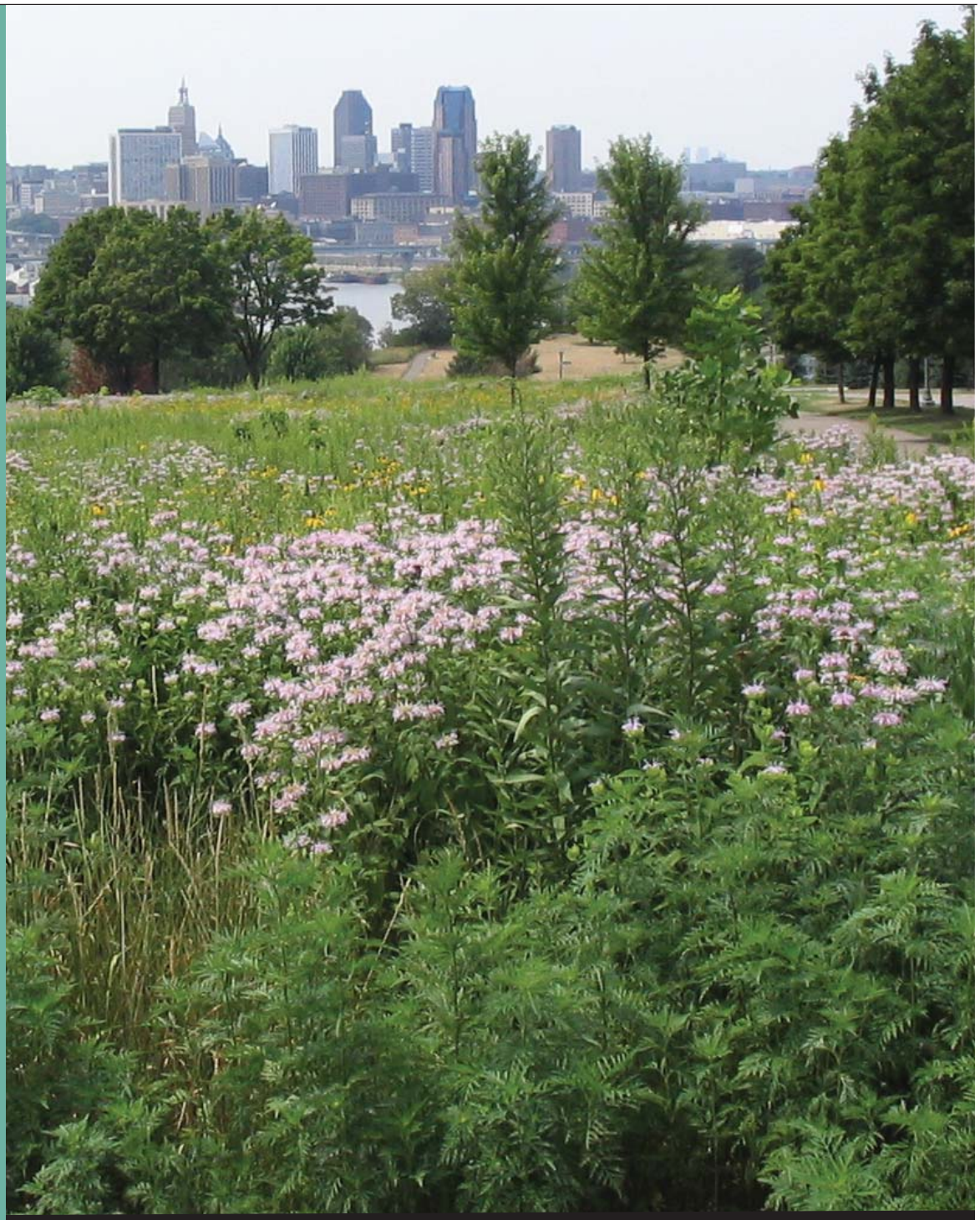
Natural Resource Inventory and Management Plan of Indian Mounds Park



GREAT RIVER GREENING

restoring the land, renewing communities

Natural Resource Inventory and Management Plan of Indian Mounds Park

December 2007

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Great River Greening is a nonprofit organization that leads and supports community-based restoration of natural areas and open spaces. Greening involves local citizens in hands-on volunteer and training programs on a larger scale than any other Twin Cities organization – 17,000 since inception in 1995.

Great River Greening can help communities manage natural areas and open spaces by raising funds, bringing volunteers, and offering training to ensure long-term stewardship.

EXECUTIVE SUMMARY

Indian Mounds Park comprises an urban natural area with a broad spectrum of native plant communities that once lined the Mississippi River Valley. Located within the City of Saint Paul, this park provides opportunities to experience Minnesota's native forest and savanna for all its visitors.

Indian Mounds Park is located in east Saint Paul bordering the blufflands of the Mississippi, and bracketed by Mounds Blvd. (T28N, R22W, Sec. 3, 4, and 5; and 29N, R22W, Sec. 32, 33, and 34). The park is approximately 300 acres in size and owned and managed by a number of different agencies: City of Saint Paul, Minnesota Department of Transportation (MN DOT), and the Minnesota Department of Natural Resources. Dayton's Bluff Community Council is actively engaged in addressing management activities occurring within the park. It is with the partnership of these agencies and stakeholders that Great River Greening has created a management plan for Mounds Park.

Over 100,000 people visit the park each year according to the Metropolitan Council. The park, both currently and historically, has served as a popular urban park for citizens of Saint Paul and other Minnesotans. A number of recreational opportunities exist for park visitors. Within the park there are bike trails, hiking, and skating; visitors often picnic, sightsee, and use the large expanses of turf for a variety of activities. The pavilion offers a meeting space for large groups, a place for barbequing, restrooms and water. The park also offers an opportunity for visitors to experience remnants of native bluffland plant communities, associated wildlife, and culturally important burial mounds left by Native American groups that lived in the area dating to at least 2000 years ago.

The Minnesota Land Cover Classification Survey (MLCCS) was used as a base map for existing vegetation communities located within the park. The MLCCS map was field checked and edited by Hannah Texler of the MN DNR in 2003 to assess the accuracy of the exiting vegetation to the MLCCS plant communities in the park.

The management plan focuses on the following main objectives:
1. Preliminary documentation of trail hazards and erosion in the park.
2. Inventory of native plant communities.
3. Identify and analyze problem areas needing management and restoration.
4. Identify strategies for managing and reconstructing native plant communities in the park.

The appendices and figures offer technical and supplemental information regarding the management plan and its recommendations.

Indian Mounds Park contains dry oak savanna and oak woodland-brushland remnants on high bluff tops; mature, red oak-dominated mesic oak forests in sheltered ravines; and a black ash seepage swamp at the base of the bluff. A population of kittentails (*Besseya bullii*), a State Threatened rare plant species associated with dry prairies and savannas was also documented in the park in the 1990s. Areas of degraded native forest and woodland cover other parts of the bluff slopes and ravines.

Preliminary examinations reveal a number of vegetative and erosion problems within Indian Mounds Park. Past and present land use and invasions of exotic species have degraded the park. Large populations of exotic or invasive species are present that should be controlled. Areas of degraded native woods with a dense understory of invasive buckthorn also pose a problem to communities of native forest. A map of the trails for the park has been created that identifies a number of trails that should be closed or carefully managed to reduce erosion and for the safety of users.

The management recommendations call for the restoration of oak savanna in an area of a degraded remnant near the east end of the site. This open oak savanna should be expanded to include the location of a past record of kittentails, which lies in an overgrown savanna. Extensive brush clearing and prescribed burns should be used to clear these areas and open the savanna allowing grasses and other ground-layer savanna species to establish. Further west, the forests of the park should be managed to reduce common buckthorn

and increase native plant diversity. The following are the key points provided in the management recommendations at the end of the plan.

PRIORITY PROJECTS

1. **Restore Oak Savanna in east end of the site**
   Goal: Clear shrubs in woodland area and return native savanna plants
   Step 1 – Burn oak savanna hilltop (Unit M)
   Step 2 – Clear brush on ridge near Kitten-tails
   Step 3 – Control invasives and continue burning
   Step 4 – Return native species under cut areas and bare soil
   Step 5 – Continue burning and controlling brush

2. **Forest Restoration**
   Goal: Control invasive species and increase native diversity
   Step 1 – Control invasive shrub species
   Step 2 – Return native species under cut areas and bare soil
   Step 3 – Plant native trees that will eventually grow into the canopy
   Step 4 – Monitor and control invasive species

3. **Expand Oak Savanna**
   Goal: Restore native Oak Savanna in areas dominated by non-natives
   Step 1 – Control invasive grassland species
   Step 2 – Remove invasive shrubs and thin trees
   Step 3 – Plant native savanna species in cut areas
   Step 4 – Control invasive species and mow newly planted areas
   Step 5 – Burn

Following this plan will lead to a site that is primarily oak savanna in the eastern one-quarter that grades into oak forest to the west. At the base of the hill in the western half of the site there is one black ash seepage swamp. Some invasive species control is recommended in the seepage swamp, but most of the management in the swamp will be exceedingly difficult due to the nature of the system. The western half of the park is primarily mown lawn with visitor facilities, including the burial mounds as well as the steep bluffs and rock outcrops.

This report did not inventory human needs and, subsequently, recommendations do not address these topics.

ACKNOWLEDGEMENTS

We would like to thank many individuals and organizations that helped by contributing to this project. The creation of the Natural Resource Inventory and Management Plan of Indian Mounds Park was made possible by the Minnesota Environment and Natural Resources Trust Fund through a Minnesota DNR Conservation Partners Grant and grants from the Mississippi River Fund and Elmer A. Anderson Foundation. Scott Anfinson the Minnesota State Archaeologist helped review the historical portion of the plan. Adam Robbins of the Saint Paul Parks and Recreation department assisted and helped review the draft. The department also provided Great River Greening access to the park to allow inventory and restoration management work. Hannah Texler of the Minnesota DNR assisted in reviewing and planning for the plan; provided detailed notes of her inventory of the site; and led volunteers on a search for rare species in the oak savannas. Tom Shevlin volunteered to help with inventories and mapping. Over 300 other volunteers contributed time and effort to help manage the site for the initial stages of the restoration.

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DESCRIPTION OF THE PROJECT AREA

Indian Mounds Regional Park is located just east of downtown St. Paul, Minnesota, along Dayton's Bluff (Figure 1). The Mississippi River flows south and east through a narrow gorge between the downtown areas of Minneapolis and St. Paul. Indian Mounds Park sits at the downstream end of the river gorge, where the floodplain begins to broaden out and river bluffs are no longer adjacent to the river banks. From the park the view to the west is of downtown St. Paul and the end of the river gorge with skyscrapers of downtown Minneapolis in the distance. Looking south from the bluffs in the park, the river is visible flowing through a broad plain dominated by industry, roads, and trains.

The primary access to the park is from the top of the bluff along Mounds Boulevard, which follows the bluff and separates neighborhoods from the open spaces and trails of the park. The park was initially protected to preserve the burial mounds of the Native Americans, who began using the site for mound building burials about 2,000 years ago. Many visitors came to the park for the view and the steep terrain provided limited development opportunities.

The park now comprises nearly 300 acres of land. At the western end of the park, the high bluff consists of bare cliff faces and steep slopes below heavily used picnic areas, paved bike trails, parking lots, overlooks, and the burial mounds. The Bruce Vento Nature Sanctuary, an area that is being restored to oak savanna and wetland vegetation, occurs below this portion of the park on the bluffs and the terrace below. The eastern end of the park is primarily natural vegetation dominated by oak forests with some small prairies on steep hilltops and south-facing slopes. This eastern portion of the park is the primary focus of this natural resources management plan.

