (active restoration)

3) **Restore and Manage Emergent Marsh and Wet Meadow by the Boardwalk**
    a) Goal: Reduce invasive weed cover and increase native plant diversity
    b) Target both MRn93 and WMn82b1 areas
    c) Spot treat cattail and RCG with a glyphosate type herbicide
    d) Intensively plant area with aggressive wetland and emergent plant species listed above
    e) Explore the opportunity for public involvement - interpretive signage and perhaps volunteer planting just off the boardwalk

4) **Investigate Purple Loosestrife Beetle Rearing**
    a) Goal: Reduce purple loosestrife cover sitewide
    b) Determine if leaf-eating beetle populations are low
    c) If so, research the possibility of beetle rearing and release with volunteers
    d) This is another excellent opportunity for public involvement

5) **Treat RCG Areas Adjacent to Buffer Restoration Areas**
    a) Goal: Restore highly visible RCG wetland areas on the east side of the wetland, by the walking paths and adjoining newly installed upland buffer areas
    b) Broadcast spray highly degraded RCG areas on the east side of the wetland
    c) Closely monitor response - multiple treatments will likely be required

d) Actively restore these areas with a combination of seeding and planting - introduce aggressive native wetland species
e) Due to the proximity to the pathway, this would be an excellent planting opportunity for volunteers
f) Research the possibility of interpretive signage

6) Set up a Series of Test Plots in the RCG/PL and RCG/PL/CT Meadows

a) Goal: To determine if there is a viable native seed bank in the highly degraded wet meadow areas
b) Treat test plots in northwest portion of the wetland, targeting RCG/PL areas - late summer/fall application
c) Closely monitor to assess plant response over time
d) Because this area is relatively large (10 ac), it would be extremely beneficial to determine if a passive restoration approach could be successful in improving this wet meadow area

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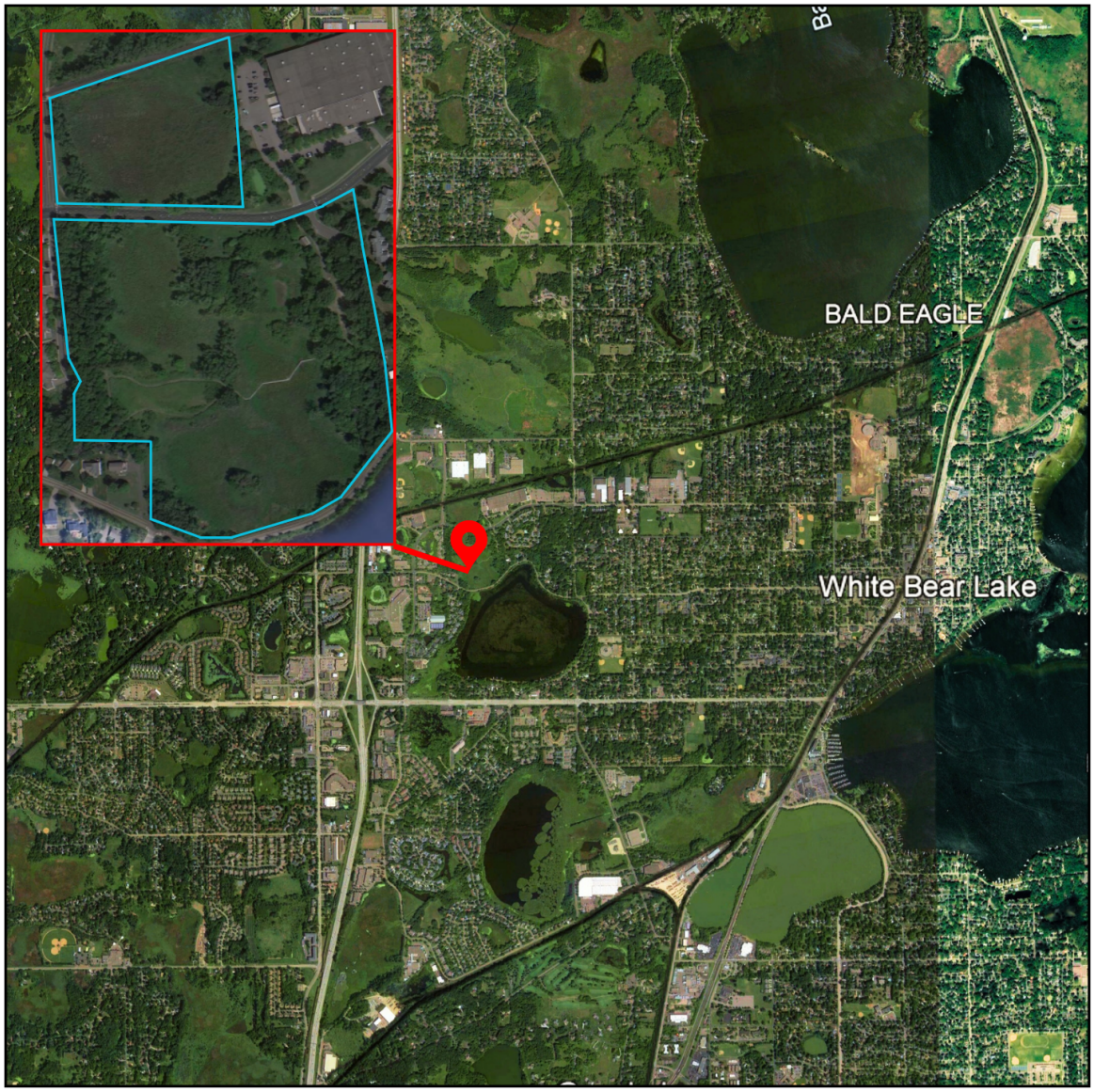
VII. APPENDIX A

Supporting Figures



Appendix A, Figure 1
Preserve Location and Extent
Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

Legend

Rotary Nature Preserve Boundary

Rotary Nature Preserve Location

.5 1 Miles

N

NATURAL SHORE

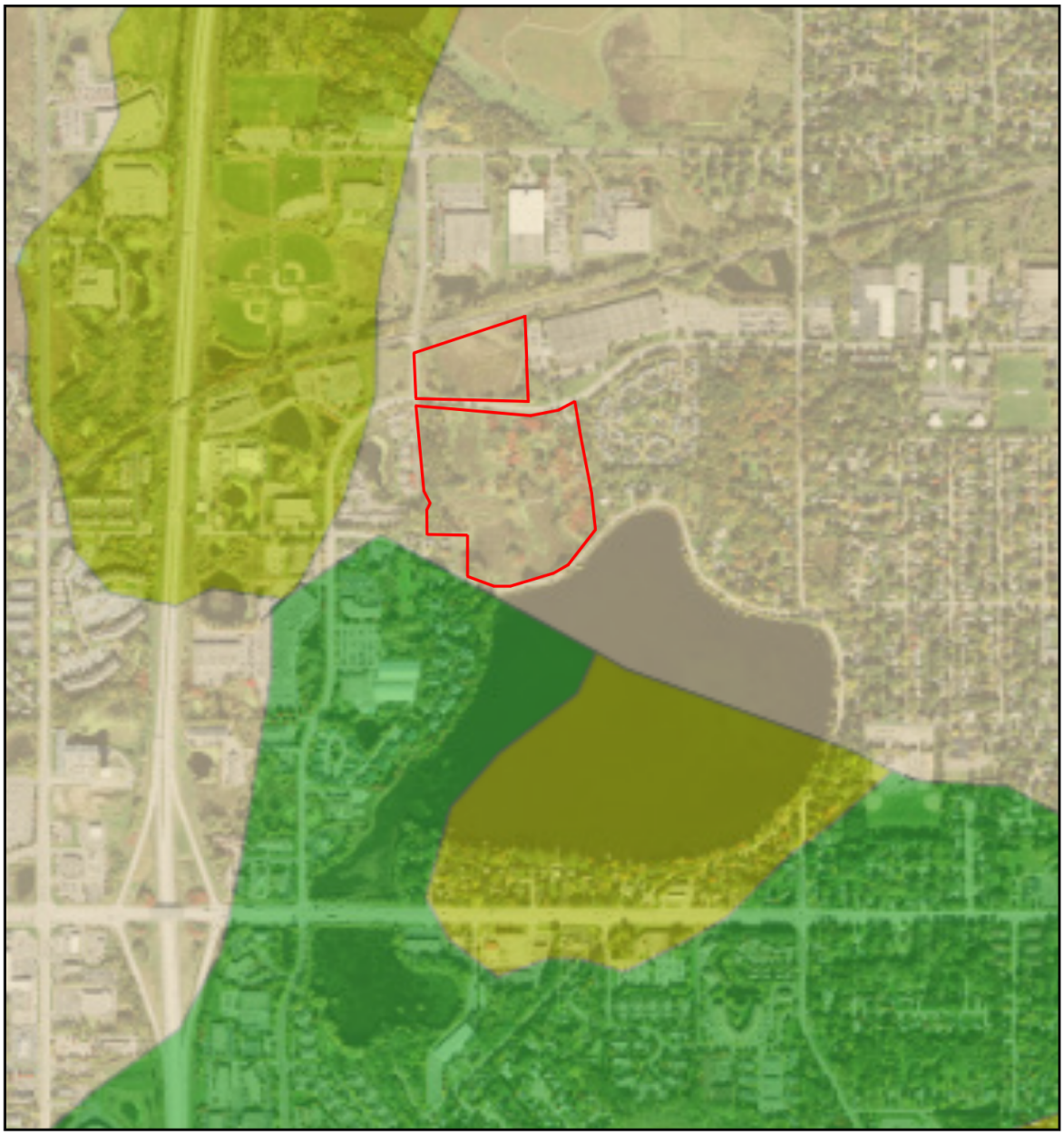
Appendix A, Figure 2
Historical Photo

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

N

NATURAL SHORE



Appendix A, Figure 3
Marschner Map

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

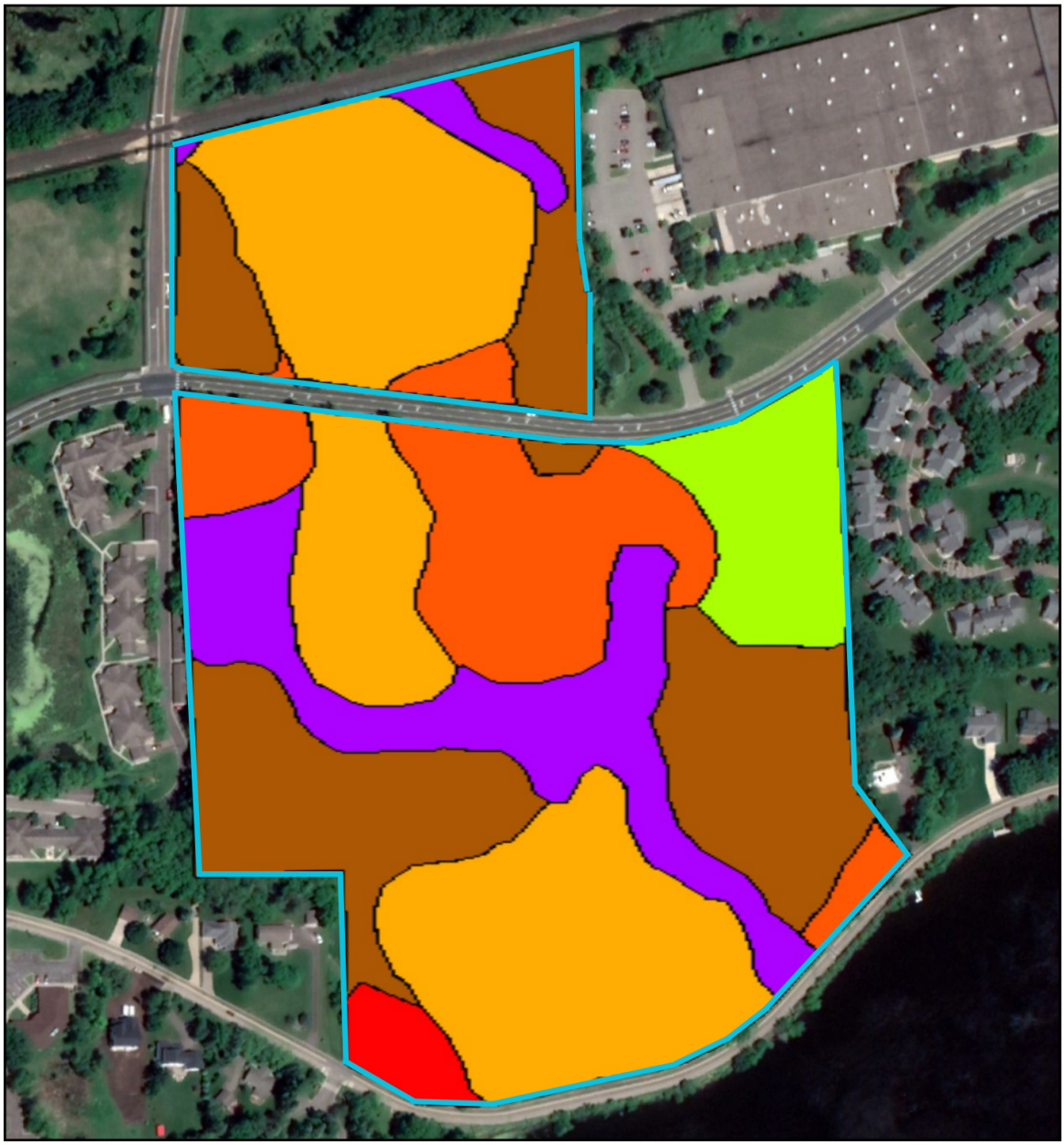
Legend

- Wet Prairie
- Big Woods - Hardwoods (oak, maple, basswood, hickory)
- Oak Openings and Barrens
- Rotary Nature Preserve Boundary