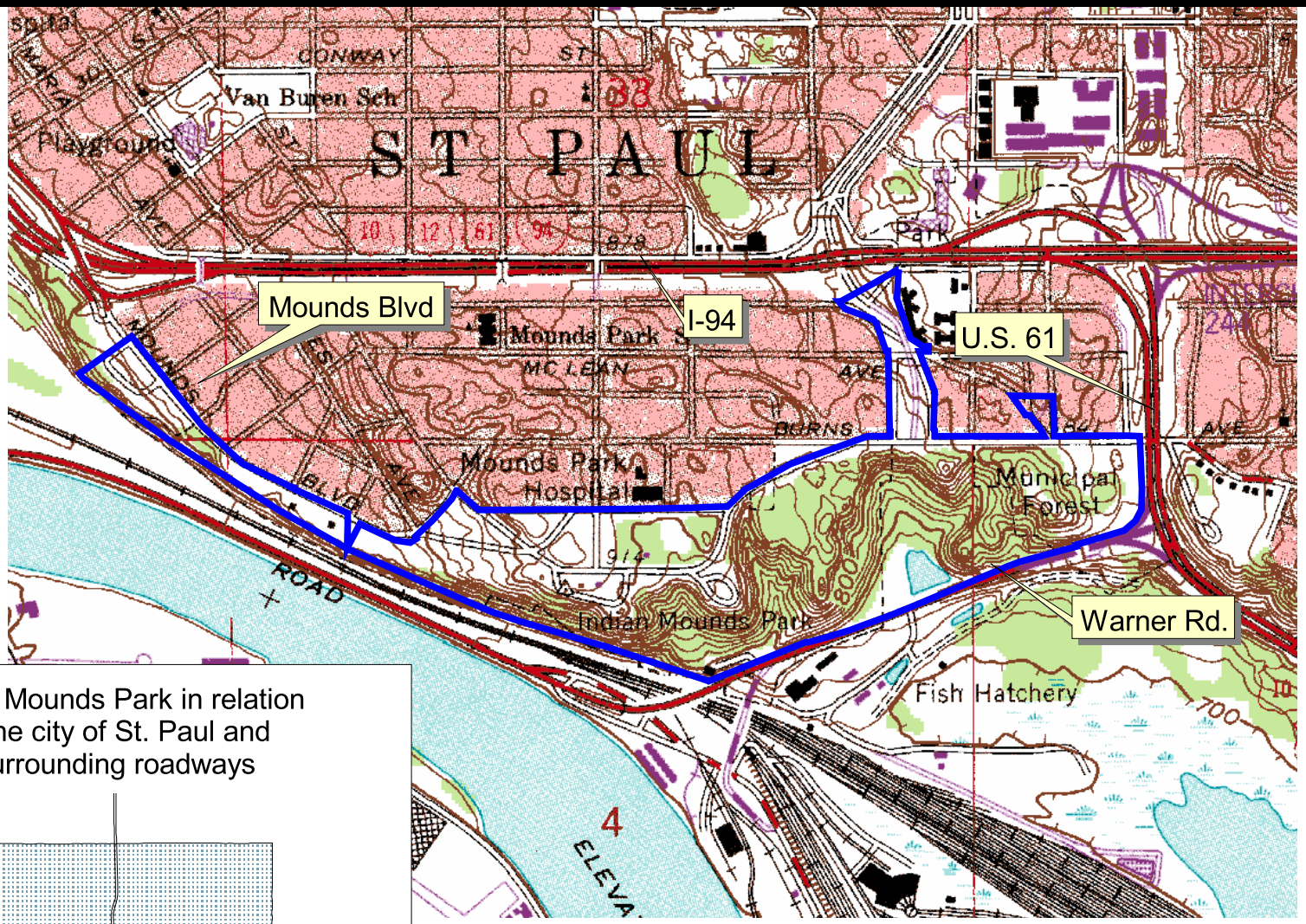
Geology

Six main geologic features are located within Indian Mounds Park's boundaries (Meyer, Swanson 1992) (Figure 2): Stream Sediment of Mississippi, Exposed Paleozoic Bedrock, Meltwater Stream Sediment from Grantsburg Sublobe, Stream Sediment of Glacial River Warren (Terrace), Till Deposits of the Superior Lobe with Stream-Modified Surface, and Hillside Sediment from Slumped Till.

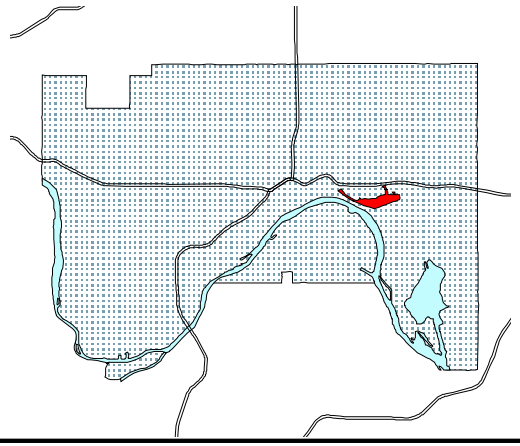
The geology within the park is defined by the layers of bedrock that are exposed in the western end of the park. The upper layer is the Platteville Formation, which is relatively resistant to erosion and provides a cap over the softer St. Peter Sandstone. Above the Platteville formation is relatively thin layer of glacial till sediment from the Grantsburg sublobe of the Des Moines Lobe glacier.

View of downtown St. Paul from restored prairie on bluff. Photo: Daniel Tix.

Figure 1: Location of Indian Mounds Regional Park



Indian Mounds Park in relation to the city of St. Paul and surrounding roadways



The steep slopes of the park were caused by the channel of Glacial River Warren, which drained Glacial Lake Agassiz in what is now northwestern Minnesota. The massive river created the valleys now used by the Minnesota River and the Mississippi River below Fort Snelling. The river cut a broad valley, of which Indian Mounds Park sits on the northeastern edge of the valley where the river turned south.

St. Anthony Falls began as River Warren Falls, near the current location of Indian Mounds Park, where the water poured over the Platteville Limestone and undercut the falls by eroding the St. Peter sandstone below. As the base of the falls eroded it moved upstream to its present location near downtown Minneapolis. This erosion created the Mississippi River gorge, the only gorge formation along the length of the Mississippi. The steep bluffs lie very close to the rivers edge, especially in the upper portions of the gorge, which formed more recently. The bluffs at Indian Mounds Park, where the gorge is the oldest, are relatively gradual, except along the cliffs at the western end of the park.

The erosion caused by the river exposed portions of the Platteville Formation in the western end of Mounds Park and at several other points along the river gorge. This formation is composed of limestone and dolomite. These formed about 400 million years ago (in the Paleozoic Era) when the land surface lay near the equator and was inundated by advancing and retreating seas.

The St. Peter Sandstone was also created in the Paleozoic Era, about 450 million years ago, when the area lay at the edge of the ocean in a broad beach. The sand deposited and has since hardened into a solid, yet highly erodible rock. The white stone is formed of sand particles that are almost perfectly round from millions of years of erosion, friction, and pressure.

The eastern end of the park is now highly eroded sediments from the glacial till and other material that have settled along the slopes and at the base of the slope. A small portion of the lowest slopes in the park is also from very recent sediment deposits from the Mississippi River floodwaters.

Multiple seeps and springs flow from the steep bluffs throughout the park. The seeps occur where the groundwater meets an impervious bedrock surface and moves laterally to where it is released at the ground surface. This occurs at the base of the slopes in the eastern end of the park, which is likely where the regional groundwater table meets the bluff face. In the western end of the park, there are also many seeps that exude water from the face of the bedrock exposures. These are especially visible during the winter when the water freezes into icicles that hang from the cliffs or large domes of ice where water seeps from the ground.

Soils

Indian Mounds Park has been mapped with six different soil types (Figure 3) described below. This soil map is based on the data provided by the Metropolitan Council (1977), based on a 1977 soil survey of Ramsey County. The soils descriptions are based on the USDA Official Soil Series Description.

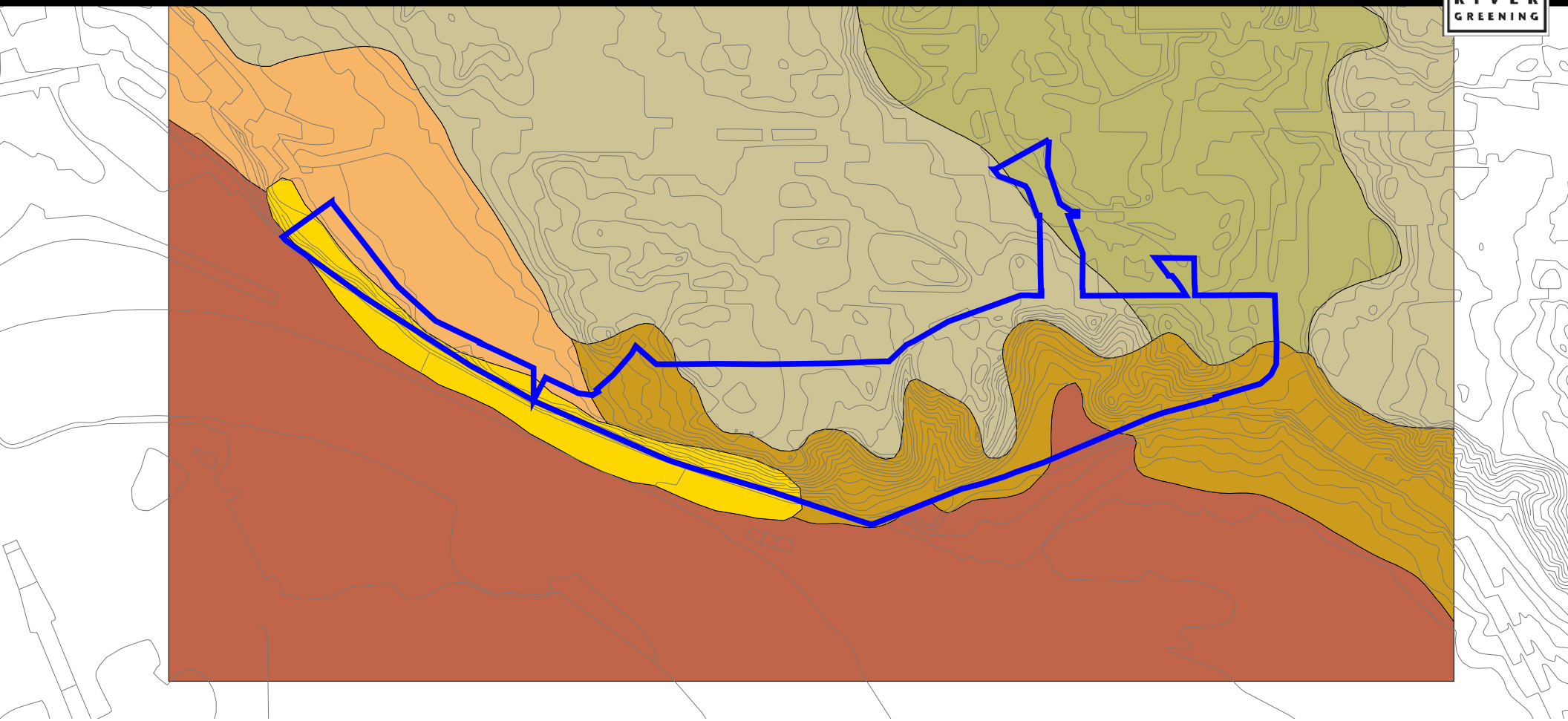
Dorerton Series

The Dorerton series consists of deep well-drained soils that formed in thin loamy mantle of mixed loess and erosional sediments, which occur on upper and lower portions of the rock outcroppings where vegetation can occur. The underlying material is typically fragmented dolostone, the same material found in the upper portion of the outcroppings from the Platteville formation. Slopes range from 50 to 65 per cent and permeability is moderately slow to moderately rapid. There are multiple seepages visible from in this area, both within and near the rock outcrops. The native vegetation for Dorerton soils would be a mixed deciduous forest with northern red oak, white oak, bur oak, and aspen being the dominant species. The current vegetation type at the park is disturbed deciduous woodland.

Kingsley Series

The Kingsley series occurs on relatively flat upper areas in Indian Mounds Park. These are very deep, well drained soils that formed in loamy glacial till on glacial moraines and have moderate permeability and slopes ranging from 2 to 40 percent. These are primarily dominated by loams. A mollic alfisol, this soil formed under alternating episodes of deciduous forest and prairie vegetation. This soil is typical for areas of oak savanna or woodlands that occurred along the prairie – forest border. Currently the vegetation consists of scattered trees growing in manicured lawn.

Figure 2: Surficial Geology



Indian Mounds Park Boundary
Topolines

Geology
- Stream Sediment of Mississippi River
- Exposed Paleozoic Bedrock
- Meltwater Stream Sediment from Grantsburg Sublobe
- Stream Sediment of Glacial River Warren (Terrace)
- Till Deposits of the Superior Lobe with Stream-Modified Surface
- Hillside Sediment from Slumped Till

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Mahtomedi Series
At Indian Mounds Park the Mahtomedi Series occur on somewhat steep slopes. This is a very deep, excessively drained, rapidly permeable soil formed in sandy outwash of Late Wisconsinan Age on glacial moraines and outwash plains. These upland soils have slopes ranging from 0 to 45 percent. Native vegetation was mixed hardwood-coniferous forest. Today these soils are dominated by oak woodlands and degraded woodlands.

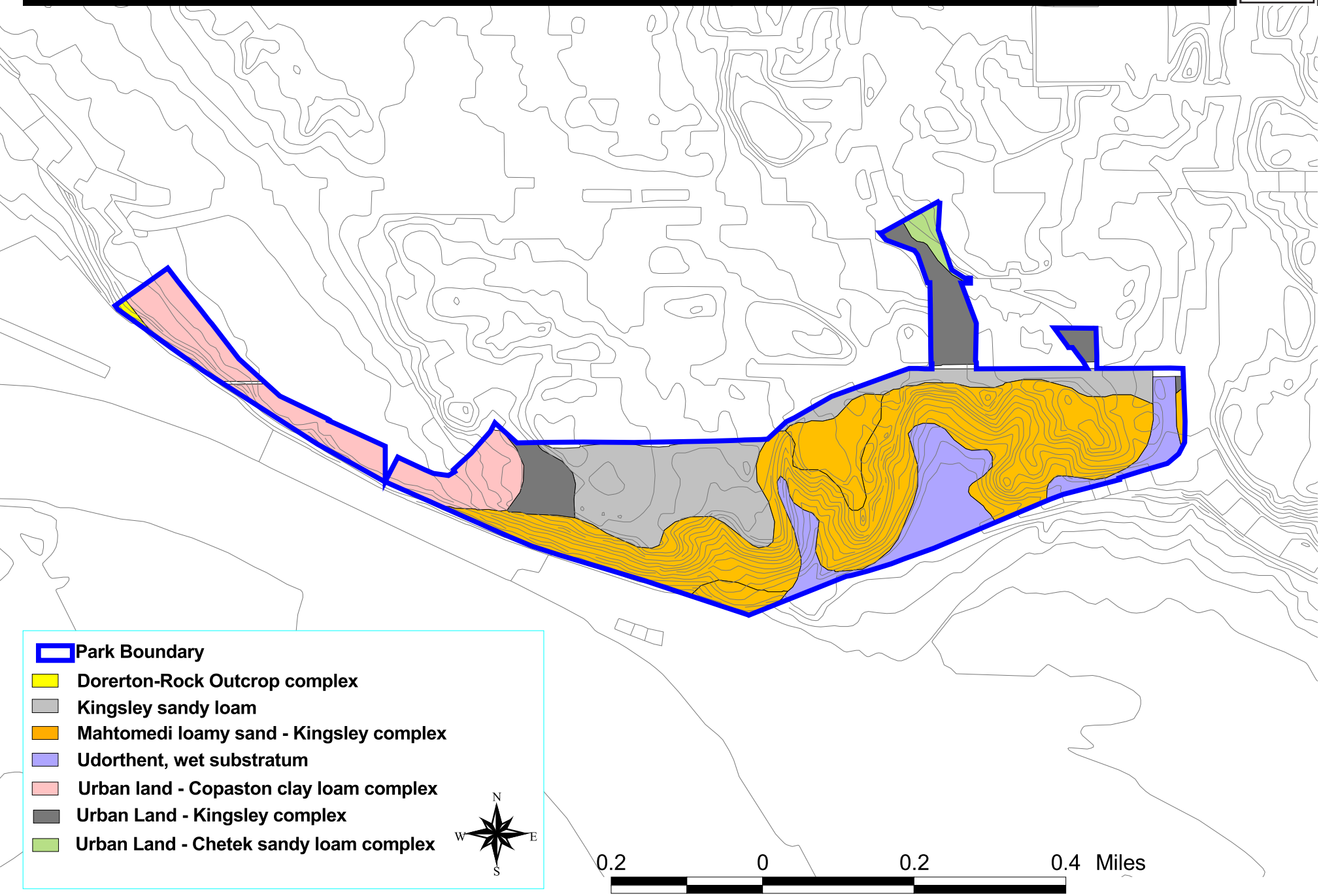
Copaston series
This soil occurs along sloping hills in the eastern end of the park. This area consists of shallow, somewhat excessively drained soils that formed in glacial drift or alluvial sediments over limestone bedrock on terraces and uplands. The slope of this series can range from 0 to 60 percent. Native vegetation on this soil is tall grass prairie. Today the area supports prairie and oak savanna, primarily overgrown savanna.

Chetek Series
The Chetek series consists of very deep, somewhat excessively drained soils that occur in a thin layer of loamy alluvium over sandy and gravelly outwash. Typically, they are on outwash plains and stream terraces but some are on moraines or kame terraces. Permeability is moderate or moderately rapid in the loamy mantle and rapid or very rapid in the sandy outwash. Slopes range from 0 to 45 percent. The native vegetation is mixed deciduous and coniferous forest. Currently this portion of the site consists of manicured lawn with scattered trees, roads, and trails.

Udorthent, wet substratum
The Udorthent is a type of soil lacking horizons because the parent material has only recently accumulated. This portion of the site is mapped as Udorthent because it is primarily created by cut and fill performed during the creation of the park, roads, and neighborhoods. These are all human modified soils in this park.


Oak Savanna Unit M after burn. June 7, 2007. Photo: Claire Luby

Figure 3: Soils Series of Indian Mounds Park



PRESETTLEMENT VEGETATION

The pre-settlement natural vegetation of Minnesota was determined using The Original Vegetation of Minnesota (F.J. Marschner, 1974). The Marschner map was created using notes and accounts from the Public Land Survey. The map indicates that three main pre-settlement plant communities dominated Indian Mounds Park: Big Woods, River Bottom Forest, and Wet Prairie (see Figure 4).

The Big Woods, Marschner's generic term for deciduous forest, would have occurred along the bluff tops of Indian Mounds Park. This forest was part of a small area of hardwood forests protected from fire within a region that was covered predominantly by frequently-burned oak savannas, woodlands, and prairies. Marschners bearing tree records in the vicinity of the bluff were bur oak, white oak, and northern pin oak, and the surveyors described the area of the bluff as “oak openings.”

The River Bottom Forest was present at the base of the bluff slopes in the park. Marschner used this designation for nearly all floodplain and river bottom forests, some of which may have flooded every year and some may have flooded infrequently. The dominant overstory species comprising the River Bottom Forest include elm, ash, cottonwood, box elder, silver maple, willow, aspen, and hackberry.

The Wet Prairie community is located in the hatchery area of Indian Mounds Park. This community would have likely been wet for much of the growing season in most years. The common plants would have been marsh-grasses, irises, sedges, rushes, wild rice, and there would have been some willow and alder-brush.

The bluff slopes were somewhat open, even though they had been mapped as a part of the Big Woods. The slopes are south-facing and sandy, and, therefore, rather dry. Forest growth on these slopes would have been slow and the potential for wildfires in the grasses below the trees would have been reasonably high. Since the Marschner map was created from notes made only once every square mile, it is likely that no notes would have described the vegetation that occur only on the bluff.

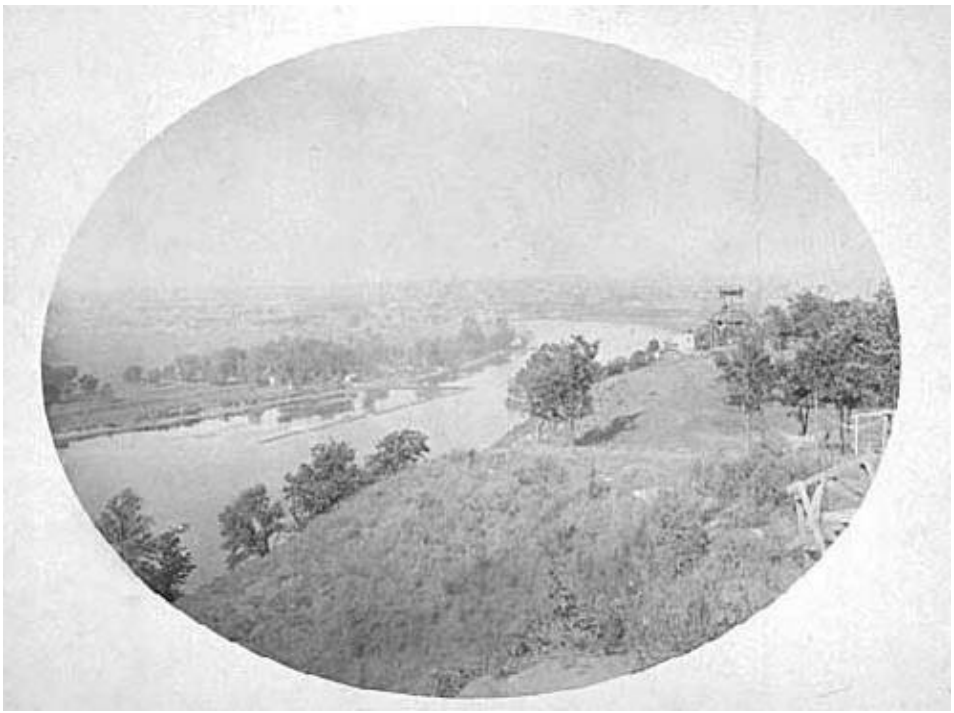
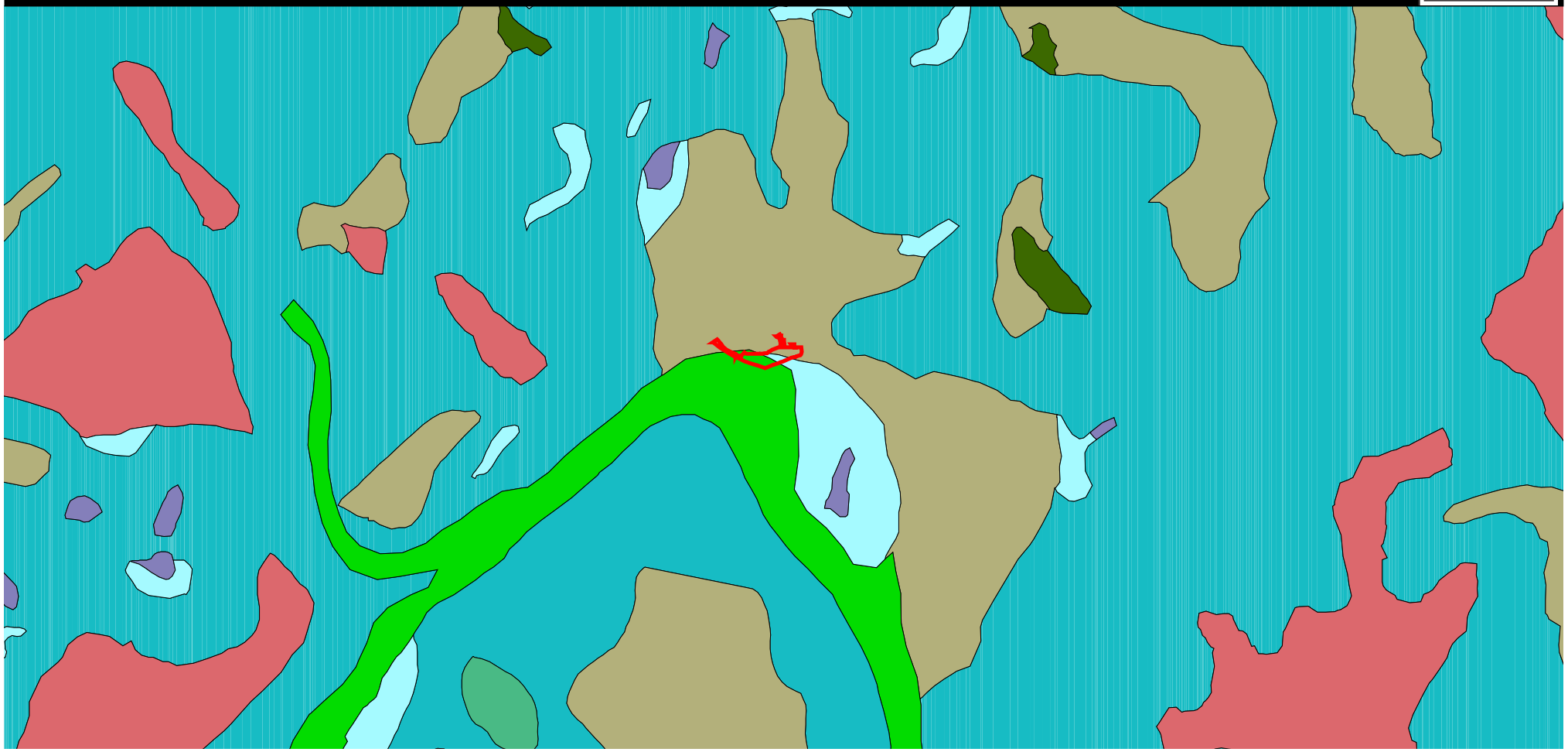


Photo Courtesy of the Minnesota Historical Society. Mounds Park, St. Paul. Photograph Collection ca. 1900. Location no. MR2.9 SP4.1I m1. Negative no. 34704. This photo shows how open the slopes were the area was likely logged extensively in the late 1800’s

Figure 4: Pre-settlement Vegetation at Indian Mounds Park
Modified from Marschner (1974)

GREAT RIVER GREENING



Indian Mounds Park Boundary

Pre-Settlement Vegetation

- Big Woods
- Conifer Bogs and Swamps
- Oak Openings and Barrens
- River Bottom Forest
- Prairie
- Wet Prairie
- Brush Prairie
- Lakes (open water)

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Land Use History

Cultural History

The park has an interesting cultural history that is thousands of years old and is the primary reason for its protection as a park. According to artifacts and other evidence, American Indians inhabited the region for over 12,000 years (Natural Resources, 1996). Artifacts found on the Mississippi River terrace below Mounds Park suggest an almost continuous human occupation for 10,000 years.

Mound building in the park probably originated around 0 AD in the Hopewellian period (Trautmann, 1984; Kunz 1991). Three distinct prehistoric cultures contributed to mound building over several hundred years: the Hopewell, Late Woodland cultures, and the Oneota (Woolworth, 1981). The mounds were used intermittently for burial during the last 2,000 years, though most of the mound building most likely occurred between 0 and 800 AD. In the 19th century almost all of the mounds were excavated revealing some burials interred in log tombs and limestone cists. Some items found in the graves were typical of Hopewell burials, including ornaments hammered from sheets of copper and a clay death mask. Unfortunately, most of the artifacts excavated from this site have been lost (MNRRA, 2003.)