.18 .36 Miles

N

NATURAL SHORE



Appendix A, Figure 4
Soil Survey

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

Legend

- Braham Loamy Fine Sand
- Bluffton Loam
- Hayden Fine Sandy Loam
- Dundas Fine Sandy Loam
- Nessel Fine Sandy Loam
- Aquolls and Histosols
- Rotary Nature Preserve Boundary

250 500 Feet

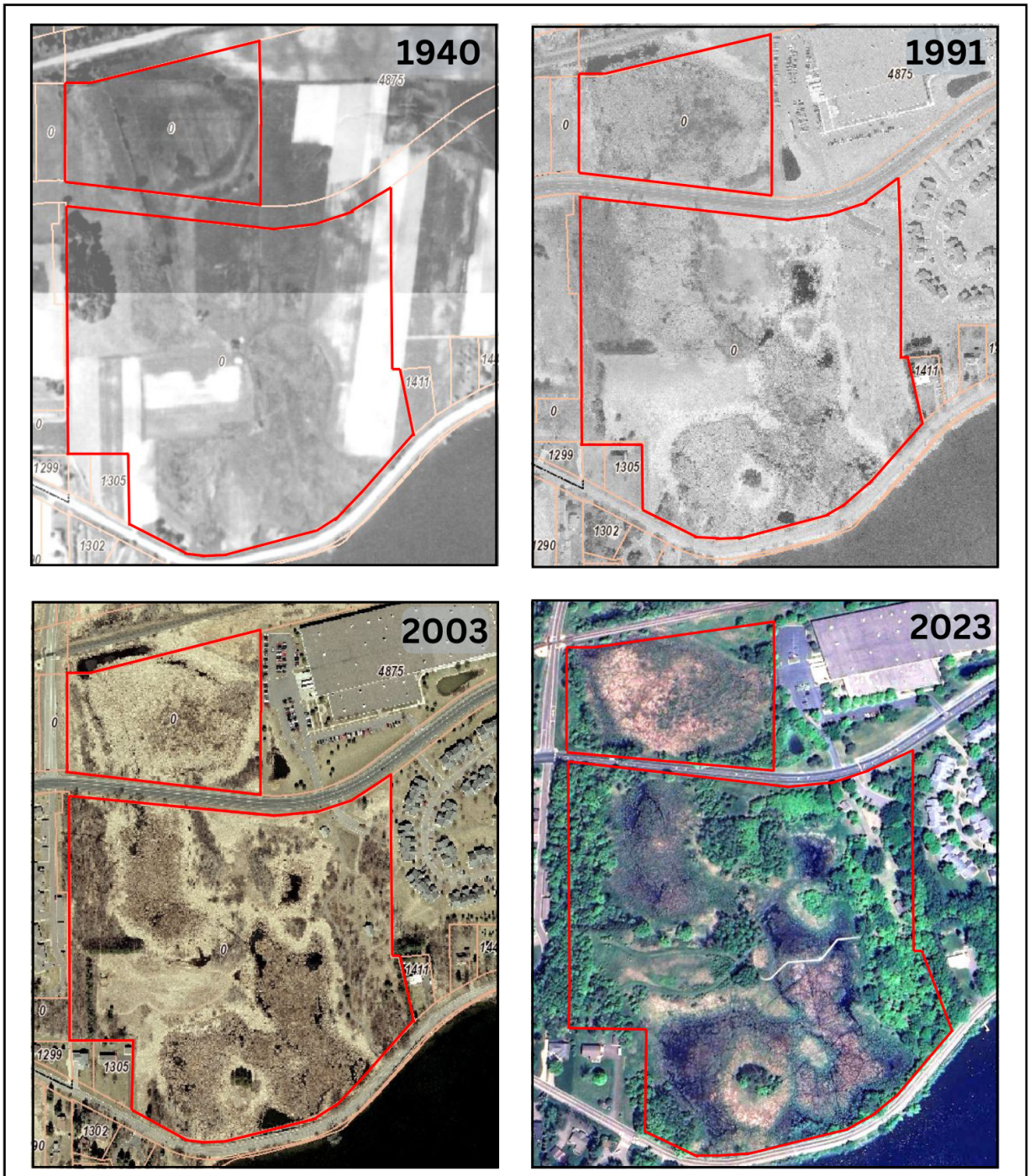
N

NATURAL SHORE

Appendix A, Figure 5
Wetland Inventory

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023



Appendix A, Figure 6
Historical Aerial Photos

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

Appendix A, Figure 7
Elevation Levels

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

Legend
- 918 ft
- 919 - 923 ft
- 924 - 929 ft
- 930 - 935 ft
- Rotary Nature Preserve Boundary

250 500 Feet

N

NATURAL SHORE

Appendix A, Figure 8
Hydrology - Sewer Map

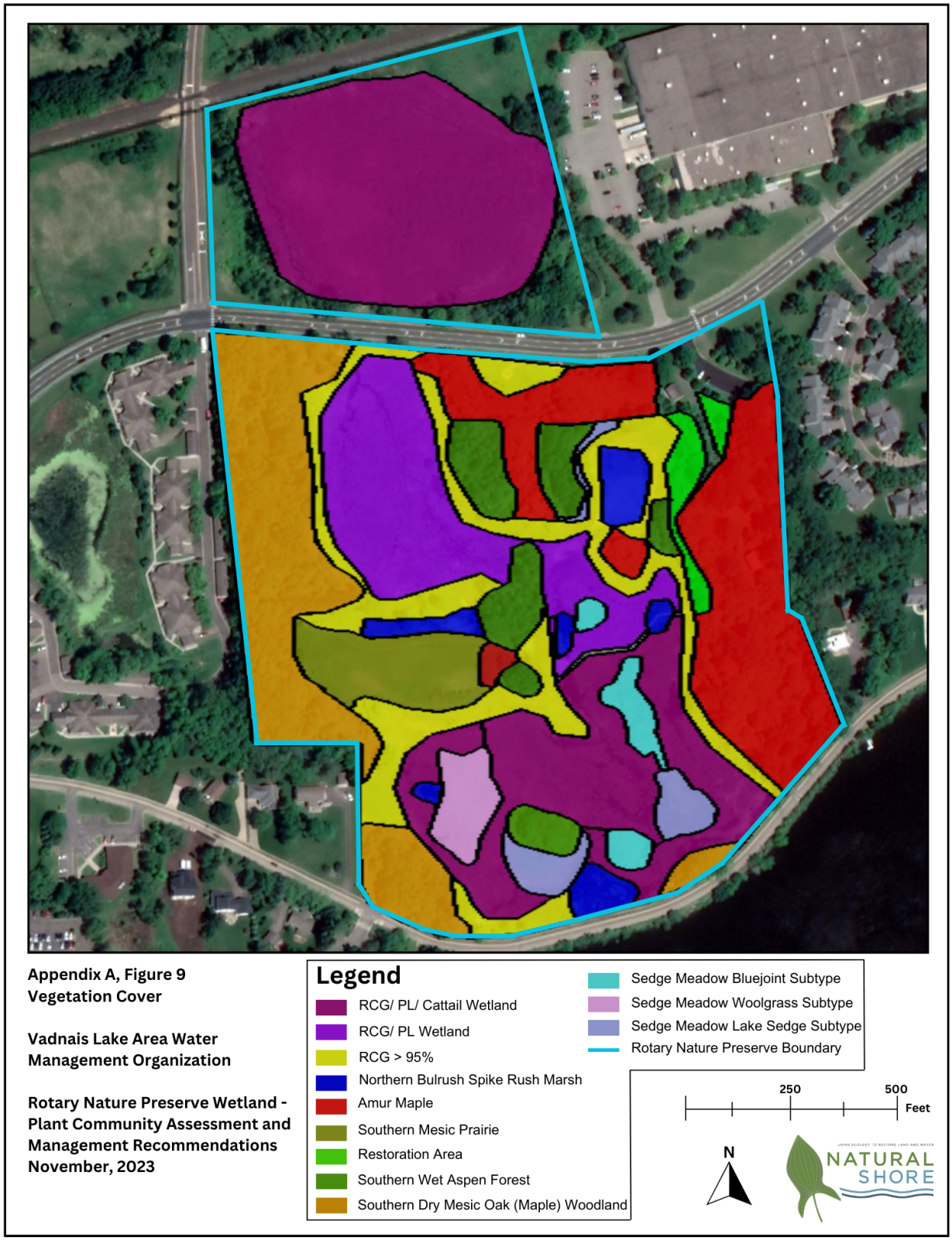
Vadnais Lake Area Water Management Organization

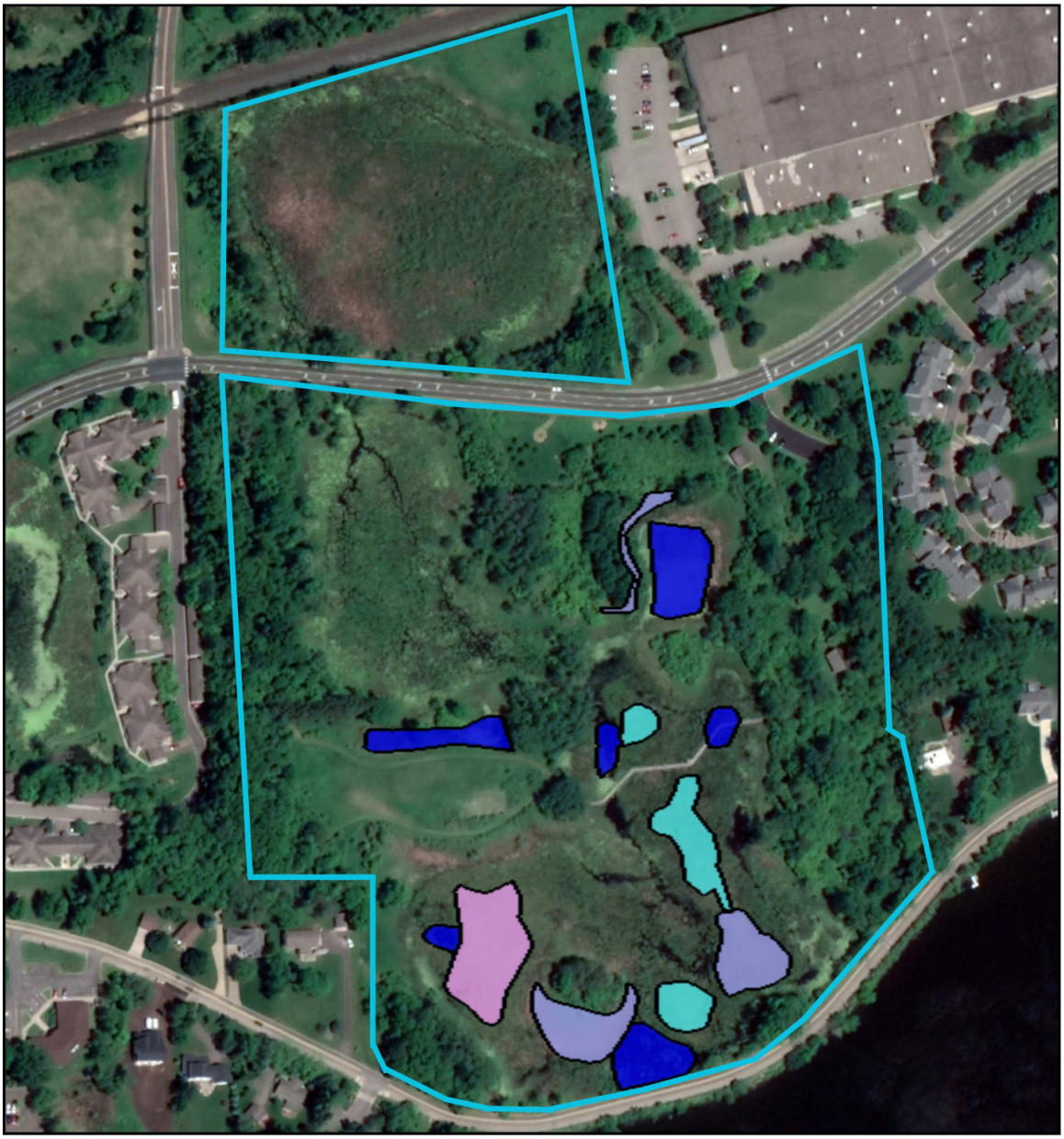
Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

200 400
Feet

N

NATURAL SHORE


Appendix A, Figure 9
Vegetation Cover
Vadnais Lake Area Water Management Organization
Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023
Legend
RCG/ PL/ Cattail Wetland
RCG/ PL Wetland
RCG > 95%
Northern Bulrush Spike Rush Marsh
Amur Maple
Southern Mesic Prairie
Restoration Area
Southern Wet Aspen Forest
Southern Dry Mesic Oak (Maple) Woodland
Sedge Meadow Bluejoint Subtype
Sedge Meadow Woolgrass Subtype
Sedge Meadow Lake Sedge Subtype
Rotary Nature Preserve Boundary
250
500
Feet
N
NATURAL SHORE



Appendix A, Figure 10
High Quality Area Distribution

Vadnais Lake Area Water Management Organization

Rotary Nature Preserve Wetland - Plant Community Assessment and Management Recommendations
November, 2023

Legend

- Northern Bulrush Spike Rush Marsh
- Sedge Meadow Bluejoint Subtype
- Sedge Meadow Woolgrass Subtype
- Sedge Meadow Lake Sedge Subtype
- Rotary Nature Preserve Boundary

250 500 Feet

N

NATURAL SHORE

VIII. APPENDIX B

Ecological Land Classification Descriptions

The Minnesota Department of Natural Resources and the U.S. Forest Service have developed an Ecological Classification System (ECS) for ecological mapping and landscape classification in Minnesota following the National Hierarchical Framework of Ecological Units (ECOMAP 1993). The system uses associations of biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation. There are eight levels of ECS units in the United States. The ecological classification of the Project area is described below.