The Woodland culture first appeared about 500 B.C. and lasted until perhaps A.D. 1000. They mainly lived by hunting and gathering combined with some agriculture (squash, corn, gourds, and beans) (Woolworth, 1981). Around 1000 A.D., migrations up the river brought new corn varieties and skills to more extensively use the flood plains for agriculture (Woolworth, 1981). The new arrivals are referred to as Oneota, some of whom may be the ancestors of the Dakota, and lived in the area for the next 300 years or so.

The Dakota people occupied the region when the first European explorers visited the area in the late 1600s, having replaced the Late Woodland and Oneota cultures before them. The Dakota likely practiced burial ceremonies atop Dayton's Bluff, during which the dead were placed on a scaffold or in a tree for a period of time before burial. Relatives made annual visits to the burial sites of their ancestors until the US – Dakota War in 1862 (Woolworth, 1981). Henry Schoolcraft noted, "the grand cemetery, which was common to all, disappeared" (Schoolcraft 1851-1857). The Dakota village of Kaposia was located immediately below Dayton's Bluff until it moved to South St. Paul in 1832. Several caves below Dayton's Bluff (including the famous Carver's Cave) were the locations of important Dakota spiritual practices.

Eighteen burial mounds once existed in the park, but only six remain visible (Upham, 1908; Kunz 1991). Most of the mounds were destroyed for streets or to provide better views for the public (Upham, 1908; Woolworth, 1981). This destruction occurred both before and after the park's establishment in 1892. Five of the original 18 mounds were reconstructed in the early 20th century (Dobbs, 1994; Woolworth, 1981).

The excavation of the burial mounds has resulted in many interesting discoveries about the cultures that created them. The mounds were first mapped in the mid-19th century, and then extensively excavated by local people. Within the mounds were human bone fragments, pottery shards, charcoal, hammered copper pieces, stone-clay pipe, mussel shells, and ashes (Upham, 1908; Woolworth, 1981). In 1923, the excavated mounds were restored to their original shape and seeded with grasses (DPPPB, n.d.a). In 1976 the mounds were placed under the protection of the state cemetery law (Minnesota Statutes 307.08). To protect the mounds fences were installed in the spring of 1990 following this sixty one Indian individuals were reburied in the park on September 27, 1990.

Native cultures used a wide variety of plants and animals for food, and altered the vegetation by cultivating the soil and setting fires. Fires were used to create desirable habitat for large game species like bison and elk. Prairies that occurred in much of the surrounding area may have been burned annually by Native Americans. The Dakota people, in particular, commonly used fire as a means of managing their landscape. Therefore, once they arrived in the area, they likely increased the amount of open prairie and savanna habitat. However, the Dakota people often traveled great distances to desirable hunting ranges, while maintaining permanent settlements in more wooded landscapes.

Euro-American Settlement History

The first written account of the Indian Mounds Park area was from the English explorer, Jonathan Carver, in 1766. He visited the cave that now bears his name, describing petroglyphs on the wall. Zebulon Pike arrived in September 1805 and stayed at the Sioux village of 11 lodges just below the park (Miller, 1928). European settlers resided in the Indian Mounds area by the mid-1830s (Woolworth, 1981).

The Dakota people lived in the park and surrounding area up until 1837 when a treaty was signed effectively selling all of the land east of the Mississippi (Woolworth, 1981). Settlers with European ancestry did not begin to rapidly move into the area until the 1880's, when Lyman Dayton owned all of the property above and below the bluff (Newson, 1886; Kunz, 1977). The Board of Park Commissioners formed in 1877 and W.A. Van Slyke soon proposed that the property be acquired by the city to preserve Mounds Park (Nason, 1932). Due to legal problems, it was not until May 1891 that a petition passed to establish the park, which was acquired in 1892 (Woolworth, 1981).

History of Roads, Structures, and Development

In 1851, even before the park establishment, steps up to the bluff were in use by the public to enjoy the view from the southern end of the Mississippi River Gorge and the valley below. By 1899, much of the grounds had been graded for visitor access including many of the roads and walks within the park. In 1903, several streets were discontinued as public streets in the park portions of Earl, Thom, Mound, Clifton Place, Hiawatha, Reserve, and Prospect Place. Many improvements to the walks, driveways, and paths occurred over the years, and new roads were built in the early 1930's and in 1960. Bike paths were not added to the park until the 1990's (Woolworth, 1981).

A number of private uses were requested within the park since its establishment. Despite many objections in 1903, the Federal Work Projects Administration (WPA) permitted a quarry within the park, that resulted in the removal of about 23,000 cubic yards of limestone until it shutdown in 1936 (Thompson, 1936).

The park began very small in size at first with only 17 acres, another 35 acres were added in 1903. By 1906, the park acreage totaled 76.4 acres and in 1912 it was 135 acres. Currently the total acreage of the park is almost 300 acres, which includes land owned by the state Department of Natural Resources, where they use the ponds as a fish hatchery.

Transportation History

In 1894, a streetcar line was completed with service to Indian Mounds Park by the Streetcar Railway Company, which allowed visitors to travel from downtown St. Paul to the park in 15 minutes (Olson, 1976). A sightseer service operated to the park between 1906 and 1917. In March 1908, the Board of Park Commissioners (BPC) determined the street railway terminus inside the park was located in too prominent a place and too dangerous and they ordered the terminus to be relocated. The railway company agreed with the Board's request, and created a new terminus 450 feet outside the park.

The Saint Paul and Pacific Railroads began operating in the floodplain below the park's bluff in 1862 and have remained since their establishment. The railroad expanded in 1880 (Williams, 1881) and by 1886 the area near Carver's Cave, which lies at the base of the bluff, was described as a solid network of rails, where 250 trains passed per day (Newson, 1886).

Recreation History

From the park's establishment, it was teeming with sightseers. Visitor appeal included the burial mounds, the view of the Mississippi River and, in the 19th century, views of the railroad and trains. By 1897, Indian Mounds Park was the second most visited park in Saint Paul, and in 1905 the BPC boasted the total attendance for Indian Mounds and Como Park combined at over 1.5 million visitors. (Woolworth, 1981)

Many recreational activities were available in the park early after its establishment and many are still available today. Concerts were enjoyed by the public in the early years of the park's establishment. In 1924 a ski jump of 125-150 feet was erected, and ski meets occurred for the next decade. By 1934, 1 brick

building, a warming house, toilets, refectory stand, store, fireplaces, 2 tennis courts, 6 horseshoe pits, and the ski jump were present. (Woolworth 1981).

Photo Courtesy of Minnesota Historical Society. Ski jumper landing on the slope, Mounds Park. Photograph Collection 1936; Location no. GV3.75 p26

Vegetation History

Before settlers came, the bluffs had majestic trees and the bottomlands were like dense jungles (Williams, 1881). Much of the forest along the bluff was cut during the establishment of rail lines before it became a city park (Millet 1996). Between 1897 and 1911, many trees and shrubs were planted in the park to reestablish forest cover.

Photo Courtesy of the Minnesota Historical Society. Photograph from St. Paul Dispatch and Pioneer Press.
St. Paul school children participate in an Arbor Day tree planting project in 1952 at the Burns Avenue section of Mounds Park. Johnson Parkway is in the background – note the large oak tree in lower right.

Photo by Daniel Tix, Great River Greening, October 20, 2006
Trees planted in 1952 were crabapples, now forming a small grove near Johnson Parkway. Notice the large oak tree in the middle of the picture.

The restoration of native plant communities became a priority in 1981when plans were made to restore and rehabilitate the park into a more natural setting (Woolworth, 1981). Native grasses were planted in 1996 in place of a number of trees and shrubs that were removed to clear the view from certain vantage points in the park. In about 2003, prairie restoration began just west of the burial mounds, in an area now known as the Triangle Prairies. About 160 native grasses and broad-leaved plants were planted in these prairies in 2006 along with 20 bur oak trees. Consequently, the area should now be called the Triangle Savanna.

Many years ago the "bowl" area of the park was planted by St. Paul Parks Dept. with native prairie/savanna species. In 2003, buckthorn and other brush were cut within the oak savanna just south of the intersection of Burns Avenue and English Street, within the bowl. By the summer of 2006, much of the buckthorn had sprouted from the bases to recreate the thicket that was originally targeted for removal. Restoring this oak savanna to a more open condition is an important priority because many of the planted native prairie and savanna species still occur within the bowl. A small population of Kitten-tails (*Besseya bullii*), a species listed as Threatened by the Minnesota DNR, was found just south of the Bowl in a dry forest opening in the early 1990s.

Just east of the burial mounds, the parks department coordinated a native planting in a landscaped area around the overlook in 2003. Just below the overlook native grasses were seeded under a large oak tree along the steep bluff slope. In addition, invasive burdock plants were removed around the overlook and along the edge of the nearby bluff in 2006. At the same time, smooth sumac in the dry prairie on top of the hill northwest of the Bowl was cut as well as buckthorn in the forested area around the northern edge of the Bowl on top of the bluff. Native woodland plants were added to this area later that year and savanna species were added along the top of the slope along the northern edge of the Bowl, a total of 730 plants were planted; Appendix C shows the species list planted in these areas.

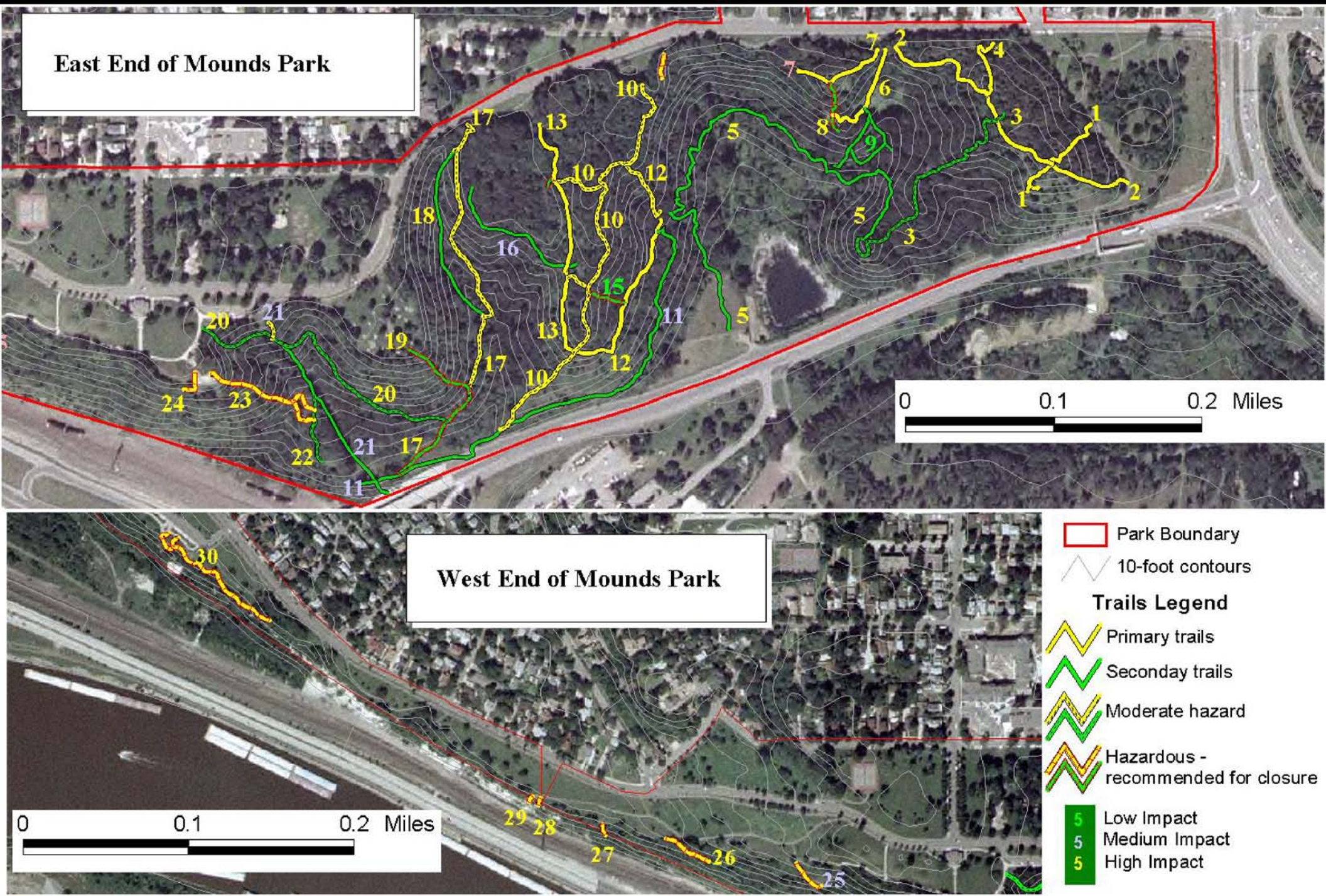
Figure 5. Indian Mounds Park in 1940

2006 PRELIMINARY ASSESSMENT OF TRAIL SOIL EROSION

An assessment of paved and unpaved foot/bike trails was completed in 2006. A Garmin hand-held GPS unit was used to establish trail locations. Unpaved trails used for foot or bicycle travel are recorded in this survey. Primary trails begin from a paved path and are generally broad and well used. Secondary trails do not begin from a paved path and are narrower and used less than the primary trails. The trails are categorized based on impact to the soil. Low impact trails are secondary trails less than 12 inches wide with greater than 75 %vegetative cover, little or no exposed soil, and are less than 50 feet in length. Medium impact trails are primary trails, 12-16 inches wide with 50-75% vegetative cover, and exposed soil observed in 25- 50% of the length of the trail. High impact trails are primary trails that are greater than 16 inches wide with less than 50% vegetative cover, and exposed soil in greater than 50% of the trail length. Each segment was scored from 1 to 3 based on the relative hazard of the trail according to the slope, channeling/rutting, and proximity to paved trails; a score of 3 is the greatest hazard for erosion. See Figure 6 for a map of the trails in the park.

TRAIL	CLASSIFICATION	IMPACT	HAZARD	CLOSE
1	Primary	High	1	NO
2	primary	High	1	NO
3	secondary	High	2	NO
4	primary	High	1	NO
5	secondary	High	1	NO
6	Primary	High	1	NO
7	Primary	High	1	NO
8	secondary	High	3	YES
9	secondary	Low	1	NO
10	Primary	High	2	NO
11	secondary	Medium	1	NO
12	Primary	High	1	NO
13	Primary	High	1	NO
15	secondary	Low	3	YES
16	secondary	Medium	1	NO
17	Primary	High	2	NO
18	secondary	High	1	NO
19	secondary	High	3	YES
20	secondary	High	2	NO
21	Primary	Medium	2	YES
22	secondary	High	2	NO
23	Primary	High	3	YES
24	Primary	Medium	3	YES
25	Primary	Medium	3	YES
26	Primary	High	3	YES
27	Primary	High	3	YES
28	Primary	High	3	YES
29	Primary	High	3	YES
30	Primary	High	3	YES

Figure 6. Existing Trails and Trail Conditions



2003 DETAILED VEGETATION INVENTORY

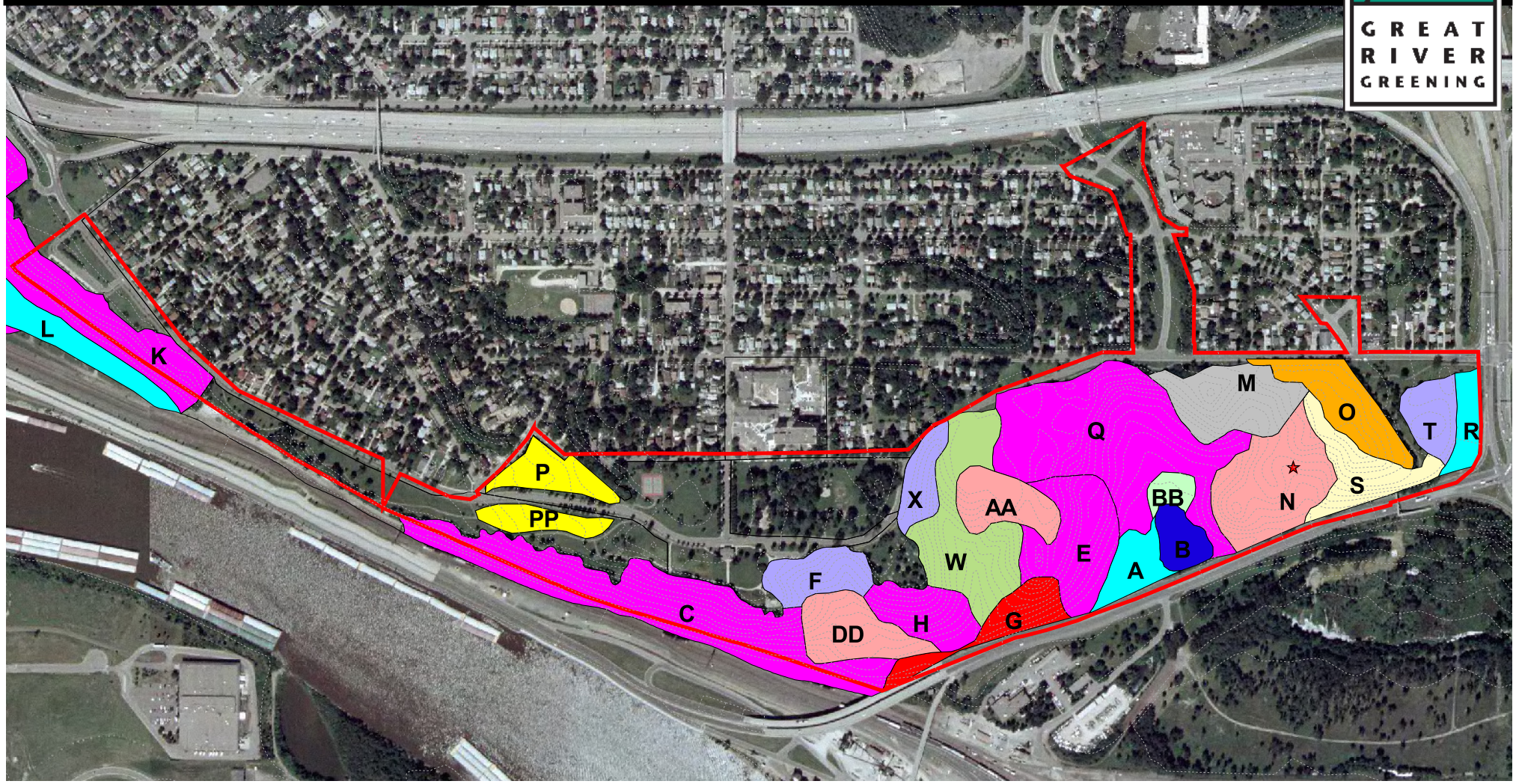
The 2003 Minnesota Land Cover Classification Survey (MLCCS) was used as a base map for existing vegetation communities located within the park. Only areas of natural vegetation are mapped, mown turf, paved surfaces, and maintained plantings are excluded from this map since they will not be covered in detail in the management plan for this park. The original MLCCS inventory of the park was done by Ethan Perry. The accuracy of the MLCCS map was verified in 2003 by Hannah Texler of the DNR and many of the descriptions were improved for the natural areas (Figure 7).

The MLCCS natural vegetation categories within Indian Mounds Park include seven main groups: Boxelder/Green Ash disturbed forest (32170), Dry Oak Savanna (62120), Disturbed Deciduous Woodland (42130), Grassland with sparse deciduous trees – non-native dominated vegetation (62140), Medium tall grassland, dominated by non-native species (61220), Mixed hardwood swamp (32320), Upland soils with planted, maintained, or cultivated coniferous trees (21110), Non-native dominated upland shrubland (52130), Oak Forest (32110), Oak Woodland/Brushland (42120), and Open water (93300).

MLCCS categories and map units were used as a basis for the map of the Natural Vegetation; a few changes were made to put the native plant communities into the Minnesota DNR classification system. Four native communities were described for the park according to this system: Southern Wet Ash Swamp (WFs57), referred to as "Wet Ash Swamp"; Southern Dry-Mesic Oak Forest (MHs37), "Oak Forest"; and Southern Dry-Mesic Oak (Maple) Woodland (FDs37), Oak Woodland. A fifth plant community has been planted to Southern Mesic Prairie (UPs23), referred to as a "Restored Prairie" because it is clearly not representative of a native mesic prairie community. A detailed list of species found at the site is included in Appendix B.

False rue anemone (*Enemonium biternatum*) at Mounds Park. Photo: Daniel Tix

Figure 7: Natural Vegetation at Indian Mounds Park



Disturbed/Non-native Dominated Communities

- Restored prairie
- Planted coniferous trees
- Boxelder - green ash disturbed native forest
- Disturbed deciduous woodland
- Grassland with sparse deciduous trees
- Medium-tall grass, non-native dominated grassland
- Non-native dominated upland shrubland

Native Plant Communities

- Oak forest
- Oak savanna
- Oak woodland-brushland
- Open water
- Wet ash swamp

- Indians Mounds Park Boundary
- ★ 1991 Location of Kittentails

N W E S

0 0.1 0.2 0.3 0.4 Miles

2006 PLANT COMMUNITY DESCRIPTIONS

Comparison of Oak Communities: Forest, Woodland, and Savanna
It is important to understand the difference between the terms used in this management plan: forest, woodland, and savanna. In all cases in this park these refer to communities dominated by oaks, which may be white, northern pin, bur, or northern red oak. The three terms refer to a continuum of plant communities that vary in the degree to which the canopy of trees shades the ground and how much grass may be found in the ground layer.

- Savanna is the most open community, it is often described as a prairie that has a few scattered trees, however, it generally has more shrubs and a different species composition than a true prairie. The few remaining savannas in the region are very patchy; they consist of open prairie alternating with areas of scattered trees and small to large clumps of trees.
- Woodlands generally have canopy covers of about 50 – 70%. The tree, shrub and groundlayer species are generally tolerant of ground fires which may occur frequently. These communities are more open and park-like than forests, though tree canopies and shrub cover can become dense if fires are infrequent.
- Oak forest typically has a canopy of greater than 70% cover dominated by various species of oaks, with other species in lesser amounts, including basswood and American elm. If the forest is not cleared by fires or another disturbance, many of the oaks will eventually die out of the canopy and be replaced by shade-tolerant trees that can regenerate within a shaded forest, especially sugar maples. The forest itself generally has a full complement of layers of vegetation, including a ground layer. Other layers include shrubs, sub-canopy, and a canopy.

Non-native or Disturbed Plant Communities
Grassland with Sparse Deciduous Trees
Unit S – This steep slope is dry and open dominated by non-native grasses, mostly Kentucky bluegrass, mixed with lesser amounts of native grasses such as porcupine grass. Smooth sumac and common buckthorn create dense thickets along the hillside and spotted knapweed is quite common. The hillside has several terraces, suggesting it has been graded in the past, probably during the construction of Warner Road or the bike trail that crosses the road on a pedestrian bridge. Dense stands of switch grass occur along the trail, these have likely established from seed that was planted for erosion control and is not necessarily a native genotype.

Medium-Tall Grass, Non-Native Dominated Grassland
Unit A – This unit is dominated by smooth brome and Kentucky bluegrass with abundant spotted knapweed, all are considered non-native invasive plants. Common buckthorn, Tartarian honeysuckle, boxelder, and green ash occur in this area, especially along the wooded edges. Few natives occur in the area such as Virginia creeper and little bluestem, though very uncommon.

Non-Native Dominated Upland Shrubland
Unit G – This community is dominated by smooth brome and Kentucky bluegrass under a canopy of smooth sumac, a native shrub. Other invasive species include common buckthorn, a species of thistle, and a species of sweet clover. This area occurs on a dry south-facing slope near Warner Road.

Degraded Native Plant Communities
Boxelder - Green Ash Disturbed Native Forest
These communities are indicative of past disturbances such as clear-cutting, selective harvests of oak trees, and heavy grazing. Boxelder and green ash are native tree species that were commonly planted for shelter belts in agriculture or as shade trees in urban areas. Both tree species spread quickly by seed and can be very successful after disturbances. Consequently these trees have likely become dominant in this park due to frequent disturbances since early settlement including the initial clear-cutting of the bluffs during the railroad expansions in the late 1800's.

Units F and X – These areas are located near the eastern overlook in the main park area. Each occurs on steep slopes, adjacent to mowed lawn in areas with heavy visitor traffic. Besides the dominant trees there are few cottonwoods and oaks in the canopy. Buckthorn is common in the shrub layer with predominantly large individuals. The ground layer is dominated by garlic mustard and white snakeroot.

Unit T – This small unit was likely more open when the original MLCCS map was created. It is now dominated by boxelder, green ash, and many small clones of basswood, which form a dense thicket. Much of the ground cover is still dominated by Kentucky bluegrass and smooth brome, though garlic mustard and common buckthorn are common in shaded areas.

Disturbed Deciduous Woodland
These areas are similar to oak forests, but they have been invaded by non-native plants in the understory and ground layers. These units were likely clear-cut for lumber at one time, but oaks and basswood were the first to become re-established. In all of these units at Indian Mounds Park northern pin oak is the dominant tree and invasive shrubs, common buckthorn and tartarian honeysuckle are abundant. The ground layer is dominated by Pennsylvania sedge and a number of other species. In general, the units identified as Disturbed Deciduous Woodland have good stands of canopy trees, but few other native species are present.

Unit K – Green ash and eastern cottonwood are common in the canopy at the western end of the park. Common buckthorn is abundant along this semi-open slope. The openings are dominated by smooth brome and there is a large patch of switch grass, likely a cultivated variety.

Unit C – This unit is located on some of the steepest slopes in the park, so management is very difficult and erosion is an important concern. Basswood and large areas of red oak occur throughout this unit.

Unit H – This steep slope is similar to Unit C except there is a small ravine at the base of the hill with several bur oak trees. Gooseberry, choke cherry, and prickly ash are common in this ravine. Virginia water-leaf is abundant in the ground layer along with lesser amounts of false Solomon's seal, rue anemone, and the invasive garlic mustard.