Eastern Broadleaf Forest Province:

The Project area is located in the Eastern Broadleaf Forest (EBF) Province portion of Minnesota. In Minnesota, the EBF Province covers nearly 12 million acres (4.9 million hectares) of the central and southeastern parts of the state and serves as a transition between semi-arid portions of the state that were historically prairie and semi-humid mixed conifer-deciduous forests to the northeast. The western boundary of the province in Minnesota is sharply defined along much of its length as an abrupt transition from forest and woodland to open grassland. The northeastern boundary is more diffuse, with a gradual transition between eastern deciduous forests and the mixed conifer-hardwood forests of northern Minnesota.

The land surface of the province is largely the product of Pleistocene glacial processes. The northwestern and central portions of the province were covered by ice in the last glaciation and are characterized by thick (100–300 feet [30–90 meters]) deposits of glacial drift that is highly calcareous and of Wisconsin Age at its surface. Glacial lakes associated with the last glacial advance contributed large volumes of meltwater to rivers that cut deep valleys along the present course of the Minnesota, St. Croix, and lower Mississippi rivers. In the southeastern part of the province, which was not covered by ice in the last glaciation, headward erosion of streams draining into the deepening Mississippi valley dissected the flanking uplands, exposing Paleozoic bedrock and pre-Wisconsin drift. The waning stages of the glacial lakes contributed massive amounts of sediment to the river valleys and provided a source of silt that was redeposited by wind as a mantle of loess over the eroded lands in the southeastern part of the province.

The EBF Province coincides roughly with the part of Minnesota where precipitation approximately equals evapotranspiration; it seems likely that this aspect of climate has an important influence on plants, as many forest species reach their western range limits and several prairie species reach their eastern range limits within the province. Precipitation in the province increases from about 24 inches (60cm) annually in the northwestern portion to 35 inches (90cm) in the southeast, while normal annual temperatures range from 38°F (3°C) in the northwest to 46°F (8°C) in the southeast.

Within the EBF, there are two major Sections. The Project area is located in the Minnesota and Northeast Iowa Morainal Section (MIM). The MIM is a long band of deciduous forest, woodland, and prairie that stretches nearly 350 miles (560km) from Polk County in northwestern Minnesota to the Iowa border. Over half of this area consists of rugged to hummocky moraines deposited along the eastern margin of the Des Moines ice lobe during the last glaciation. Another quarter of the area consists of rolling till or basal till deposited as drumlins. Small sand plains occur

locally within the moraines. A rather large sand plain, the Anoka Sand Plain, is present north of the Twin Cities metropolitan area. This level plain is formed from sand deposited by meltwater from the Grantsburg sublobe, a spur of ice emanating from the east flank of the Des Moines lobe.

The pre-settlement pattern of upland vegetation in the MIM reflects substrate texture and landform topography. These features affected plants directly through their influence on moisture and nutrient availability, insolation, and local temperature, and also indirectly through their influence on the frequency and severity of fires. Sandy flat areas were dominated by prairie, savanna, and oak and aspen woodlands. This is especially true of the Anoka Sand Plain and sandy terraces along the major rivers. In these areas, droughty soils and absence of impediments to the spread of fire promoted fire-dependent prairie and woodland vegetation. A large area of prairie, savanna, and oak woodland was also present on gently undulating glacial till in the southern part of the section, adjacent to the extensive prairie lands of western Minnesota. The low-relief landscape in this part of the section afforded few impediments to the spread of fire, including fires that spread into the section from the adjacent prairie region. Woodland and forest dominated sites in the section where fire was uncommon or rare. Fine textured drift deposited in hummocky moraines supported mesic forests dominated by sugar maple, basswood, American elm, and northern red oak. Even small reductions in fire frequency afforded by streams, lakes, or topographic breaks permitted the formation of forest on finer-textured soils, and once formed these forests were highly resistant to burning.

Floodplain and terrace forests were present historically along the valleys of the major rivers, the Mississippi, Minnesota, and St. Croix, and are still prominent today along many stretches of these rivers. Forests of silver maple occupy the active floodplains, while forests of silver maple, cottonwood, boxelder, green ash, and elm occupy terraces that flood infrequently. These valleys are also characterized by herbaceous and shrubby river shore communities along shorelines and on sand bars, and in some areas by cliff communities on steep rocky river bluffs. Closed depressions that pond water in the spring provide habitat for open wetlands such as marshes, wet meadows, shrub swamps, and wet prairies. Peatlands are uncommon in the section and usually develop following formation of sedge or moss mats over sediments in former lake basins.

Within the MIM, there are multiple ecological subsections. The Project area is located in the Saint Paul Baldwin Plains ecological subsection. The northern boundary of this subsection consists of a Superior Lobe end moraine complex (St. Croix Moraine). To the west, terraces associated with the Mississippi River separate the subsection from the Anoka Sand Plain subsection. The southern boundary coincides with the southern edge of the Rosemount Outwash Plain.

This subsection is small and continues into Wisconsin. Although it is topographically low in comparison to other areas in the state, the subsection is dominated by a large moraine and areas of outwash plain. The subsection encompasses part of the seven county metropolitan area and as a result is affected by urban development.

This subsection is dominated by a Superior lobe end moraine complex. South of this moraine is a series of outwash plains associated with the Superior lobe. There are some areas of loess plain over bedrock or till in the southeastern portion of the subsection. Topography is rolling to hummocky on the moraine (steep, short complex slopes) and level to rolling on the outwash.

Glacial drift is generally less than 100 feet thick within the subsection, with maximum thickness of about 200 feet (Olsen and Mossler 1982). Ordovician and Devonian dolomite (some limestone, sandstone, and shale) is locally exposed, especially in the dissected stream valleys at the eastern edge of the subsection (Morey 1976, Olsen and Mossler 1982). Precambrian bedrock is exposed along the St. Croix River.

Soils in this subsection are primarily Alfisols (soils formed under forested vegetation). Areas of Mollisols (soils formed under prairie vegetation) are present on the outwash plains. Parent materials are mixed on the moraines (mixtures of clay loams, loams, sandy loams, and loamy sands). The outwash plains have sandy parent materials (Cummins and Grigal 1981).

Annual normal precipitation ranges from 28 inches in the north to 31 inches in the south, and growing season precipitation ranges from 12.5 to 13 inches. The average growing season length ranges from 146 to 156 days.

The drainage network is poorly developed throughout most of the subsection. This is due to the nature of the landforms. The Mississippi River cuts through the center of the subsection. There is a well developed floodplain associated with the Mississippi. The end moraines in the northern third have an undeveloped drainage network. The St. Croix River forms the east boundary (as well as the boundary between Minnesota and Wisconsin). The river flows into the Mississippi southeast of the Twin Cities. There are many lakes in this subsection. Most are present on the moraines.

A mosaic of vegetation occurred in the subsection. Oak and aspen savannas were the primary communities, but areas of tallgrass prairie and maple-basswood forest were common. Tallgrass prairie was concentrated on level to gently rolling portions of the landscape. Bur oak savanna developed on rolling moraine ridges at the western edge of the subsection and in dissected ravines at the eastern edge. Maple-basswood forest was restricted to the portions of the landscape with the greatest fire protection, either in steep, dissected ravines or where stream orientation reduced fire frequency or severity (Albert 1993).

Urban development is the primary land use. There are small areas of forest present in the eastern portion of the subsection, although these are becoming scarce as urban development continues. There is significant recreational activity along the Mississippi and St. Croix river corridors.

Fire is the most important disturbance within the subsection. Tornados and high wind events also created significant disturbances. Periodic flooding occurs in river and stream valleys.

IX. APPENDIX C

Soil Survey Descriptions

Bluffton -Ramsey County Soils - 75 - Bluffton Complex
The Bluffton Seres is a Endoaquoll with the following characteristics:

- Very deep, very poorly drained
- Soils that formed in a mantle of loamy alluvium from glacial till and in underlying loamy glacial till on glacial moraines.
- These soils have moderately rapid or moderate permeability in the upper part and moderate or moderately slow permeability in the lower part.
- Slopes range from 0 to 2 percent.
- Used for pasture; and some are drained and used for small grain, corn and soybeans. Native vegetation is a mixture of water-tolerant grasses, deciduous trees and coniferous trees. Principal species are alder, black ash, black spruce, willow, and sedges.

Hayden - Ramsey County Soils – 132C – Hayden
The Hayden series is an Alfisol with the following characteristics:

- Deep, well drained soils.
- Formed in calcareous loamy glacial till on glacial moraines and till plains.
- Their slopes range from 2 to 40 percent.
- Fine-loamy, mixed, superactive, mesic Glossic Hapludalfs
- On gently undulating through steep glacial moraines of the Des Moines and Grantsburg sublobe of the Late Wisconsinan glaciation. Montmorillonite is the dominant clay mineral in the glacial till.
- Native vegetation was deciduous forest of maple, basswood, oak, and elm.

Dundas - Ramsey County Soils – 862 – Urban Land – Dundas Complex
The Dundas series is an Alfisol with the following characteristics:

- Very deep, poorly drained soils that formed in loamy calcareous till on moraines.
- Soils on level, or nearly level, plane to slightly convex slopes on end or ground moraines.
- They formed mostly in friable calcareous, glacial till of Late Wisconsin Age.
- These soils have moderately slow saturated hydraulic conductivity. Poorly drained.
- Slopes range from 0 to 2 percent.
- Fine-loamy, mixed, superactive, mesic Mollic Endoaqualfs.
- Native vegetation was mixed deciduous forest and prairie grass.

Nessel - Ramsey County Soils - 225 Nessel Series
The Nessel series is an Oxyaquic Hapludalfs with the following characteristics:

- Very deep, moderately well drained soils
- Formed in calcareous loamy glacial till on glacial moraines.
- These soils have moderate permeability.
- Slopes range from 1 to 3 percent.
- Native vegetation is deciduous forest.

Aquolls and histosols - Ramsey County Soils - 1055 - Ponded Muck
Aquolls and histosols with the following characteristics:

- Level,very poor drained mineral and organic soils around lakes or rivers and in depressions on till plains and outwash plains
- Areas of dry late summer or during periods of drought
- Individual areas may include one or both soil types
- Mapped areas covered in dense water tolerant vegetation or open water

X. APPENDIX D

Wetland Classification Descriptions

System **Palustrine (P)** : The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 ppt. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2.5 m (8.2 ft) at low water; and (4) salinity due to ocean-derived salts less than 0.5 ppt.

Class **Emergent (EM)** : Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

Subclass **Persistent (1)** : Dominated by species that normally remain standing at least until the beginning of the next growing season. This subclass is found only in the Estuarine and Palustrine systems.

Water Regime:

- Water Regime **Temporary Flooded (A)** : Surface water is present for brief periods (from a few days to a few weeks) during the growing season, but the water table usually lies well below the ground surface for the most of the season. -OR-
- Water Regime **Seasonally Flooded (C)** : Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface. -OR-
- Water Regime **Semipermanently Flooded (F)** : Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

XI. APPENDIX E

Plant Species Noted in Field Surveys

Common Names	Scientific Names
American plum	*Prunus americana*
Aster	*Symphyotrichum spp.*
Aspen/poplar	*Populus spp.*
Basswood	*Tilia americana*
Beggarticks	*Biden spp.*
Bidens	*Bidens spp.*
Bittersweet nightshade	*Solanum dulcamara*
Big bluestem	*Andropogon gerardii*
Black cherry	*Prunus serotina*
Black eyed susan	*Rudbeckia hirta*
Blue vervain	*Verbena hastata*
Bottlebrush sedge	*Carex comosa*
Box elder	*Acer negundo*
Broad-leaf Arrowhead	*Sagittaria latifolia*
Broadleaf cattail	*Typha latifolia*
Canada bluejoint	*Calamagrostis canadensis*
Canada goldenrod	*Solidago canadensis*
Canada wild rye	*Elymus canadensis*
Common buckthorn	*Rhamnus cathartica*
Common elder	*Sambucus canadensis*
Common jewelweed	*Impatiens capensis*
Common ragweed	*Ambrosia artemisiifolia*
Cottonwood	*Populus deltoides*
Duckweed	*Lemna minor*
False indigo	*Amorpha fruticosa*
Fraser's marsh St. Johnswort	*Triadenum fraseri*
Garlic mustard	*Alliaria petiolata*
Grey dogwood	*Cornus racemosa*
Grape vine	*Vitis riparia*

Great water dock	*Rumex britannica*
Green ash	*Fraxinus pennsylvanica*
Hybrid cattail	*Typha X glauca*
Ironweed	*Vernonia fasciculata*
Joe pye weed	*Eutrochium maculatum*
Lake sedge	*Carex lacustris*
Little bluestem	*Schizachyrium scoparium*
Monkey flower	*Mimulus ringens*
Narrowleaf cattail	*Typha angustifolia*
Northern pin oak	*Quercus ellipsoidalis*
Northern marsh fern	*Thelypteris palustris*
Paper birch	*Betula papyrifera*
Phragmites	*Phragmites spp.*
Poison ivy	Toxicodendron spp.
Prairie cordgrass	*Spartina pectinata*
Purple loosestrife	*Lythrum salicaria*
Quaking aspen	*Populus tremuloides*
Red oak	*Quercus rubra*
Red pine	*Pinus resinosa*
Red raspberry	*Rubus idaeus var. strigosus*
Red-osier dogwood	*Cornus sericea*
Reed canary grass	*Phalaris arundinacea*
River birch	*Betula papyrifera*
River bulrush	*Bolboschoenus fluviatilis*
Sedge	*Carex spp.*
Sensitive fern	*Onoclea sensibilis*
Siberian elm	*Ulmus pumila*
Smooth brome	*Bromus inermis*
Smooth sumac	*Rhus glabra*
Softstem bulrush	*Schoenoplectus tabernaemontani*
Sowthistle	*Sonchus arvensis*
Smartweed	*Persicaria amphibia*