Unit E – Green ash and eastern cottonwood are common in the canopy of this unit. Black cherry, basswood, oaks, and boxelder are common saplings. Common buckthorn and Tartarian honeysuckle are very dense and some invasive Norway maples are also present in the shrub layer. False Solomon's seal and Virginia creeper are common in the ground layer and other species include wild geranium, thimbleweed, sweet cicely, and wild sarsaparilla.

Unit Q – This is a large area that covers most of the valley at the end of Johnson Parkway and is very similar to a Dry-Mesic Oak Forest (described below) except that hackberry, cottonwood, green ash, boxelder, and black locust are frequent. Many large oaks, including northern pin, red, white and bur, are present in this unit. Common buckthorn is the most common shrub species, though it is considerably less dense than in Unit E. The ground layer species indicate the area was likely more open: northern bedstraw, little bluestem, Canada wild-rye, etc. Some small openings are present, but most of the valley is forested and ground layer species in the shadier locations include white snakeroot and garlic mustard.

Native Plant Communities
Oak Savanna
Unit M – C-rank – Large open-grown northern pin and bur oak are the dominant tree in this community, which occurs within an open south-facing bowl with a steep open hillside on the east side dominated by dry prairie species. This area forms the highest quality plant community at the park largely due to the sensitive species that dominate the dry prairie and the restoration potential for oak savanna within the bowl just to the east and on the surrounding slopes.

Raspberries and burdock are common in the bottom of the bowl along with many small green ash and boxelder. Pennsylvania sedge and white snakeroot are the most common native plants in the shaded areas, though they are scattered among garlic mustard and bare soil. In the dry prairie, snowberry, little bluestem, and northern bedstraw are the dominant plant species.

In 2006, management activities occurred within Unit M. Buckthorn was removed from most of the sunny portions and on the lower portions of the steep hill. Smooth sumac was cut from the top of the dry hillside where it formed a dense shaded canopy over porcupine grass and leadplant. Large stems of buckthorn were cut along the entire hillside and on the north-facing slope along Burns Avenue, the cut stumps were treated with herbicide. Smaller individuals were hand pulled by volunteers from the wooded edges in the bottom of the bowl.

After the cutting and removal, herbaceous plants, vines, and a few shrubs were installed along the north-facing slope and at the top of the slope along the north side of the bowl. All plants were in 1-gallon container provided by a local nursery and grown from locally-collected seeds. Plants were then mulched with wood chip provided by the city of St. Paul. The plant list is provided in Appendix D.

In April, 2007, the western half of Unit M was burned, from the trail at the bottom of the hill up to the trails at the top. The fire helped control resprouts of brush and killed several green ash. The fire carried through leaf litter in the more shaded areas and will contribute to a greater expanse of this oak savanna. The native grasses, forbs, and small shrubs like wolfberry and leadplant responded favorably to the fire.

Oak Woodland

The Oak Woodland communities occur in the eastern half of the park in sandy soils and along the steep hillsides and on ridges. Northern pin oak or white oak are the most common canopy tree species in these areas and they tend to have widely spreading branches, typical of trees that once grew in the open rather than in a forest. Common buckthorn and Tartarian honeysuckle are present in all of the units to varying degrees, though raspberries, choke cherry, and nannyberry are better indicators of this community. Ground layer species include those that prefer shady habitats such as Pennsylvania sedge and zig-zag goldenrod as well as plants that require more sunlight such as northern bedstraw and little bluestem. Three Oak Woodland communities have been identified.

Unit N – D-rank – This unit is dominated by large open-grown northern pin oak and bur oak. Common buckthorn is abundant throughout the understory and in most of the area there is little vegetation on the ground surface besides garlic mustard. A dry ridge top has widely spreading oaks, dense sumac and some non-native grasses along the ground as well as Canada goldenrod and Penn's sedge. This area also has a record of kittentails, which was once found here. Extensive searches in 2006 did not find kittentails.

Unit AA – D-rank – Basswood and northern pin oak are the dominant trees in this unit and common buckthorn and Tartarian honeysuckle are common in the understory. The woodland is fairly open along south- and west-facing slopes with a small prairie opening. Wolfberry and eastern red cedar are common shrubs. The ground layer includes little bluestem, long-headed anemone, northern bedstraw, and Pennsylvania sedge. Other species present include prairie alum root and Culver's root.

Unit DD – D-rank – White oak is the dominant tree species and there are lesser amounts of cottonwood, boxelder, green ash, and other oaks. Common buckthorn and Tartarian honeysuckle are very dense in this unit, though choke cherry and sumac are present. White snakeroot occurs in some areas and leafy spurge, an invasive prairie plant is dominant in the opening beneath the power lines.

Oak Forest

Unit W – D-rank – White and northern pin oak are common in the canopy along with many cottonwoods. Smaller trees include green ash, basswood, boxelder, oaks, and American elm. Shrubs include prickly ash, choke cherry, Missouri gooseberry, though common buckthorn and Tartarian honeysuckle are abundant throughout. Pennsylvania sedge dominates much of the ground layer as well as small-flowered buttercup, Solomon's seal, sweet cicely, and wild geranium.

This forest occurs within a narrow valley just east of the picnic area. The soil is a little moister than the Oak Woodland communities, likely because it is in narrow shaded valley. Other weedy tree species, such as green ash and boxelder, have not invaded this community very much, so it is still a predominantly native plant community.

Wet Ash Swamp
Unit BB – D-rank – This wetland community occurs near the bottom of the bluff along the slope where groundwater comes to the surface into small streams and thick organic soils. The forest canopy of black ash and green ash is sparse, many of the large trees are dead. There are many shrubs including nannyberry and high bush cranberry as well as many young trees such as basswood and green ash. Common buckthorn is abundant throughout the swamp. The area has relatively good diversity of native plants though invasive species are problematic including reed canary grass and water-cress. Marsh marigold is abundant in narrow waterways and other common species include touch-me-not, lake sedge, beggar ticks, Joe-Pye weed, and common boneset.

Southern Mesic Prairie – Planted
Units P and PP – These two prairies were planted in an area that used to be mown turf. The restoration is rather low-quality since it has not been actively managed in several years. Forbs are the most common group of plants including New England aster, Canada goldenrod, Canada thistle, and sweet clovers. Kentucky bluegrass is the most common grass though many natives are still present, especially big bluestem. Several small trees grow throughout the prairie, especially boxelder and green ash and there are a couple of planted silver maples on the southern unit.

In October 2006, volunteers planted 20 bur oak trees in order to begin restoration as an Oak Savanna community. A number of bur oaks were present prior to the planting. Additional grasses and forbs were also planted near each tree to encourage native species and increase diversity in the prairie. A prescribed burn was performed in the spring of 2007 by the city of St. Paul Parks and Recreation Department on the southern prairie, Unit PP. The planted trees were protected from the fire, but most did not survive the hot and dry summer of 2007. The trees in the northern prairie, Unit P, had very good survival.

RARE PLANT SPECIES

KITTENTAILS (*Besseya bulii*)
Kittentails is a rare plant that was first collected in Mounds Park in 1903 by C.O. Rosendahl, who observed that it was growing on sandy hillsides, and was frequent near the fish hatchery. One small population was recorded in Mounds Park in 1992 during a survey by the Minnesota DNR. The sample location is shown in Unit N on the 2006 Natural Vegetation map. It was found near the top of a ridge on a south-facing slope in oak woodland community. The community is now more shaded than it had been, which likely is why it has not been found there in recent surveys.


MN DNR Natural Heritage Program

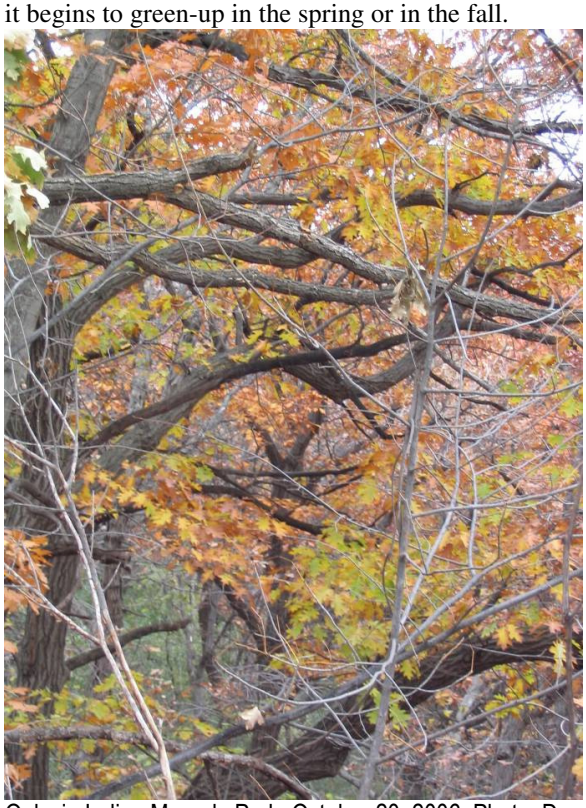
Official Minnesota Status: Threatened

Basis for status**:**
Kittentails is found only in the midwestern U.S. and is considered rare wherever it occurs. This perennial is found only in parts of Minnesota, Iowa, Wisconsin, Illinois, Indiana and Michigan. In Minnesota, it is only found in the counties of Washington, Ramsey, Hennepin, Carver, Scott, Goodhue and Dakota. It grows in a distinct habitat type that is regionally uncommon and frequently exploited. Habitat loss is the primary threat to this species. There are many locations where kittentails are known to survive in the greater Twin Cities metropolitan area of Minnesota, but most of them are severely degraded and contain fewer than 20 plants.

Habitat:
In Minnesota, kittentails is found on the bluffs and terraces along the Mississippi, St. Croix and Minnesota Rivers in the Twin Cities area. The plants prefer partially shaded areas on gravelly soil in dry savannas and open woodlands.

Description:
The yellowish-green flowers are in a dense spike closely attached to the stalk. The stem leaves are alternate and partially clasp the stem. The basal leaves are large, hairy and heavily veined with scalloped or toothed edges. They stay green for a long time in the fall and can be found beneath the leaf litter or among the brown grasses where they grow. The plants flower early in the spring, usually in May, the fruits ripen and drop seed by the end of June, and the spike remains visible most of the summer.

Management recommendations for kittentails:
Providing habitat that supports the growth and spread of kittentails should be the goal of management in areas where kittentails occur. Commonly practiced prairie management techniques, i.e. fire, shrub and tree removal may be applied as long as care is taken to protect the plants from damage. Avoid management that may damage flowers and fruit to ensure successful seed production. Wherever possible, conduct management activities so that only part of a single population is affected by a particular management practice at any one time. Prescribed burns where there is an existing population should be performed before it begins to green-up in the spring or in the fall.


Oaks in Indian Mounds Park. October 20, 2006. Photo: Dan Tix

RECOMMENDED MANAGEMENT AND RESTORATION PROJECTS

Managing the park to create a core community dominated by native plants, and then continuing to expand the core should be the key objective. The primary target of management activities should be invasive species control within the present native plant communities. The highest quality communities are the Oak Woodlands and the main management goal is clearly to control the invasive species.

The most logical center of the core should be the Oak Savanna in the area mapped as Oak Woodland, Units N and U. Management activities in these areas have begun to control of invasive shrubs. Another logical area to focus a smaller amount of resources towards is the restored prairie/savanna, the Triangle Prairies. If these are not properly managed for native prairie in the next few years they will continue to degrade and become a major source of invasive plants. Prescribed burning should be utilized as a management tool in these areas as well.

Units AA and DD are degraded Oak Woodlands that may be too difficult to maintain as oak woodland or oak savanna, since these require burning. Access to these units and maintenance of burn breaks are probably too difficult and expensive for the limited size of the savanna or woodland community that would be maintained. In addition, the openings would create a fragmented forest habitat that decreases the overall value for wildlife. Consequently, Units AA and DD are recommended to be managed as part of the oak forest community. Do not actively plant trees or shrubs within the small prairie openings, and also do not actively burn in these units unless a broader woodland or oak savanna is a future goal.

OVERALL VISION FOR INDIAN MOUNDS PARK

The natural communities in Indian Mounds Park should become dominated by native plant species with reasonably high diversity and few invasive species. The plan below describes efforts to restore oak savanna in the eastern end of the park, from Johnson Parkway to Highway 61. The rest of the natural habitat at the park will be predominantly oak forest, which may eventually, in 100 year or so, become dominated by shade-tolerant forest species like sugar maples and basswood. The oak forest community is targeted, primarily because it provides a greater ability for managers to leave it alone, aside from invasive species control. The oak savanna requires periodic prescribed burns, which are often difficult in this dense urban area. Burning every couple of years should be utilized in the eastern end of the park because of a potential kittentails population and a high potential for oak savanna habitat.

Oak savanna in Unit N after 2007 burn. Photo: Daniel Tix

PROJECT DESCRIPTIONS IN ORDER OF PRIORITY

1. Restore Oak Savanna in Units M and N

Goal: Clear shrubs in woodland area and return native savanna plants

Much of Unit M has high potential for restoration with continued shrub control and the reintroduction of fire. There is a record of Kittentails in the area that could potentially return by clearing woody material from the area. Also, the dry hillside in Unit M is dominated by prairie species, which will be lost if burns are not returned to this area. Eventually, this area can be managed with prescribed burning only which will keep exotic shrubs under control.

Step 1 – Burn Unit M – Completed in Spring of 2007
During the summer of 2006, volunteers removed buckthorn from the woodland to the north and east of the bowl. October 2006 a planting occurred along the north edge of the savanna to augment the natives that would return to the area (see Appendix C). In the spring of 2007, the savanna was burned, which helped to clear the area and further reduce the shrub component. The burn also killed some of the green ash trees and facilitated the growth of native grasses in areas once in rather dense shade. The burned carried into wooded areas through leaf litter along the northern edge of the savanna and in the south and western sides.

The new growth of the grasses is essential for carrying fire in the future. Burns should occur in Unit M at least every 2 years for the first 10 years or until shrubs are under control. Burning can then occur every 5 to 10 years if shrubs are not shading out the ground layer. During each burn, allow the fire to carry as far as possible into the shaded woodland areas, thereby expanding the oak savanna community in all directions. In between burns, continue to control and remove invasive plants and all problematic woody species (non-native species, smooth sumac, green ash, boxelder, etc.)


Hauling buckthorn from Unit M oak savanna. October 7, 2006. Photo: Tessa Pinkstaff.

Step 2 – Clear shrubs on ridge near Kitten-tails
The area where Kitten-tails had been found several years ago has become very overgrown with sumac and other woody plants. The shrubs must be controlled quickly so that a prescribed burn can carry through the grasses on this ridge within the next 2 years. This area should be a focal point for clearing. Expand the clearing out from the location of the Kitten-tails record, where sumac is most common and there are still grasses growing. Perform a prescribed burn in this area every 2 years, while allowing the fire to carry as far into the woodland as possible. This area should become more open, with scattered oaks and perhaps some patches of native shrubs occurring over a grass-dominated ground cover.

Step 3 – Remove invasive shrubs

Additional areas within Units M and N should be cleared of shrubs, especially common buckthorn (Figure 8) (See Appendix D for the preferred control methods of invasive shrubs that occur in the park.) In general, after cutting deciduous shrubs the stump should be treated with herbicide, such as triclopyr. If herbicide cannot be added to the stumps, the whole plant should be pulled from the soil; cutting alone will encourage resprouts. Pulling, however, should be limited to areas that are not susceptible to erosion. Conifers, such as eastern red cedar, can be cut and do not require treatment. Foliar sprays can also be used for dense patches of small plants, it is best to use a mix of glyphosate and triclopyr, applied in the late summer or early fall and avoid desirable plants. Be careful not to cut an area greater than the area for which plants and seed available for Step 4, especially if the cut area has bare soil or few natives on the ground.

The Bowl area of Unit M should be opened continuously to the ridge where the kittentails population was recorded. A prescribed fire should occur within Unit M within the next 3 years, though after a fire has occurred near the kittentails population in Unit N. The area should be cleared to encourage light to reach the ground, promote grasses, and allow fires to carry through the area. This expansion of open savanna should occur within the next couple of years to provide the best opportunity for kittentails and other savanna species to return on their own.

Follow the removal and clearing with at least one additional treatment with herbicide, pulling and cutting, to ensure thorough removal and control before proceeding to the next step.

Step 4 – Return native species under cut areas and bare soil

After clearing shrubs, desirable native plants should be added to out-compete invasive plants that will come back from seed. This is especially important where the soil has been disturbed from hand-pulling or traffic during shrub control. Seeds can be added to areas that have been cleared where bare soil occurs. Live plants can also be installed they are very good for erosion control and provide a greater advantage over the undesirable species. Plant species lists are provided in Appendix B for the appropriate species for an Oak Savanna and Dry-Mesic Oak Woodland Community. Ensure that the species occur in these communities, they are well adapted to the sandy soils at Mounds Park, and to the level of sun and exposure they will receive where they will be planted. Ideally, the seed should be collected from Indian Mounds Park or other local sources.

Utilize robust and even somewhat aggressive native plants to discourage invasive species. For example, Virginia creeper, zig-zag goldenrod, and Pennsylvania sedge do quite well after planting and can form dense colonies in shady woodlands. In the open savanna plant wild bergamot, prairie sage, and little bluestem among other species. More conservative native plants can be added in the future to boost diversity in the park. It is also important to limit the plant species that are sensitive to herbivory from deer or rabbits, so that plantings are not lost. Carefully monitor all plantings to determine which species are doing well and focus future efforts on those species.

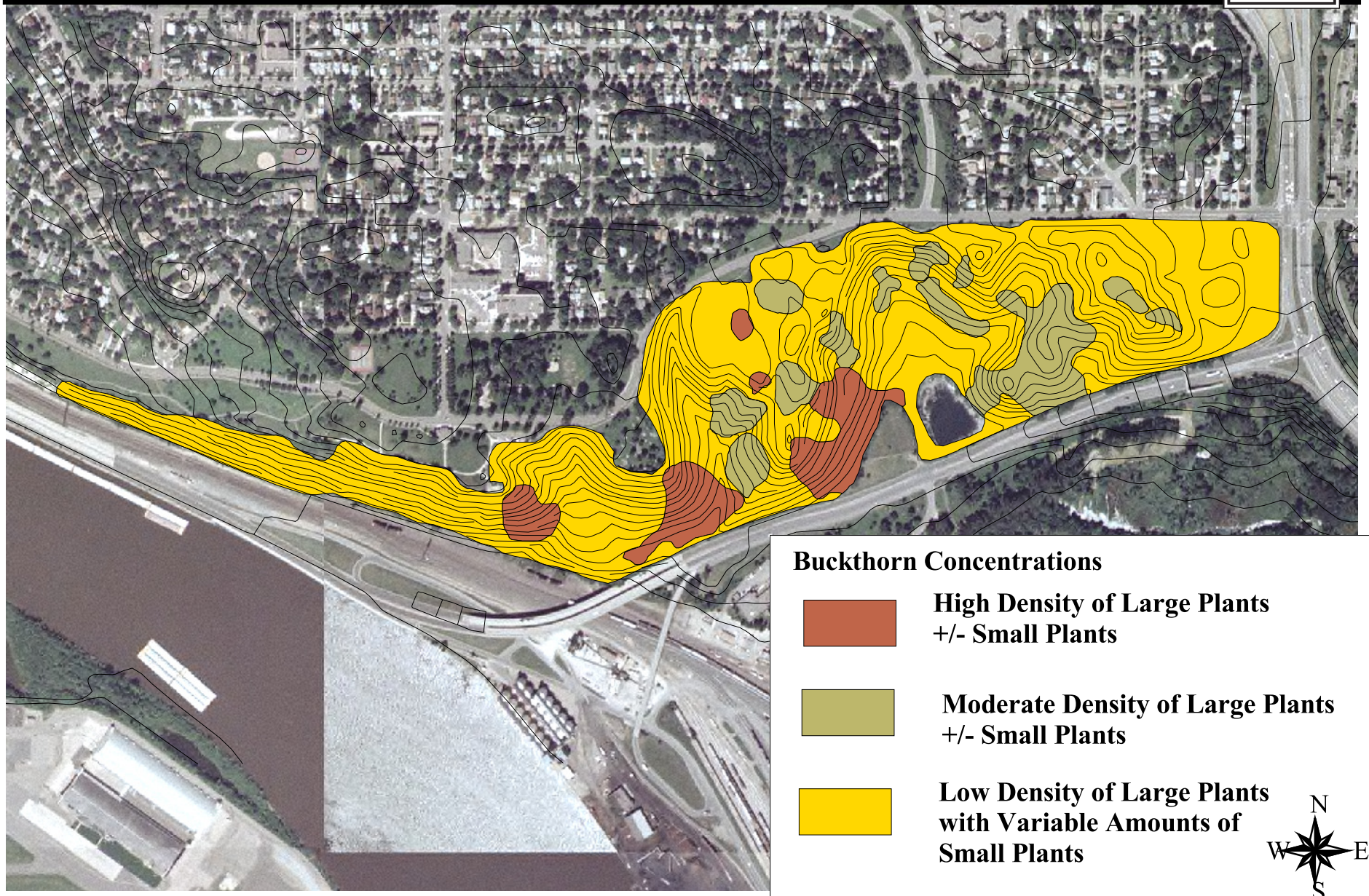
It will be necessary to purchase many of the plants or seeds from local nurseries that specialize in native plants. Ensure that the plants are grown locally, within about 100 miles of Indian Mounds Park, the closer the better.

Areas with a dense groundlayer do not need to be planted and no planting should occur near the kittentails record. There are several areas with dense sumac that have grasses and sedges covering the ground, these should also not be planted. The goal in these areas will be to remove shrubs and monitor the native species that come back on their own, especially after a controlled burn. Digging to plant aggressive native species in these areas may be detrimental for natural re-colonization.

Step 5 – Continue burning and controlling brush

Continue to manage invasive species in Unit M and N before moving to the next priority. Perform prescribed burns on one-half or one-third of the whole unit every year for the first five to ten years. Burning

Figure 8: Buckthorn Concentrations within Park Boundary



frequency can be reduced once the shrubs are under control; then each area can be burned every 6 years or less if woody plants are uncommon.

The whole oak savanna should be split into thirds, so that no more than one-third is burned in a given season. The burns can occur at any time of the year so long as the conditions are safe. Burning in the late fall or winter on steep hillsides can expose the soil for a long period and may lead to erosion. Otherwise, it is best to vary the season during which a certain area is burned, since plants species differ in their ability to recover from fires during a given season.

In addition, burns could be allowed to spread into Units S and O to the east. Management for these units is described as a lower priority because of the effort needed to fully restore them. However, if feasible, burning and basic management steps will facilitate the expansion of savanna and simplify some of the efforts needed to restore it. Since there is a population of spotted knapweed in Unit S, this species should be carefully monitored and controlled aggressively if it spreads into the oak savanna. Biological controls should be added to the population early to help limit the spread; however, it may be too small at this time to support the insect biocontrols.

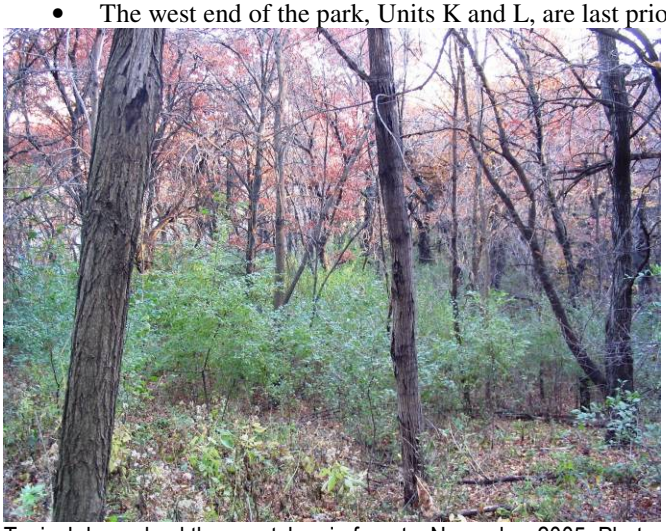
2. Forest Restoration

Goal: Control invasive species and increase native diversity

Management should begin in Unit Q along the edge of the Oak Savanna restoration and move westward through the park. This will allow managers to track new invasions of buckthorn or honeysuckle and allow control of them quickly.

Notes

- Buckthorn is dense in Units E and H, controlling it in these areas should be a priority for the park. Utilize basal bark treatments to control large plants and minimize seed spread.
- Units G and A are not currently forested so planting trees, especially oaks, should be the priority there. In Unit G, cut sumac to allow tree and shrub plantings without herbicide treatment.
- Limit erosion on the steep hillsides, especially in units C, F, and DD.
- The west end of the park, Units K and L, are last priority, unless incorporated with Phalen Creek.



Typical dense buckthorn patches in forests. November 2005. Photo: Fred Harris.

Step 1 – Control invasive shrub species

Aggressively remove all non-native shrubs and trees from Unit Q and BB including buckthorn, honeysuckle, black locust, and Norway maple. Herbaceous invasive species such as garlic mustard should not be aggressively controlled since control is difficult, expensive, and the plants come back from seed readily. See Appendix D for the Fact Sheets on Invasive Plants species control and follow the appropriate guidance suggested under Priority 1. In the Wet Ash Swamp (Unit BB), buckthorn is a problem and it

should be controlled there as well. Do not attempt to control reed Canary grass or purple loosestrife in the swamp; it will be too difficult for a relatively small area.

Step 2 – Return native species under cut areas and bare soil
In shaded areas it is most effective to utilize live plants since seeds for understory plants are difficult to find and have a low establishment rate. Include plant species for the ground layer as well as shrubs and small trees. Oaks should be planted into areas with sufficient light. See Appendix B for the plant species appropriate for the Southern Dry-Mesic Oak Forest community and follow the appropriate guidance in Priority 1-Step 3.