Speckled alder	*Alnus incana*
Spikerush	*Eleocharis palustris*
Spreading dogbane	*Apocynum androsaemifolium*
Steeplebush	*Spiraea tomentosa*
Stinging nettle	*Urtica dioica subsp. gracilis*
Swamp milkweed	*Asclepias incarnata*
Tamarack	*Larix laricina*
Tartarian honeysuckle	*Lonicera tatarica*
Three way sedge	*Dulichium arundinaceum*
Water horehound	*Lycopus americanus*
Water lily	*Nymphaea odorata*
Water plantain	*Alisma triviale*
White mulberry	*Morus alba*
White oak	*Quercus alba*
Wild bergamot	*Monarda fistulosa*
Willow	*Salix spp.*
Wind grape	*Vitis riparia*
Woolgrass	*Scirpus cyperinus*
Yellow foxtail	*Setaria pumila*

XII. APPENDIX F

MN DNR Native Plant Community Classifications

WMn82

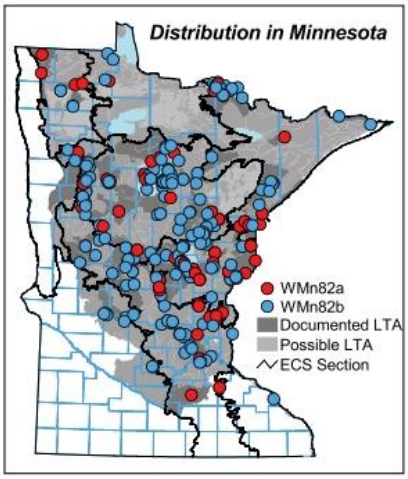
WET MEADOW/CARR SYSTEM
Northern Floristic Region

Northern Wet Meadow/Carr

Open wetlands dominated by dense cover of broad-leaved graminoids or tall shrubs. Present on mineral to sapric peat soils in basins and along streams.

Vegetation Structure & Composition

Description is based on summary of vegetation data from 293 plots (relevés) and moss data from 23 bryophyte plots.



- **Moss** cover most often is < 5% but can range to > 75%. Brown mosses are usually dominant, but *Sphagnum* can be dominant on some sites.
- **Graminoid** layer consists of dense stands of mostly broad-leaved graminoids, including bluejoint *(Calamagrostis canadensis)*, lake sedge *(Carex lacustris)*, tussock sedge *(C. stricta)*, and beaked sedge *(C. utriculata)*.
- **Forb** cover is variable, with tufted loosestrife *(Lysimachia thyrsiflora)*, marsh bellflower *(Campanula aparinoides)*, marsh skullcap *(Scutellaria galericulata)*, and great water dock *(Rumex orbiculatus)* common, and small or three-cleft bedstraw *(Galium tinctorium* or *G. trifidum)*, bulb-bearing water hemlock *(Cicuta bulbifera)*, northern bugleweed *(Lycopus uniflorus)*, linear-leaved, marsh, or downy willow-herb *(Epilobium leptophyllum*, *E. palustre*, or *E. strictum)*, water smartweed *(Polygonum amphibium)*, and northern marsh fern *(Thelypteris palustris)* occasional.
- **Shrub** cover is variable. Tall shrubs such as willows *(Salix* spp.), red-osier dogwood *(Cornus sericea)*, and speckled alder *(Alnus incana)* can be dense, along with meadowsweet *(Spiraea alba)*. Paper birch, black ash, red maple, American elm, and tamarack saplings are occasionally present in the shrub layer.
- **Trees** taller than 16ft (5m) are rarely present and if so, have low cover (< 25%).

Landscape Setting & Soils

WMn82 occurs in wetland basins on a variety of landforms. It is also associated with streams and drainageways, drained beaver ponds, shallow bays, and semifloating mats on lakes. Soils range from mineral or muck soil to sapric peat. Organic sediments are typically shallow but can be deep (> 15in [40cm]) in basins filled by sedimentary peat or where WMn82 has succeeded an Open Rich Peatland community following changes to the hydrology of the basin.

Natural History

WMn82 is subjected to moderate inundation following spring runoff and heavy rains, and periodic drawdowns during summer. Peak water levels are high enough and persistent enough to prevent trees (and often shrubs) from becoming established, although there may be little or no standing water much of the growing season. As a result of water-level fluctuations, the surface substrate alternates between aerobic and anaerobic conditions. Any organic matter that may accumulate over time is usually oxidized during drawdowns following drought or is removed by fire. Where deep peat is present in the community, it likely was formed previously on the site by a peat-producing community—such as a forested rich peatland—that was flooded by beaver activity and ultimately converted to a wet meadow. Deep peat may also develop from debris settling into basins with standing water, forming sedimentary peat. Because surface water in WMn82 is derived from runoff, stream flow, and groundwater sources, it has circumneutral pH (6.0–8.0) and high mineral and nutrient content. Although mosses are typically sparse in WMn82 because of alternating flooding and drawdown, moss cover can be relatively

high in settings where water levels have become stabilized. In these situations, it appears that *Sphagnum* can quickly invade the community, especially on floating mats that are completely above the water surface. The water chemistry in these sites can be rapidly converted by *Sphagnum* to rich fen or even poor fen conditions before characteristic wet meadow species, especially wide-leaved sedges, have been replaced by plants of rich or poor fens such as narrow-leaved sedges. The process of succession of WMn82 to rich or poor fens is readily reversed by return of higher or more variable water levels, such as from beaver activity or variation in precipitation.

Similar Native Plant Community Classes

- **OPn81 Northern Shrub Shore Fen**

OPn81 often has abundant broad-leaved graminoids and can appear similar to occurrences of WMn82 with abundant speckled alder (WMn82a). OPn81 typically occurs on deep peat, often along lakeshores, and is more likely to have high cover of leatherleaf *(Chamaedaphne calyculata)*, bog birch *(Betula pumila)*, or sweet gale *(Myrica gale)* in addition to speckled alder. WMn82 commonly occurs on mineral soil or shallow peat and is often situated away from lakeshores; WMn82 is more likely to have abundant willows and red-osier dogwood in addition to speckled alder.

WMn82 Indicator Species	(freq%) *WMn82*	OPn81
Touch-me-not *(Impatiens* spp.)	**54**	2
Labrador bedstraw *(Galium labradoricum)*	**24**	2
Cut-leaved bugleweed *(Lycopus americanus)*	**20**	2
Mad dog skullcap *(Scutellaria lateriflora)*	**20**	2
Pussy willow *(Salix discolor)*	**56**	9
Spotted Joe pye weed *(Eupatorium maculatum)*	**54**	9
Bebb's willow *(Salix bebbiana)*	**46**	9
Bulb-bearing water hemlock *(Cicuta bulbifera)*	**54**	16

OPn81 Indicator Species	(freq%) WMn82	*OPn81*
Small cranberry *(Vaccinium oxycoccos)*	-	**30**
Bog rosemary *(Andromeda glaucophylla)*	-	**19**
Round-leaved sundew *(Drosera rotundifolia)*	1	**23**
Leatherleaf *(Chamaedaphne calyculata)*	6	**88**
Black spruce (C,U)	3	**40**
Labrador tea *(Ledum groenlandicum)*	3	**35**
Tamarack (U)	4	**37**
Balsam willow *(Salix pyrifolia)*	9	**49**

- **FPn73 Northern Rich Alder Swamp**

FPn73 may resemble occurrences of WMn82 that have significant amounts of speckled alder (WMn82a). FPn73 is typically associated with other communities of the Forested Rich Peatland System and is more likely to have trees > 6ft (2m) tall, including paper birch, red maple, and black ash, and shade-tolerant swamp forest species in the ground layer.

WMn82 Indicator Species	(freq%) *WMn82*	FPn73
Cut-leaved bugleweed *(Lycopus americanus)*	**20**	2
Swamp milkweed *(Asclepias incarnata)*	**16**	2
Water smartweed *(Polygonum amphibium)*	**29**	5
Tussock sedge *(Carex stricta)*	**47**	11
Slender willow *(Salix petiolaris)*	**71**	18
Beaked sedge *(Carex utriculata)*	**27**	9
Bebb's willow *(Salix bebbiana)*	**46**	16
Bulb-bearing water hemlock *(Cicuta bulbifera)*	**54**	20

FPn73 Indicator Species	(freq%) WMn82	*FPn73*
Starflower *(Trientalis borealis)*	1	**50**
Bunchberry *(Cornus canadensis)*	1	**48**
Canada mayflower *(Maianthemum canadense)*	1	**43**
Three-fruited bog sedge *(Carex trisperma)*	1	**27**
Lowbush or Velvet-leaved blueberry*	1	**27**
Labrador tea *(Ledum groenlandicum)*	3	**50**
White cedar (C,U)	1	**23**
Balsam fir (C,U)	4	**45**

*Lowbush or Velvet-leaved blueberry *(Vaccinium angustifolium* or *V. myrtilloides)*

Native Plant Community Types in Class

- **WMn82a Willow - Dogwood Shrub Swamp**

Open wetlands with abundant broad-leaved graminoids, and shrub cover typically > 25%. Shrubs that may be abundant include willows, red-osier dogwood, speckled alder, and occasionally bog birch. Description is based on summary of vegetation data from 69 plots.

- **WMn82b Sedge Meadow**

Open wetlands with abundant broad-leaved graminoids, and shrub cover typically < 25%. The invasive species common reed grass *(Phragmites australis)* and reed canary grass *(Phalaris arundinacea)* have become increasingly abundant in this community type over the past several decades, reducing species diversity in many occurrences. WMn82b is divided into four subtypes, based on dominant graminoid species. Description is based on summary of vegetation data from 224 plots.

- *WMn82b1 Bluejoint Subtype*
- *WMn82b2 Tussock Sedge Subtype*
- *WMn82b3 Beaked Sedge Subtype*
- *WMn82b4 Lake Sedge Subtype*

photo by E.R. Rowe MN DNR

Becker County, MN

WMn82 Northern Wet Meadow/Carr — Species Frequency & Cover

Species	freq%	cover
Grasses & Sedges		
Bluejoint *(Calamagrostis canadensis)*	80	●●●●
Lake sedge *(Carex lacustris)*	72	●●●●
Tussock sedge *(Carex stricta)*	41	●●●●
Beaked sedge *(Carex utriculata)*	33	●●●
Fen wiregrass sedge *(Carex lasiocarpa)*	29	●●●
Woolgrass *(Scirpus cyperinus)*	22	●●
Aquatic sedge *(Carex aquatilis)*	11	●●●
Forbs, Ferns & Fern Allies		
Tufted loosestrife *(Lysimachia thyrsiflora)*	59	●
Marsh bellflower *(Campanula aparinoides)*	58	●
Marsh skullcap *(Scutellaria galericulata)*	53	●
Great water dock *(Rumex orbiculatus)*	52	●
Three-cleft or small bedstraw *(Galium trifidum* or *G. tinctorium)*	46	●
Bulb-bearing water hemlock *(Cicuta bulbifera)*	46	●
Northern bugleweed *(Lycopus uniflorus)*	45	●
Linear-leaved, Marsh, or Downy willow-herb*	44	●
Water smartweed *(Polygonum amphibium)*	42	●
Northern marsh fern *(Thelypteris palustris)*	40	●●
Touch-me-not *(Impatiens* spp.)	39	●●
Marsh cinquefoil *(Potentilla palustris)*	38	●
Spotted Joe pye weed *(Eupatorium maculatum)*	34	●
Broad-leaved cattail *(Typha latifolia)*	32	●●
Arrow-leaved tearthumb *(Polygonum sagittatum)*	28	●
Crested fern *(Dryopteris cristata)*	24	●
Marsh St. John's wort *(Triadenum fraseri)*	23	●
Swamp milkweed *(Asclepias incarnata)*	22	●
Northern blue flag *(Iris versicolor)*	22	●
Broad-leaved arrowhead *(Sagittaria latifolia)*	22	●●
Labrador bedstraw *(Galium labradoricum)*	21	●
Bur marigold and Beggarticks *(Bidens* spp.)	21	●●

Species	freq%	cover
Sensitive fern *(Onoclea sensibilis)*	20	●
Common mint *(Mentha arvensis)*	19	●
Red-stemmed aster *(Aster puniceus)*	19	●
Marsh vetchling *(Lathyrus palustris)*	17	●
Common marsh marigold *(Caltha palustris)*	17	●
Cut-leaved bugleweed *(Lycopus americanus)*	17	●
Long-leaved chickweed *(Stellaria longifolia)*	13	●
Bog aster *(Aster borealis)*	12	●
Mad dog skullcap *(Scutellaria lateriflora)*	12	●
Giant goldenrod *(Solidago gigantea)*	12	●
Big-leaf white violet or Northern white violet**	12	●
Lesser-duckweed *(Lemna minor)*	12	●
Dwarf raspberry *(Rubus pubescens)*	11	●
Sweet flag *(Acorus calamus)*	11	●●
Rough cinquefoil *(Potentilla norvegica)*	11	●
Common boneset *(Eupatorium perfoliatum)*	11	●
Water horsetail *(Equisetum fluviatile)*	10	●
Low Shrubs		
Red raspberry *(Rubus idaeus)*	13	●
Tall Shrubs		
Slender willow *(Salix petiolaris)*	42	●●●
Pussy willow *(Salix discolor)*	29	●●
Red-osier dogwood *(Cornus sericea)*	24	●●
Speckled alder *(Alnus incana)*	24	●●●
Meadowsweet *(Spiraea alba)*	23	●
Bebb's willow *(Salix bebbiana)*	20	●●
Bog birch *(Betula pumila)*	14	●●
Tree Seedlings & Saplings (< 16ft)		
Paper birch	8	●
Black ash	7	●
Red maple	5	●

*Linear-leaved, Marsh, or Downy willow-herb *(Epilobium leptophyllum, E. palustre,* or *E. strictum)* **Big-leaf white violet or Northern white violet *(Viola blanda* or *V. macloskeyi)*

MRn93

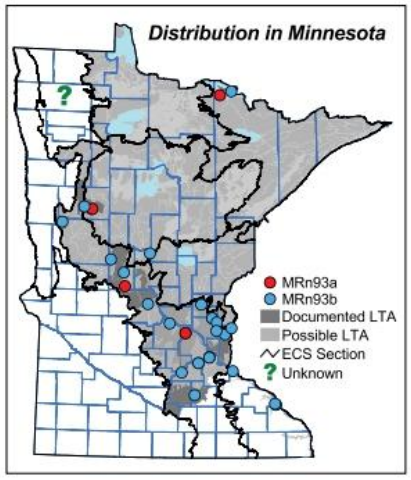
MARSH SYSTEM
Northern Floristic Region

Northern Bulrush-Spikerush Marsh

Emergent marsh communities, typically dominated by bulrushes or spikerushes. Present mainly along lakeshores and stream borders.

Vegetation Structure & Composition

Description is based on summary of field survey records and vascular plant data from 34 plots (relevés).



- **Floating-leaved** and **submergent aquatic plant** cover is variable, frequently with water smartweed *(Polygonum amphibium* var. *stipulaceum)* and duckweed *(Lemna* spp.) and infrequently with greater duckweed *(Spirodela polyrhiza)* and pondweed *(Potamogeton* spp).
- **Graminoid** cover is variable, often consisting of dense, clonal, single-species patches interspersed with areas of open water. Community most often is dominated by bulrushes, including soft stem bulrush *(Scirpus validus)* and river bulrush *(S. fluviatilis)*, or by red-stalked spikerush *(Eleocharis palustris)*, with lesser amounts of rice cut grass *(Leersia oryzoides)*.
- **Forb** cover is variable. Typical species include broad-leaved arrowhead *(Sagittaria latifolia)* and bur reeds *(Sparganium* spp.).
- **Shrubs** are absent.

Landscape Setting & Soils

MRn93 occurs in shallow water (typically 20–40in [50–100cm] deep) along wave-washed and protected lakeshores and along stream borders. Substrates are usually mineral soil, sometimes held together by mats of plant roots. MRn93 appears to occur on permanently flooded sites but may be intermittently exposed during periods of low water.

Natural History

MRn93 develops in settings where standing water is present most of the year, providing conditions favorable to hydrophytic plants. The community is most common along shorelines where exposure to waves hinders accumulation of peat and formation of floating mats. Variation in vegetation composition within the class is likely due to variation in water level, substrate, and exposure to wave action.

Similar Native Plant Community Classes

- **MRn83 Northern Mixed Cattail Marsh**

MRn83 is similar to MRn93 but occurs in shallow water on softer substrates more protected from wave action. MRn83 is dominated by cattails *(Typha* spp.), with abundant sedges *(Carex* spp.) and forbs such as marsh cinquefoil *(Potentilla palustris)*, northern bugleweed *(Lycopus uniflorus)*, and tufted loosestrife *(Lysimachia thyrsiflora)*. MRn93 is dominated by bulrushes *(Scirpus* spp.) and submergent aquatic species such as pondweeds and water milfoil *(Myriophyllum* spp.).

MRn93 Indicator Species	(freq%) MRn93	MRn83
False nettle *(Boehmeria cylindrica)*	**18**	-
Northern manna grass *(Glyceria borealis)*	**15**	-
Common water plantain *(Alisma triviale)*	**26**	4
Three-way sedge *(Dulichium arundinaceum)*	**18**	4
Rice cut grass *(Leersia oryzoides)*	**71**	21
River bulrush *(Scirpus fluviatilis)*	**41**	13
Nodding smartweed *(Polygonum lapathifolium)*	**24**	8
Water smartweed *(Polygonum amphibium)*	**68**	29

MRn83 Indicator Species	(freq%) MRn93	MRn83
Marsh cinquefoil *(Potentilla palustris)*	-	**13**
Cyperus sedge *(Carex pseudocyperus)*	-	**13**
Linear-leaved, Marsh, or Downy willow-herb*	3	**21**
Common bladderwort *(Utricularia vulgaris)*	9	**42**
Great water dock *(Rumex orbiculatus)*	12	**42**
Marsh bellflower *(Campanula aparinoides)*	12	**38**
Lake sedge *(Carex lacustris)*	18	**50**
Tufted loosestrife *(Lysimachia thyrsiflora)*	21	**50**

* Linear-leaved, Marsh, or Downy willow-herb *(Epilobium leptophyllum, E. palustre*, or *E. strictum)*

- **MRp93 Prairie Bulrush - Arrowhead Marsh**

MRp93 is similar to MRn93 but by convention the range of MRp93 is limited to the Prairie Parkland Province, and the range of MRn93 is limited to the Eastern Broadleaf Forest and Laurentian Mixed Forest provinces. There are too few detailed records available to identify species differences between the two classes. Collection of additonal data and further analysis may result in revision of the floristic and geographic relationships between the two classes.

- **MRu94 Lake Superior Coastal Marsh**

MRu94 is similar to MRn93 but is restricted to estuaries and embayments near the mouths of rivers flowing into Lake Superior, where seiches cause regular fluctuations in water level. MRu94 generally has higher species diversity than MRn93.

Native Plant Community Types in Class

Very little data are available for MRn93, but field observations indicate that the class can be divided into two community types based on dominant species.

- **MRn93a Bulrush Marsh (Northern)**

Emergent marshes typically dominated by bulrushes (*Scirpus* spp.).

- **MRn93b Spikerush - Bur Reed Marsh (Northern)**

Emergent marshes dominated by spikerushes (*Eleocharis* spp.) or bur reeds (*Sparganium* spp.).

photo by K. A. Rusterholz, MN DNR

Itasca County, MN

MRn93 Northern Bulrush-Spikerush Marsh — Species Frequency & Cover

Species	freq%	cover
Grasses & Sedges		
Rice cut grass *(Leersia oryzoides)*	65	●●●
Soft stem bulrush *(Scirpus validus)*	38	●●●
River bulrush *(Scirpus fluviatilis)*	38	●●●●
Red-stalked spikerush *(Eleocharis palustris)*	32	●●●
Tall manna grass *(Glyceria grandis)*	26	●●●
Lake sedge *(Carex lacustris)*	24	●●●
Common reed grass *(Phragmites australis)*	18	●●●
Three-way sedge *(Dulichium arundinaceum)*	18	●●●
Bristly sedge *(Carex comosa)*	18	●
Bluejoint *(Calamagrostis canadensis)*	18	●●
Northern manna grass *(Glyceria borealis)*	15	●
Fen wiregrass sedge *(Carex lasiocarpa)*	12	●
Woolgrass *(Scirpus cyperinus)*	12	●
Beaked sedge *(Carex utriculata)*	12	●●●
Floating-Leaved & Submergent Forbs		
Water smartweed *(Polygonum amphibium)*	65	●●
Lesser-duckweed *(Lemna minor)*	56	●●●
Greater duckweed *(Spirodela polyrhiza)*	18	●
Common white water-lily *(Nymphaea odorata)*	15	●●●
Common coontail *(Ceratophyllum demersum)*	12	●
Northern water milfoil *(Myriophyllum sibiricum)*	12	●
Flat-stemmed pondweed *(Potamogeton zosteriformis)*	12	●
Star-duckweed *(Lemna trisculata)*	12	●●
Flexuous naiad *(Najas flexilis)*	12	●
Floating pondweed *(Potamogeton natans)*	9	●
Common bladderwort *(Utricularia vulgaris)*	9	●
Straight-leaved pondweed *(Potamogeton strictifolius)*	9	●
Spiny coontail *(Ceratophyllum echinatum)*	9	●
Watershield *(Brasenia schreberi)*	6	●●
Unbranched bur reed *(Sparganium emersum)*	6	●●●●

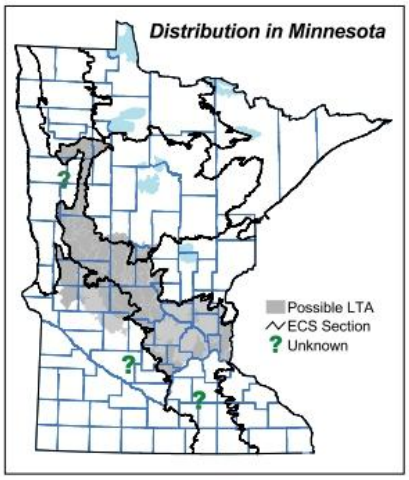
Species	freq%	cover
Emergent Forbs		
Broad-leaved arrowhead *(Sagittaria latifolia)*	68	●●●
Bur marigold and Beggarticks *(Bidens* spp.)	59	●●
Giant bur reed *(Sparganium eurycarpum)*	47	●●●●
Bulb-bearing water hemlock *(Cicuta bulbifera)*	35	●
Water parsnip *(Sium suave)*	29	●
Clearweed *(Pilea* spp.)	26	●●
Three-cleft or small bedstraw *(Galium trifidum* or *G. tinctorium)*	26	●●
Marsh skullcap *(Scutellaria galericulata)*	26	●
Tufted loosestrife *(Lysimachia thyrsiflora)*	26	●●
Common water plantain *(Alisma triviale)*	26	●●
Nodding smartweed *(Polygonum lapathifolium)*	24	●
Northern bugleweed *(Lycopus uniflorus)*	24	●●
Sweet flag *(Acorus calamus)*	21	●●●●
Common mint *(Mentha arvensis)*	21	●
Cut-leaved bugleweed *(Lycopus americanus)*	18	●
Dotted smartweed *(Polygonum punctatum)*	18	●
Broad-leaved cattail *(Typha latifolia)*	15	●
Arrow-leaved tearthumb *(Polygonum sagittatum)*	15	●
False nettle *(Boehmeria cylindrica)*	15	●●
Great water dock *(Rumex orbiculatus)*	15	●
Golden dock *(Rumex maritimus)*	15	●
Mad dog skullcap *(Scutellaria lateriflora)*	12	●
Swamp milkweed *(Asclepias incarnata)*	12	●
Bulrush *(Scirpus acutus or S. heterochaetus)*	12	●●●
Icelandic yellow cress *(Rorippa palustris)*	12	●
Labrador bedstraw *(Galium labradoricum)*	12	●
Touch-me-not *(Impatiens* spp.)	12	●
Northern blue flag *(Iris versicolor)*	9	●
Marsh bellflower *(Campanula aparinoides)*	9	●
Pennsylvania smartweed *(Polygonum pensylvanicum)*	9	●●

Southern Wet Aspen Forest

Wet to wet mesic forests on slightly raised "islands" in large open wet meadows and in transition zones between wet meadows and adjacent forested uplands. Present mostly on level to gently rolling outwash plains.

Vegetation Structure & Composition

Description is based on field observations.



- **Ground-layer** cover is patchy to continuous (25–100%) and composed of a mixture of wet prairie, wet forest and upland forest species. Common species include mountain rice grass *(Oryzopsis asperifolia)*, bluejoint *(Calamagrostis canadensis)*, false melic grass *(Schizachne purpurascens)*, long-stalked sedge *(Carex pedunculata)*, large-leaved aster *(Aster macrophyllus)*, wild sarsaparilla *(Aralia nudicaulis)*, dwarf raspberry *(Rubus pubescens)*, common strawberry *(Fragaria virginiana)*, Canada mayflower *(Maianthemum canadense)*, Peck's sedge *(Carex peckii)*, and field horsetail *(Equisetum arvense)*. In wetter parts of the community, lake sedge *(Carex lacustris)*, tussock sedge *(C. stricta)*, Hayden's sedge *(C. haydenii)*, swamp thistle *(Cirsium muticum)*, spotted water hemlock *(Cicuta maculata)*, and bottle gentian *(Gentiana andrewsii)* are common.
- **Shrub layer** cover is patchy to interrupted (25–75%). Common species include downy arrowwood *(Viburnum rafinesquianum)*, Saskatoon juneberry *(Amelanchier alnifolia)*, chokecherry *(Prunus virginiana)*, gray dogwood *(Cornus racemosa)*, prickly rose *(Rosa acicularis)*, wild honeysuckle *(Lonicera dioica)*, highbush cranberry *(Viburnum trilobum)*, pussy willow *(Salix discolor)*, beaked hazelnut *(Corylus cornuta)*, red raspberry *(Rubus idaeus)*, poison ivy *(Toxicodendron rydbergii)*, and nannyberry *(Viburnum lentago)*.
- **Subcanopy** cover is patchy to interrupted (25–75%). The most common species are quaking aspen, bur oak, American elm, and black ash.
- **Canopy** cover is mostly interrupted to continuous (50–100%). The most common species are quaking aspen, black ash, and bur oak.

Landscape Setting & Soils

WFs55 occurs on level to gently rolling outwash plains. Parent material is deep, circumneutral, sandy glacial outwash. Soil texture is sandy-loam over loose sand. The top 14in (35cm) are very dark to dark. Below this, soils are grayish to light brownish gray. Soils are moderately well drained to poorly drained with moderate to high organic matter. The water table is usually not high enough to affect the ground-layer composition of the community or to cause peat accumulation.

Natural History

Wet aspen forests develop in the absence of fire on small, slightly raised "islands" in areas of open wet prairie, wet meadow, or shrub swamp. They may also occur in transition areas between wet prairies and upland forests and around the edges of wet meadows. Soil moisture can vary from site to site. In transition areas between uplands and lowlands and also around the edges of raised islands, where broad-leaved sedges are dominant, soils are wet. In the interior of these islands, species with affinity for mesic and dry-mesic soils are common.

Similar Native Plant Community Classes

- **WFs57 Southern Wet Ash Swamp**

The range of WFs57 overlaps with WFs55 in southern and western Minnesota. WFs57 is

almost always dominated by black ash and has little if any quaking aspen, while WFs55 is dominated by quaking aspen with only scattered black ash. WFs57 is generally wetter than WFs55 and is more likely to have shallow open pools and wetland plants such as marsh marigold *(Caltha palustris)*, fowl manna grass *(Glyceria striata)*, and brome-like sedge *(Carex bromoides)* in the ground layer. WFs57 is dependent on groundwater seepage and is often present at the bases of steep slopes in strongly rolling to steeply dissected terrain. WFs55 is more likely to have species characteristic of dry-mesic to mesic woodlands and wet meadows such as gray dogwood, false melic grass, and Hayden's sedge *(Carex haydenii)*.

- **WFw54 Northwestern Wet Aspen Forest**

WFw54 is very similar to WFs55 but occurs only in the extreme northwestern part of the state on lacustrine deposits in the Glacial Lake Agassiz plain. WFw54 is more likely to have occasional white spruce or tamarack in the canopy or understory, while WFs55 is more likely to have bur oak.

Native Plant Community Types in Class

- **WFs55a Lowland Aspen Forest**

WFs55a is the only plant community type recognized in this class. Further sampling and analysis is needed to better describe the community class and may result in alteration of the concept of the community.

photo by T.J. Whitfield MN DNR

Ottertail County, MN

FDs37

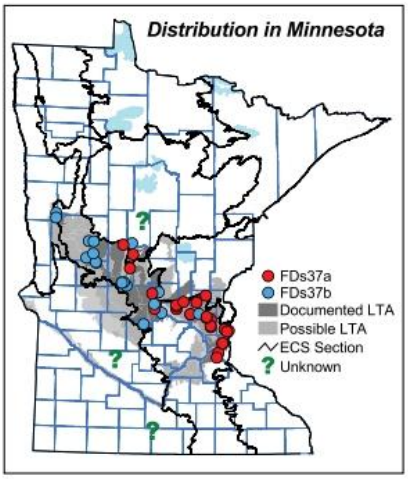
FIRE-DEPENDENT FOREST/WOODLAND SYSTEM
Southern Floristic Region

Southern Dry-Mesic Oak (Maple) Woodland

Dry-mesic hardwood forests on undulating sand flats, hummocky moraines, and river bluffs. Present mostly on fine sand or sand-gravel soils. Often on south- or west-facing slopes but common also on flat to undulating sandy lake plains. Historically, fires were common in this community, and many stands are on sites occupied by brushlands 100–150 years ago.

Vegetation Structure & Composition

Description is based on summary of vegetation data from 43 plots (relevés).



- **Ground-layer** cover is patchy to continuous (25–100%). Pointed-leaved tick trefoil *(Desmodium glutinosum)*, Clayton's sweet cicely *(Osmorhiza claytonii)*, hog peanut *(Amphicarpaea bracteata)*, Canada mayflower *(Maianthemum canadense)*, and wild geranium *(Geranium maculatum)* are commonly present. Pennsylvania sedge *(Carex pensylvanica)* is the most abundant graminoid. Dewey's sedge *(Carex deweyana)* and starry sedge *(Carex rosea)* may also be present.
- **Shrub-layer** cover is patchy to continuous (25–100%). Common species include black cherry, red maple, chokecherry *(Prunus virginiana)*, American hazelnut *(Corylus americana)*, gray dogwood *(Cornus racemosa)*, prickly ash *(Zanthoxylum americanum)*, Virginia creeper *(Parthenocissus* spp.), and poison ivy *(Toxicodendron rydbergii)*.
- **Subcanopy** cover is patchy to interrupted (25–75%). The most common species are black cherry, red maple, and bur oak.
- **Canopy** cover is usually interrupted to continuous (50–100%). Bur oak and northern pin oak are the most common species. Northern red oak, white oak, and red maple are occasionally present. Older trees are often open grown, indicating previously more open conditions on the site.
- **Note:** Red maple and white oak are generally absent from occurrences in the CGP.

Landscape Setting & Soils

- **Glacial lake plains**—Common. Present on undulating sand flats that were deposited in the shallow waters of Glacial Lake Grantsburg. Parent material is stoneless, well-sorted fine sand. It was initially calcareous, but soils are now leached of carbonates. Subsoil horizons capable of perching snowmelt are lacking, but general fine-sand texture and occasional bands of silt and gravel can help to retain some soil moisture. Densely cemented layers of sand that may reflect past positions of the water table occur at depth and can help hold water for deeply rooted plants. Soils are excessively drained and the soil-moisture regime is moderately dry. (Anoka Sand Plain in MIM)
- **Stagnation moraines**—Occasional. Present on hummocky moraines, often adjacent to fire-prone outwash plains and tunnel valleys that were occupied in the past by brushland or prairie. Parent material is a discontinuous cap of partially sorted gravelly sand over a base of denser till and is often complexly stratified. Parent material can be calcareous or noncalcareous; when calcareous, soils are leached of free carbonates to at least 30in (75cm). Although some clays have accumulated in the subsoil, clays are insufficient to perch snowmelt and rainfall. The complex stratification allows these sites to retain some rainfall, and water is available to deeply rooted plants just above the dense till. Where the sandy cap is thick, the soils are excessively drained, and the soil-moisture regime is moderately dry. Where the cap is thinner, the soils are well drained, and the soil-moisture regime is fresh. (St. Paul-Baldwin Plains and Hardwood Hills in MIM; locally in Pine Moraines and Outwash Plains in MDL; and Minnesota River Prairie in CGP)

• **River bluffs**—Common. Present on steep (20–50%) south- or west-facing slopes along the Minnesota River valley and other major streams. Soils are developed on eroded calcareous till or cut-faces of gravelly terraces well above modern alluvium. Free carbonates are present at or close to the surface and topsoil layers are thin because of surface erosion. Soils are somewhat excessively to excessively drained. Soil moisture regime is dry to moderately fresh. (Minnesota River Prairie in CGP)

Natural History

In the past, fires were very common throughout the range of FDs37. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was about 110 years, and the rotation of mild surface fires about 10 years.[1] The rotation of all fires combined is estimated to be 9 years. Windthrow was not common, with an estimated rotation exceeding 1,000 years. Based on the historic composition and age structure of these forests, FDs37 had two growth stages.

• **0–75 years**—Young forests recovering from fire, dominated by bur oak with some northern red oak or white oak. Quaking aspen, northern pin oak, and black cherry are minor components.

• **> 75 years**—Mature forests dominated by a mixture of bur oak, white oak, northern pin oak, and some northern red oak, with minor amounts of American elm. (In the past, sites now occupied by FDs37 typically supported more open communities, including brush-prairie or savanna. Air photos from the 1930s show these sites to have scattered oaks rather than forest canopies. With suppression of wildfires since the mid-1800s, these sites have developed denser tree canopies and herbs typical of mesic forests have become common in the understory. The examples of FDs37 used in this classification are best described by the mature forest growth stage.)

Similar Native Plant Community Classes

• **FDs36 Southern Dry-Mesic Oak-Aspen Forest**

FDs36 can be similar to FDs37, and the ranges of the two communities overlap in the central part of the Hardwood Hills Subsection in the MIM and adjacent parts of the RRV. FDs36 tends to occur on loamy rather than fine sand or sand-gravel soils.

FDs37 Indicator Species	(freq%) *FDs37*	FDs36
Northern pin oak (C,U)	**60**	-
Tall blackberries*	**53**	-
Large-leaved aster *(Aster macrophyllus)*	**51**	-
Wild geranium *(Geranium maculatum)*	**71**	4
Red maple (C,U)	**67**	4
Lady fern *(Athyrium filix-femina)*	**53**	8
Black cherry (C,U)	**87**	16
Northern bedstraw *(Galium boreale)*	**40**	8

FDs36 Indicator Species	(freq%) FDs37	*FDs36*
Canada goldenrod *(Solidago canadensis)*	2	**32**
Tall coneflower *(Rudbeckia laciniata)*	2	**28**
Golden alexanders *(Zizia aurea)*	2	**28**
Basswood (C)	4	**40**
American elm (C)	7	**36**
Large-flowered bellwort *(Uvularia grandiflora)*	20	**88**
Lindley's aster *(Aster ciliolatus)*	16	**64**
Bloodroot *(Sanguinaria canadensis)*	9	**32**

*Tall blackberries *(Rubus allegheniensis* and similar *Rubus* spp.)

• **MHc26 Central Dry-Mesic Oak-Aspen Forest**

MHc26 generally occurs to the north and east of FDs37, although the ranges of the two classes overlap along the border between the EBF and LMF Provinces. The presence of sugar maple, especially in the canopy, differentiates MHc26 from FDs37.

FDs37 Indicator Species	(freq%) *FDs37*	MHc26
Box elder (U)	**42**	-
Prickly ash *(Zanthoxylum americanum)*	**67**	4
Northern pin oak (C,U)	**60**	4
Black cherry (C)	**29**	3
Wild grape *(Vitis riparia)*	**62**	7
Giant Solomon's seal *(Polygonatum biflorum)*	**27**	4
Lopseed *(Phryma leptostachya)*	**62**	9
Wild geranium *(Geranium maculatum)*	**71**	13

MHc26 Indicator Species	(freq%) FDs37	*MHc26*
Fly honeysuckle *(Lonicera canadensis)*	-	**32**
Sugar maple (C,U)	4	**71**
Large-flowered trillium *(Trillium grandiflorum)*	2	**29**
Bluebead lily *(Clintonia borealis)*	2	**27**
Basswood (C)	4	**45**
Rose twistedstalk *(Streptopus roseus)*	7	**54**
Round-lobed hepatica *(Anemone americana)*	7	**47**
Pagoda dogwood *(Cornus alternifolia)*	13	**61**

[1]Forested communities that extend into the prairie regions of Minnesota tend to have shorter rotations of disturbance from fire (and often wind) on the western edge of their range compared with the eastern part. This probably results from drier climate in the west and being surrounded by prairie vegetation that burns frequently. Because estimated rotations of disturbance for forested communities are calculated from PLS bearing-tree records across the range of the community, and records in the prairie regions are often much sparser than those to the east, disturbance rotations may be much shorter for forest stands in the prairie regions than those presented for the class as a whole.

• FDc34 Central Dry-Mesic Pine-Hardwood Forest

FDc34 generally occurs north of FDs37; the presence of conifers almost always distinguishes FDc34 from FDs37.

FDs37 Indicator Species	(freq%) FDs37	FDc34
Prickly ash (*Zanthoxylum americanum*)	67	-
Box elder (U)	42	-
Wild grape (*Vitis riparia*)	62	2
Lopseed (*Phryma leptostachya*)	62	2
Northern pin oak (C,U)	60	2
Wild geranium (*Geranium maculatum*)	71	3
Common enchanter's nightshade (*Circaea lutetiana*)	60	3
Pointed-leaved tick trefoil (*Desmodium glutinosum*)	80	7

FDc34 Indicator Species	(freq%) FDs37	FDc34
Red pine (C)	-	51
Bunchberry (*Cornus canadensis*)	-	39
Bluebead lily (*Clintonia borealis*)	2	46
Rose twistedstalk (*Streptopus roseus*)	7	68
White pine (C,U)	4	41
Paper birch (U)	7	51
Round-lobed hepatica (*Anemone americana*)	7	39
Lowbush blueberry (*Vaccinium angustifolium*)	13	61

• MHc36 Central Mesic Hardwood Forest (Eastern)

MHc36 can be similar to FDs37 when FDs37 is dominated by northern red oak (FDs37a). FDs37, however, generally lacks sugar maple, which is prominent in MHc36.

FDs37 Indicator Species	(freq%) FDs37	MHc36
Northern pin oak (C,U)	50	2
Prickly or Smooth wild rose*	27	2
Nannyberry (*Viburnum lentago*)	46	4
Black cherry (C)	38	4
Gray dogwood (*Cornus racemosa*)	62	7
Tall blackberries**	73	9
Wild grape (*Vitis riparia*)	69	10
American hazelnut (*Corylus americana*)	85	12

MHc36 Indicator Species	(freq%) FDs37	MHc36
Leatherwood (*Dirca palustris*)	-	38
Zigzag goldenrod (*Solidago flexicaulis*)	4	79
Long-stalked sedge (*Carex pedunculata*)	4	53
Large-flowered trillium (*Trillium grandiflorum*)	4	52
Sugar maple (C,U)	8	91
Basswood (C)	8	87
Blue beech (U)	4	40
Bloodroot (*Sanguinaria canadensis*)	8	58

*Prickly or Smooth wild rose (*Rosa acicularis* or *R. blanda*) **Tall blackberries (*Rubus allegheniensis* and similar *Rubus* spp.)

• MHs37 Southern Dry-Mesic Oak Forest

MHs37 can be similar to FDs37 but is more likely to occur on loamy soils (at least in the upper soil layers) than on fine sand or sand-gravel soils. MHs37 occurs on sites less affected by fire in the recent past and therefore generally lacks the open-grown canopy trees often present in FDs37.

FDs37 Indicator Species	(freq%) FDs37	MHs37
Mountain rice grass (*Oryzopsis asperifolia*)	42	-
Large-leaved aster (*Aster macrophyllus*)	51	2
Bush honeysuckle (*Diervilla lonicera*)	36	2
Red maple (C,U)	67	7
Pale bellwort (*Uvularia sessilifolia*)	62	7
Quaking aspen (C,U)	29	5
Spreading dogbane (*Apocynum androsaemifolium*)	40	7
Northern pin oak (C,U)	60	23

MHs37 Indicator Species	(freq%) FDs37	MHs37
Maidenhair fern (*Adiantum pedatum*)	-	56
Spreading Jacob's ladder (*Polemonium reptans*)	-	47
Gregarious black snakeroot (*Sanicula gregaria*)	4	58
Bitternut hickory (C,U)	4	56
Sugar maple (C,U)	4	51
White snakeroot (*Eupatorium rugosum*)	7	65
Hackberry (C,U)	9	60
Honewort (*Cryptotaenia canadensis*)	13	72

• FDs27 Southern Dry-Mesic Pine-Oak Woodland

The range of FDs27 occasionally overlaps with FDs37 in the area around the Twin Cities, where it occurs on deep sands that accumulate along valley walls of tributaries to the Mississippi River.

FDs37 Indicator Species	(freq%) FDs37	FDs27
Red maple (C,U)	67	-
Pale bellwort (*Uvularia sessilifolia*)	62	-
Large-leaved aster (*Aster macrophyllus*)	51	-
Mountain rice grass (*Oryzopsis asperifolia*)	42	-
Beaked hazelnut (*Corylus cornuta*)	24	-
Starflower (*Trientalis borealis*)	22	-
Downy arrowwood (*Viburnum rafinesquianum*)	49	8
Nannyberry (*Viburnum lentago*)	42	8

FDs27 Indicator Species	(freq%) FDs37	FDs27
Flowering spurge (*Euphorbia corollata*)	-	62
Heart-leaved aster (*Aster cordifolius*)	-	46
Downy rattlesnake plantain (*Goodyera pubescens*)	-	38
Bitternut hickory (C,U)	4	62
Eastern red cedar (C,U)	4	62
White pine (C,U)	4	54
White snakeroot (*Eupatorium rugosum*)	7	69
Black raspberry (*Rubus occidentalis*)	9	54

• FDc25 Central Dry Oak-Aspen (Pine) Woodland

The range of FDc25 overlaps with FDs37 in east-central Minnesota, where FDc25 occurs on level lake plains and on glacial river terraces. Species more commonly found in prairies are often present in FDc25 while generally absent from FDs37.

FDs37 Indicator Species	(freq%) FDs37	FDc25
Box elder (U)	42	-
Common enchanter's nightshade *(Circaea lutetiana)*	60	3
Prickly ash *(Zanthoxylum americanum)*	67	7
Lopseed *(Phryma leptostachya)*	62	7
Black cherry (C)	29	3
Lady fern *(Athyrium filix-femina)*	53	7
Missouri gooseberry *(Ribes missouriense)*	24	3
Wild geranium *(Geranium maculatum)*	71	13

FDc25 Indicator Species	(freq%) FDs37	FDc25
Wintergreen *(Gaultheria procumbens)*	-	47
Wild bergamot *(Monarda fistulosa)*	-	37
Jack pine (C)	-	30
Prairie willow *(Salix humilis)*	-	30
Yarrow *(Achillea millefolium)*	2	43
Big-toothed aspen (U)	4	33
Lowbush blueberry *(Vaccinium angustifolium)*	13	93
Veiny pea *(Lathyrus venosus)*	7	47

Native Plant Community Types in Class

- **FDs37a Oak - (Red Maple) Woodland**

Canopy is dominated by northern red oak, northern pin oak, and white oak with lesser amounts of bur oak and red maple. Red maple is also common in the subcanopy and shrub layers. Chokecherry, American hazelnut, gray dogwood, and prickly ash are common in the shrub layer. FDs37a is distinguished from FDs37b by the presence of northern red oak or white oak in the canopy or understory. Other species that can help to differentiate FDs37a from FDs37b include red maple, bush honeysuckle *(Diervilla lonicera)*, lady fern *(Athyrium filix-femina)*, interrupted fern *(Osmunda claytoniana)*, and starflower *(Trientalis borealis)*. FDs37a has been documented in the MIM and MDL; it is most common in the Anoka Sand Plain Subsection in the MIM. Description is based on summary of vegetation data from 26 plots.

- **FDs37b Pin Oak - Bur Oak Woodland**

Canopy has abundant northern pin oak and bur oak. The subcanopy is not well differentiated from the canopy; bur oak, black cherry, and green ash are the most common subcanopy species. The shrub layer is often dense, with prickly ash, chokecherry, American hazelnut, gray dogwood, prickly gooseberry *(Ribes cynosbati)*, and downy arrowwood *(Viburnum rafinesquianum)* all common. FDs37b is distinguished from FDs37a by the greater dominance of northern pin oak and bur oak in the canopy. Other species that help to differentiate FDs37b from FDs37a when present include green ash, wild honeysuckle *(Lonicera dioica)*, snowberry or wolfberry *(Symphoricarpos* spp.), giant Solomon's seal *(Polygonatum biflorum)*, Lindley's aster *(Aster ciliolatus)*, and side-flowering aster *(Aster lateriflorus)*. FDs37b has been documented in the MIM and CGP, where it is most common in the Hardwood Hills Subsection with occasional occurrences in the Anoka Sand Plain and Minnesota River Prairie Subsections. (Occurrences in the Minnesota River Prairie Subsection and other parts of southwestern Minnesota are included on the basis of field observations; few samples from FD communities are available for this part of the state.) Description is based on summary of vegetation data from 18 plots.

photo by D.S. Wovcha MN DNR

Boot Lake Scientific and Natural Area, Anoka County, MN

FDs37 Southern Dry-Mesic Oak (Maple) Woodland — Species Frequency and Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Clayton's sweet cicely *(Osmorhiza claytonii)*	78	●●
Pointed-leaved tick trefoil *(Desmodium glutinosum)*	78	●●
Hog peanut *(Amphicarpaea bracteata)*	76	●●
Canada mayflower *(Maianthemum canadense)*	73	●
Wild geranium *(Geranium maculatum)*	69	●●
Common enchanter's nightshade *(Circaea lutetiana)*	60	●
Wild sarsaparilla *(Aralia nudicaulis)*	60	●
Lopseed *(Phryma leptostachya)*	60	●
Common false Solomon's seal *(Smilacina racemosa)*	60	●
Pale bellwort *(Uvularia sessilifolia)*	60	●●
Lady fern *(Athyrium filix-femina)*	51	●
Bracken *(Pteridium aquilinum)*	51	●●
Sweet-scented bedstraw *(Galium triflorum)*	51	●
Large-leaved aster *(Aster macrophyllus)*	49	●●
Columbine *(Aquilegia canadensis)*	40	●
Northern bedstraw *(Galium boreale)*	40	●
Wood anemone *(Anemone quinquefolia)*	40	●
Spreading dogbane *(Apocynum androsaemifolium)*	38	●
Maryland black snakeroot *(Sanicula marilandica)*	36	●
Early meadow-rue *(Thalictrum dioicum)*	31	●
Giant Solomon's seal *(Polygonatum biflorum)*	27	●
Starry false Solomon's seal *(Smilacina stellata)*	22	●
Starflower *(Trientalis borealis)*	20	●
Interrupted fern *(Osmunda claytoniana)*	20	●●
Large-flowered bellwort *(Uvularia grandiflora)*	20	●●
Elliptic shinleaf *(Pyrola elliptica)*	20	●
Tall-leaved aster *(Aster sagittifolius)*	18	●
Grasses & Sedges		
Pennsylvania sedge *(Carex pensylvanica)*	84	●●●
Moutain rice grass *(Oryzopsis asperifolia)*	40	●
Nodding fescue *(Festuca subverticillata)*	11	●
Bottlebrush grass *(Elymus hystrix)*	11	●
Woody Vines		
Virginia creeper *(Parthenocissus spp.)*	91	●
Wild grape *(Vitis riparia)*	62	●
Low Shrubs		
Red raspberry *(Rubus idaeus)*	64	●
Tall blackberries *(Rubus allegheniensis* and similar *Rubus* spp.)	47	●
Tall Shrubs		
Chokecherry *(Prunus virginiana)*	82	●●
American hazelnut *(Corylus americana)*	80	●●●
Gray dogwood *(Cornus racemosa)*	67	●●●
Prickly ash *(Zanthoxylum americanum)*	67	●●
Poison ivy *(Toxicodendron rydbergii)*	64	●
Prickly gooseberry *(Ribes cynosbati)*	49	●
Downy arrowwood *(Viburnum rafinesquianum)*	49	●●
Juneberries *(Amelanchier* spp.)	47	●
Nannyberry *(Viburnum lentago)*	42	●
Bush honeysuckle *(Diervilla lonicera)*	33	●
Missouri gooseberry *(Ribes missouriense)*	24	●
Beaked hazelnut *(Corylus cornuta)*	22	●●●
Snowberry or Wolfberry *(Symphoricarpos albus* or *S. occidentalis)*	20	●
Red-berried elder *(Sambucus racemosa)*	20	●
Round-leaved dogwood *(Cornus rugosa)*	16	●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Bur oak	67	●●●	58	●●	33	●
Northern pin oak	60	●●●●	33	●●●	38	●
Northern red oak	33	●●●●	13	●●●	22	●
White oak	29	●●●	9	●●	18	●
Black cherry	29	●	58	●●	69	●
Quaking aspen	27	●●	18	●●	18	●
Red maple	27	●●	56	●●●	53	●
Paper birch	20	●●	-	-	-	-
Big-toothed aspen	11	●●●	-	-	-	-
Green ash	9	●●●	31	●●	36	●
American elm	-	-	31	●●	33	●
Ironwood	-	-	29	●●●	18	●●

UPs23

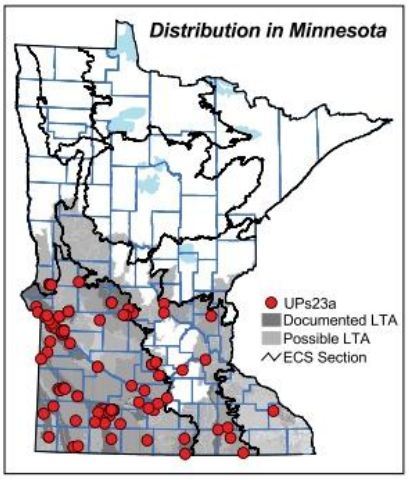
UPLAND PRAIRIE SYSTEM
Southern Floristic Region

Southern Mesic Prairie

Grass-dominated but forb-rich herbaceous communities on somewhat poorly drained to well-drained loam soils mainly formed in unsorted glacial till, sometimes in a thin loess layer over till, and locally in lacustrine sediments and outwash deposits. Communities in this class occur primarily on level to gently rolling sites. Drought stress is irregular in occurrence and usually not severe.

Vegetation Structure & Composition

Description is based on summary of vegetation data from 102 plots (relevés).



- **Graminoid** cover is usually continuous (75–100%). Tallgrasses dominate, but several midheight grasses are also important. Species composition is fairly uniform, although relative abundances shift across the moisture gradient within the community. Big bluestem *(Andropogon gerardii)* and Indian grass *(Sorghastrum nutans)* are the dominant tallgrasses, with prairie dropseed *(Sporobolus heterolepis)* either a codominant or subdominant component. On the drier end of the gradient, little bluestem *(Schizachyrium scoparium)*, porcupine grass *(Stipa spartea)*, and side-oats grama *(Bouteloua curtipendula)* are important. On moister sites, switchgrass *(Panicum virgatum)* may be common, and prairie cordgrass *(Spartina pectinata)* is usually present. Leiberg's panic grass *(Panicum leibergii)* is distinctive, although usually minor in terms of cover.
- **Forb** cover is sparse to patchy (5–50%). Forb species composition also responds to moisture. A number of species are common across the moisture gradient, including heart-leaved alexanders *(Zizia aptera)*, heath aster *(Aster ericoides)*, stiff and Canada goldenrods *(Solidago rigida* and *S. canadensis)*, purple and white prairie clovers *(Dalea purpurea* and *D. candida)*, silverleaf scurfpea *(Pediomelum argophyllum)*, stiff sunflower *(Helianthus pauciflorus)*, white sage *(Artemisia ludoviciana)*, northern bedstraw *(Galium boreale)*, and smooth blue aster *(Aster laevis)*. Maximilian's sunflower *(Helianthus maximiliani)*, tall meadow-rue *(Thalictrum dasycarpum)*, prairie phlox *(Phlox pilosa)*, and gray-headed coneflower *(Ratibida pinnata)* are most common on the moister end of the gradient. Rough blazing star *(Liatris aspera)*, Missouri and gray goldenrods *(Solidago missouriensis* and *S. nemoralis)*, and bird's foot coreopsis *(Coreopsis palmata)* are common in the drier end. Rattlesnake master *(Eryngium yuccifolium)* and compass plant *(Silphium laciniatum)* are typical species in southeastern Minnesota but rare to absent in the community elsewhere. Narrow-leaved purple coneflower *(Echinacea pallida)* is common in the drier end of the gradient in the CGP but absent from the Eastern Broadleaf Forest Province.
- **Shrub layer** is sparse (5–25% cover). The low semi-shrubs leadplant *(Amorpha canescens)* and prairie rose *(Rosa arkansana)* are generally common. Sparse patches of wolfberry *(Symphoricarpos occidentalis)* are occasional. Gray dogwood *(Cornus racemosa)*, American hazelnut *(Corylus americana)*, and wild plum *(Prunus americana)* are rare.
- **Trees** are absent except where fire suppression has allowed invasion by woody species.
- **Notes**: Kentucky bluegrass *(Poa pratensis)*, an introduced species, is invariably present; it increases in the prolonged absence of fire but becomes dominant only with heavy grazing pressure. Smooth brome *(Bromus inermis)*, another exotic, is a very troublesome invasive species favored by disturbance, including natural disturbance by pocket gophers.

Landscape Setting & Soils

The region of Minnesota in which UPs23 occurs is predominantly a low-relief landscape interrupted by local areas of greater relief associated with stagnation moraines and large erosional features created by glacial meltwaters. The deeply dissected PPL in the southeast corner of the state, where UPs23 is rare, is exceptional. Historically in the PPL, UPs23 was confined to the tops of broader interfluves. UPs23 typically occupies ground moraines and end moraines and smaller inclusions of outwash and lacustrine sediments. In southwestern and southeastern Minnesota, outside the boundaries of the Wisconsin glacial deposits, UPs23 occurs on older, loess-mantled ground moraines. Soils are somewhat poorly drained to well drained, mostly moderately permeable to permeable, fine- and medium-textured loams and loamy sands. Soils are mollisols, characterized by thick, dark, organic-enriched upper horizons with high base saturation and dominantly bivalent cations.

Natural History

UPs23 is present on level to gently sloping sites where the water table is below the rooting zone except for brief periods during the growing season. Soil moisture availability remains high on average because of soil texture and composition. Recurrent fire is essential for the existence of UPs23, as environmental conditions are otherwise suitable for the growth of trees; where propagules are available, succession to forest occurs rapidly in the absence of fire. Fires also recycle nutrients bound up in litter and promote flowering and seed production. These events temporarily expose the soil surface and so probably play an important role in plant regeneration. Before Euro-American settlement, grazing and trampling by large ungulates were regular occurrences in UPs23. The contribution of this disturbance to the composition and structure of the vegetation is not well understood, although it is known that confined grazing by domestic livestock can quickly destroy mesic prairies, promoting the replacement of most native species by introduced ones. Episodic grazing probably enables the persistence of some native species that cannot otherwise reproduce in the dense canopy of tall grasses and forbs characteristic of UPs23; these would include shorter species and especially annual or biennial species. Spatial patchiness in grazing intensity is also thought to have influenced fire behavior, providing a shifting patchwork of refugia for fire-sensitive animal species. The fertile soils and gentle relief of UPs23 are ideal for row-crop agriculture, and almost all of the land that supported this class has been converted to cropland.

Similar Native Plant Community Classes

- **UPn23 Northern Mesic Prairie**

UPn23 differs from UPs23 mainly in the rarity or absence of several species typically present in UPs23, although none is present throughout the range of UPs23. Shrubs become increasingly important northward in UPn23. Tufted hairgrass *(Deschampsia cespitosa)*, absent from UPs23, is present in UPn23, although limited to wet-mesic occurrences. The boundary between these two classes is set more or less by convention; further study may determine that it should be repositioned or abandoned. Because of differences between the predominant glacial landforms in the ranges of the two classes, wet-mesic prairies are more common in UPn23 and dry-mesic prairies more common in UPs23. This imbalance seems to account for most of the differences in species frequency and cover between these two classes.

UPs23 Indicator Species	(freq%) *UPs23*	UPn23
Gray-headed coneflower *(Ratibida pinnata)*	**36**	-
Bird's foot coreopsis *(Coreopsis palmata)*	**30**	-
Skyblue aster *(Aster oolentangiensis)*	**18**	-
Clammy ground cherry *(Physalis heterophylla)*	**14**	-
Bicknell's sedge *(Carex bicknellii)*	**11**	-
Round-headed bush clover *(Lespedeza capitata)*	**10**	-
Canada tick trefoil *(Desmodium canadense)*	**17**	1
Aromatic aster *(Aster oblongifolius)*	**10**	2

UPn23 Indicator Species	(freq%) UPs23	*UPn23*
Tufted hair grass *(Deschampsia cespitosa)*	-	**35**
Harebell *(Campanula rotundifolia)*	2	**48**
Bebb's willow *(Salix bebbiana)*	2	**24**
Glaucous false dandelion *(Agoseris glauca)*	2	**24**
-	-	-
-	-	-
-	-	-
-	-	-

- **UPs24 Southern Mesic Savanna**

Scarcity of data for UPs24 makes comparison with UPs23 speculative. The herbaceous component of the two classes is probably similar, although forbs possibly are more important relative to graminoids in UPs24 than in UPs23. UPs24 is distinguished by the presence of at least sparse (> 10%) tree cover, dominated by bur oak.

- **UPs13 Southern Dry Prairie**

The greater importance of midheight grasses relative to tallgrass species in UPs13 results in generally lower canopy height in UPs13 than in UPs23. UPs13 typically has sparser vegetation cover, with some bare soil exposed, often with terricolous lichens, while the soil surface is completely hidden in UPs23. There is little difference in species composition between drier examples of UPs23 and occurrences of UPs13 on loamier soils. Topography, soil characteristics, and relative abundances of species characteristic of dry versus mesic habitats provide the basis for determination.

UPs23 Indicator Species	(freq%) ***UPs23***	UPs13
Prairie cordgrass *(Spartina pectinata)*	**30**	-
American vetch *(Vicia americana)*	**23**	1
Ox-eye *(Heliopsis helianthoides)*	**31**	2
Tall meadow-rue *(Thalictrum dasycarpum)*	**44**	5
Maximilian's sunflower *(Helianthus maximiliani)*	**31**	4
Switchgrass *(Panicum virgatum)*	**44**	8
Silverleaf scurfpea *(Pediomelum argophyllum)*	**43**	12
Leiberg's panic grass *(Panicum leibergii)*	**43**	16

UPs13 Indicator Species	(freq%) UPs23	***UPs13***
Hairy grama *(Bouteloua hirsuta)*	-	**30**
Dotted blazing star *(Liatris punctata)*	1	**34**
Sage wormwood *(Artemisia frigida)*	1	**23**
Flowering spurge *(Euphorbia corollata)*	1	**22**
Harebell *(Campanula rotundifolia)*	2	**25**
Western ragweed *(Ambrosia psilostachya)*	4	**26**
Plains muhly *(Muhlenbergia cuspidata)*	11	**56**
Hoary vervain *(Verbena stricta)*	5	**23**

- **WPs54 Southern Wet Prairie**

WPs54 grades into UPs23 at the moist end of the moisture gradient in UPs23, without a distinct floristic boundary between the two classes. WPs54 is always present on level or slightly concave sites except in the unusual situation where groundwater seepage creates moist habitat. Prairie cordgrass is typically much more important in WPs54 than in UPs23, as are sedges *(Carex* spp.). Big bluestem is typically present, although its contribution to total cover is usually less than in UPs23, and it may be absent. Leadplant is present in most instances of UPs23 and rarely present in WPs54.

UPs23 Indicator Species	(freq%) ***UPs23***	WPs54
Stiff sunflower *(Helianthus pauciflorus)*	**50**	-
White sage *(Artemisia ludoviciana)*	**43**	-
Porcupine grass *(Stipa spartea)*	**58**	2
Leiberg's panic grass *(Panicum leibergii)*	**43**	2
Leadplant *(Amorpha canescens)*	**74**	6
Missouri goldenrod *(Solidago missouriensis)*	**47**	4
Rough blazing star *(Liatris aspera)*	**59**	6
White prairie clover *(Dalea candida)*	**55**	8

WPs54 Indicator Species	(freq%) UPs23	***WPs54***
Bluejoint *(Calamagrostis canadensis)*	1	**25**
Spotted water hemlock *(Cicuta maculata)*	2	**35**
Autumn sneezeweed *(Helenium autumnale)*	3	**37**
Prairie loosestrife *(Lysimachia quadriflora)*	4	**33**
Riddell's goldenrod *(Solidago riddellii)*	6	**41**
Golden or False golden ragwort*	9	**43**
Stemless blue violets**	9	**41**
Woolly sedge *(Carex pellita)*	9	**41**

*Golden or False golden ragwort *(Senecio aureus* or *S.pseudaureus)* **Stemless blue violets *(Viola nephrophylla* and similar *Viola* spp.)

Native Plant Community Types in Class

- **UPs23a Mesic Prairie (Southern)**

UPs23a is the only community type recognized in this class. Additional data and further analysis may warrant subdivision based on soils (sands versus loams) and differences in moisture regime (dry-mesic versus wet-mesic).

photo by R. P. Dana MN DNR

Schaefer Prairie, McLeod County, MN

UPs23 Southern Mesic Prairie — Species Frequency & Cover

Species	freq%	cover
Forbs, Ferns & Fern Allies		
Heart-leaved alexanders *(Zizia aptera)*	78	•
Heath aster *(Aster ericoides)*	77	••
Stiff goldenrod *(Solidago rigida)*	74	•
Canada goldenrod *(Solidago canadensis)*	69	••
Purple prairie clover *(Dalea purpurea)*	68	•
Yarrow *(Achillea millefolium)*	65	•
Rough blazing star *(Liatris aspera)*	59	•
Prairie phlox *(Phlox pilosa)*	55	•
White prairie clover *(Dalea candida)*	55	•
Hoary puccoon *(Lithospermum canescens)*	53	•
Stiff sunflower *(Helianthus pauciflorus)*	50	•
Prairie wild onion *(Allium stellatum)*	49	•
Missouri goldenrod *(Solidago missouriensis)*	47	••
Long-headed thimbleweed *(Anemone cylindrica)*	46	•
Bearded birdfoot violet *(Viola palmata)*	45	•
Flodman's thistle *(Cirsium flodmanii)*	45	•
Tall meadow-rue *(Thalictrum dasycarpum)*	44	•
Daisy fleabane *(Erigeron strigosus)*	44	•
Silverleaf scurfpea *(Pediomelum argophyllum)*	43	•
White sage *(Artemisia ludoviciana)*	43	•
Northern bedstraw *(Galium boreale)*	39	••
Smooth blue aster *(Aster laevis)*	37	•
Gray-headed coneflower *(Ratibida pinnata)*	36	••
Silky aster *(Aster sericeus)*	34	•
Maximilian's sunflower *(Helianthus maximiliani)*	31	••
Gray goldenrod *(Solidago nemoralis)*	31	••
Ox-eye *(Heliopsis helianthoides)*	31	•
Tall cinquefoil *(Potentilla arguta)*	31	•
Common milkweed *(Asclepias syriaca)*	31	•
Bird's foot coreopsis *(Coreopsis palmata)*	30	••
Narrow-leaved purple coneflower *(Echinacea pallida)*	30	•
Prairie turnip *(Pediomelum esculentum)*	30	•
Alumroot *(Heuchera richardsonii)*	28	•
Great blazing star *(Liatris pycnostachya)*	27	••

Species	freq%	cover
White camas *(Zigadenus elegans)*	27	•
Common strawberry *(Fragaria virginiana)*	26	•
Bastard toadflax *(Comandra umbellata)*	25	•
Virginia mountain mint *(Pycnanthemum virginianum)*	25	•
Pale-spiked lobelia *(Lobelia spicata)*	25	•
American vetch *(Vicia americana)*	23	•
Ground plum *(Astragalus crassicarpus)*	23	•
Canada anemone *(Anemone canadensis)*	22	•
Clasping dogbane *(Apocynum sibiricum)*	22	•
Virginia ground cherry *(Physalis virginiana)*	22	•
Toothed evening primrose *(Calylophus serrulatus)*	21	•
Wood betony *(Pedicularis canadensis)*	20	•
Northern plains blazing star *(Liatris ligulistylis)*	20	•
Wild bergamot *(Monarda fistulosa)*	19	•
Skyblue aster *(Aster oolentangiensis)*	18	••
Canada tick trefoil *(Desmodium canadense)*	17	•
Smooth rattlesnakeroot *(Prenanthes racemosa)*	15	•
Wood lily *(Lilium philadelphicum)*	13	•
Rattlesnake master *(Eryngium yuccifolium)*	12	•
Grasses & Sedges		
Big bluestem *(Andropogon gerardii)*	94	••••
Indian grass *(Sorghastrum nutans)*	80	••••
Little bluestem *(Schizachyrium scoparium)*	67	•••
Prairie dropseed *(Sporobolus heterolepis)*	66	•••
Porcupine grass *(Stipa spartea)*	58	•••
Side-oats grama *(Bouteloua curtipendula)*	46	•••
Switchgrass *(Panicum virgatum)*	44	••
Leiberg's panic grass *(Panicum leibergii)*	43	••
Slender wheatgrass *(Elymus trachycaulus)*	32	•
Prairie cordgrass *(Spartina pectinata)*	30	••
Semi-Shrubs		
Leadplant *(Amorpha canescens)*	74	••
Prairie rose *(Rosa arkansana)*	70	•
Shrubs		
Wolfberry *(Symphoricarpos occidentalis)*	17	••