Step 3 – Plant native trees that will eventually grow into the canopy
Throughout the forest there are small gaps in the forest canopy that allow enough sunlight for saplings. Green ash and cottonwood are common in this unit, so it is important to increase diversity of canopy trees. Some oaks could be planted where there is moderate shade, but will not handle dense shade. Species such as basswood, black cherry, and ironwood can be planted in shaded areas; whereas, hackberry can be planted with oaks in the small gaps. Other species can also be planted, but minimize sugar maples, since this species does so well in the shade that it eventually becomes the only tree species in a forest.

Although the canopy species of this forested community are weedy species that indicate disturbance, it is not recommended to remove them. Maintaining the integrity of the forest canopy is more important than attempting to reforest the area after cutting green ash or cottonwoods. The major emphasis should be controlling invasive non-native shrubs that are the major sign of degradation in this woodland.

Step 4 – Monitor and control invasive species
Ensure that small populations of invasive plants are controlled immediately. Continue to increase the plant diversity by adding plants and seed to areas where invasive species were controlled. Keep aware of new biological controls available for some of the invasive species, especially garlic mustard.

3. Expand Oak Savanna

Goal: Restore native Oak Savanna in areas dominated by non-natives

Units O, R, S, and T can be restored to Oak Savanna and incorporated into the savanna in Unit N. This will create a larger community of savanna at the eastern end of the park. This restoration effort was prioritized last because the oak forest is in relatively good condition and it will be fairly difficult to restore oak savanna from non-native dominated grassland.

Step 1 – Control invasive grassland species
Begin control measures on invasive plants before this area becomes directly connected to open portions of Unit N. In particular, spotted knapweed and leafy spurge control should begin as soon as it is anticipated that this area will become part of the oak savanna (Figure 9). As soon as possible biological controls should be added to both invasive plant species, this is a relatively simple step and can be performed annually to ensure a thriving population of the insect. Herbicide applications should be used to control smooth brome and Kentucky bluegrass. It will be best to clear the open grassland to bare soil before planting native species. A few small populations of desirable native grasses occur in openings, such as porcupine grass and little bluestem, these can be avoided.

Recommended technique to control existing vegetation and prepare the site for planting:

1. In late summer, mow and rake off the dead vegetation (burning may be easier if the site is dry enough at this time of year)
2. Apply herbicide (Glyphosate) once the vegetation is at least 3 inches tall, before the end of September.
3. In spring, as soon as the vegetation is about 8 inches tall, apply glyphosate again. (Other herbicides may be necessary depending on the species that occur at that time.)
4. Burn again once the dead vegetation is dry (By mid-June)
5. Apply native seed and install plants – see Step 2

Smooth brome and Kentucky bluegrass will likely need further management to control them and they will always be present at some level. Spring burning will help to minimize their spread as will well-timed herbicide applications. As soon as new areas are cleared of woody material, ensure that native species are added having an advantage to colonize the new sunny area.

Step 2 – Remove invasive shrubs and thin trees

Woody material in Units O, R, S, and T must be minimized, opening the area for light to reach the ground to help support ground layer species, especially grasses. Buckthorn, honeysuckle, and black locust should be the first priority. Most tree and shrub species should be cut, though treatment is not always necessary if regular burning is anticipated. Oaks should be left alone except for dense patches of small trees. Native shrubs should be part of the community in the future as long as they do not become too dense and reduce overall community diversity. Such shrubs can include chokecherry, hazelnut, smooth sumac, and juneberry. Many of these will die-back when fire is reintroduced, but they will remain in small numbers.

Step 3 – Plant native savanna species in cut areas

At first, focus planting efforts on native grasses, which are aggressive and can help prevent some of the non-native invaders. Utilize seed and live plants and follow species lists for Oak Savanna, see Appendix B. Follow guidelines provided in Priority 1, Step 3.

Step 4 – Control invasive species and mow newly planted areas

Use all methods necessary, especially in the first two years after seed addition, to control invasive species. More seed and plants may need to be added if herbicides are used in some areas, but it is most important to control invasions early and prevent them from going to seed. The area can be mowed two or three times a year for the first two years, this will encourage germination of the native seeds and control brush and possibly some herbaceous invaders. Use appropriate herbicides to control species such as spotted knapweed and leafy spurge. Continue aggressive control for at least 3 years. Continue to add native seed, prairie mulch, and native plants, especially in areas where invasives have been problematic.

Step 5 – Burn

Prescribed burns should be used every year for the first 5 years in Units O, R, S, and T. Spring burning will be most effective to control non-native, cool season grasses. However, if other invasives are problematic, burning at different seasons may be prudent.

Buckthorn in Unit N. October 20, 2006. Photo: Daniel Tix

Figure 9: Exotic Species Locations

GREAT RIVER GREENING

Invasive Species Concentration

- Siberian elm
- Tartarian honeysuckle
- Brome
- Black locust
- Spotted knapweed

Indian Mounds Park Boundary

0 0.1 0.2 Miles

N W E S

MANAGEMENT SUMMARY

The overall management goal at Indian Mounds Regional Park should be to reduce invasive shrub species in natural areas. Oak savanna should be restored in the eastern end of the park by continued shrub clearing and prescribed burning. The rest of the park should be managed as an oak forest, but it requires extensive invasive species control in most of the area. The goal of this forest should be to have native species dominate the forest community, in the tree canopy as well as other layers.

The oak savanna community already exists in a portion of Unit M, but a prescribed burn soon would be very beneficial. The savanna should be expanded extensively into all of Unit N and, eventually, into units O, R, S, and T. This will require considerable restoration efforts, though, so the priority should be based in Units M and N where native species are more likely to re-colonize after invasive control and prescribed burning.

The oak forest community in the rest of the park should be managed by controlling invasive species and reintroducing native plants, including trees and shrubs to perpetuate a forested habitat. The oak forest may eventually succeed to a maple-basswood dominated community, but this will be in several generations and is an acceptable future condition. Without appropriate controls of invasive shrubs, this future community may be dominated only by invasive plants since native trees are unable to regenerate under the canopy of these shrubs.

The ash, cottonwood, elm, and boxelder currently present in the forest should be allowed to be phased out of the community. Do not actively control these species. Instead, encourage oaks, bitternut hickory, hackberry, basswood, etc. by planting into appropriate locations after invasive shrub removal. The undesirable native trees will be phased out by forest succession and the dead wood will provide excellent wildlife habitat as the forest ages. On the following page are the recommended first and second priorities for restoration.

Oak Savanna Unit M. October 20, 2006. Photo: Daniel Tix

OAK SAVANNA RESTORATION:
1st Priority (Units M and N)

Finish work described here before moving into other areas of the park. If resources are available in any given year to work on other areas, see 2nd priority.

	Activity	Notes
2008 (Year 1)	Remove shrubs in Unit N along ridge near kittentails record	Create an opening large enough to increase sunlight
2008 (Year 1)	Spot treat or pull woody resprouts in Unit M	Check areas that had been cut or pulled in 2006
Year 1 or 2	Burn in Unit N near kittentails record	
Years 2-5 – Late Summer or fall	Spot treat or pull woody resprouts in areas that have already been cleared	Follow-up management to prevent re-infestations in areas already cut. This should get easier every year in any given area.
Years 2-5 – Summer – winter	Cut and treat buckthorn in Unit M and N	Clear as much as possible every year
Years 2-6 – Spring or fall	Plant in areas cut after buckthorn removal	Continue to re-introduce appropriate native species while controlling invasives
Year 7 -10 – Late summer or fall	Control invasive shrubs – spot treat or pull new growth	Monitor closely in Unit M and N, which should be well controlled by this time

- Burn each unit every 2 years until Year 8 (4 burns each) – then assess the control of woody plants. After that, burn every 5-10 years, depending on brush growth rates. Burn only one unit in a single season. Once the savanna is expanded to the east, burn only ¼ of the area in a single season.
- Invasive plants should be monitored annually.
  - Garlic mustard – introduce biocontrols when they are ready
  - Spotted knapweed, leafy spurge – control immediately
  - Watch for other invasive species that may invade the savanna

OAK FOREST RESTORATION
2nd Priority (Begin in Units Q and BB and work west through the park)

Finish work described here before moving into other areas of the park. If resources are available in any given year to work on other areas, begin to expand the oak savanna according to Project Descriptions.

	Activity	Notes
Spring or Fall – as soon as possible	Plant Units G and A with trees: oaks, bitternut hickory, basswood, etc.	Begin this reforestation to expand on existing forest units; carefully monitor in the future to prevent buckthorn invasion
Best time – late summer or fall	Cut and stump treat invasive shrubs	Consider basal bark spraying in fall or winter in very dense stands
Fall or the spring following shrub control	Plant native shrubs, herbs, and trees	Plant species that do well with outcompeting invasive shrubs
Every year	Closely monitor past plantings	Determine which species are most successful, add those to future plantings
Every year – late summer or fall	Spot treat or pull woody resprouts in areas already cleared	Follow-up management to prevent re-infestations in areas already cut. This should get easier every year in any given area.

- Plant Oaks, butternut hickory, basswood, and ironwood after clearing to increase canopy diversity. Oaks should be planted in light gaps whenever possible.
- Invasive plants should be monitored annually.
  - Garlic mustard – introduce biocontrols when they are ready
  - Spotted knapweed, leafy spurge – control immediately
  - Watch for other invasive species that may invade the savanna

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Appendix A: Inventory

KEY:

Lifeform:	c climber, f forb, g graminoid, s shrub, t tree
Exotic:	Exotic Species (includes some invasive native spp. Not native to Minnesota)
Habitat categories:	WF: Wet Forest (Mixed Hardwood Swamp)
	MH: Mesic Hardwood Forests – Oak and Boxelder-Green ash forests
	W: Woodlands (Deciduous Woodlands, Savanna, and Planted coniferous trees)
	PR: Prairie Restoration
	GR: Disturbed grassland (non-native dominated grasslands and shrublands)

				Habitat				
Common name	**Scientific Name**	**Lifeform**	**Exotic**	**WF**	**MH**	**W**	**PR**	**OF**
boxelder	*Acer negundo*	t			x	x	x	
red maple	*Acer rubrum*	t			x			
Norway maple	*Acer platanoides*	t	x		x			
silver maple	*Acer saccharinum*	t					x	
sugar maple	*Acer saccharum*	t			x			
yarrow	*Achillea millefolium*	f					x	x
fragrant giant hyssop	*Agastache foeniculum*	f				x		
quack grass	*Agropyron repens*	g	x			x		x
redtop	*Agrostis stolonifera*	g	x	x				
garlic mustard	*Alliara petiolata*	f	x	x	x	x		
common ragweed	*Ambrosia artemisiifolia*	f				x	x	x
western ragweed	*Ambrosia psilostachya*	f				x		
giant ragweed	*Ambrosia trifida*	f					x	
Leadplant	*Amorpha canescens*	S				x		
false indigo	*Amorpha fruticosa*	s				x	x	
hog peanuts	*Amphicarpea bracteata*	f				x		
big bluestem	*Andropogon gerardii*	g				x	x	x
long-headed anemone	*Anemone cylindrica*	f				x		
hemp dogbane	*Apocynum cannabinum*	f					x	
columbine	*Aquilegia canadensis*	f				x		
rock cress	*Arabis* spp.	f				x		
wild sarsaparilla	*Aralia nudicaulis*	f			x			
American spikenard	*Aralia racemosa*	f				x		
burdock	*Arctium minus*	f	x		x	x	x	x
Jack-in-the-pulpit	*Arisaema triphyllum*	f			x	x		
biennial wormwood	*Artemisia biennis*	f						
wild ginger	*Asarum canadense*	f						
marsh milkweed	*Asclepias incarnata*	f		x				
common milkweed	*Asclepias syriaca*	f					x	x
butterfly weed	*Asclepias tuberosa*	f					x	
whorled milkweed	*Asclepias verticillata*	f						x
wild asparagus	*Asparagus officinalis*	f	x			x	x	
heart-leaved aster	*Aster cordifolius*	f				x		
heath aster	*Aster ericoides*	f						
panicled aster	*Aster lanceolatus*	f						x
New England aster	*Aster novae-angliae*	f		x				
ontario aster	*Aster ontarionis*	f				x		

Common name	Scientific Name	Lifeform	Exotic	WF	MH	W	PR	OF
Sky blue aster	*Aster oolentagiensis*	f				x		
Western silvery aster	*Aster sericeus*	f				x		
hoary alyssum	*Berteroa incana*	f	x					
beggar ticks	*Bidens* spp.	f				x		
false nettle	*Boehmeria cylindrica*	f		x				
Side oats grama	*Bouteloua curtipendula*	g				x		
smooth brome	*Bromus inermis*	g	x			x	x	x
bluejoint	*Calamagrostis canadensis*	g		x				
marsh marigold	*Caltha palustris*	f		x				
throatwort	*Campanula rapunculoides*	f	x		x			
harebell	*Campanula rotundifolia*	f					x	
musk thistle	*Carduus nutans*	f	x					x
water sedge	*Carex aquatilis*	g		x				
woodland sedge	*Carex blanda*	g				x		
bristly sedge	*Carex comosa*	g		x				
riverbank sedge	*Carex emoryii*	g		x				
lake sedge	*Carex lacustris*	g		x				
pennsylvania sedge	*Carex pensylvanica*	g			x	x		
sprengel's sedge	*Carex sprengelii*	g			x			
unknown sedges - several	*Carex* spp.	g		x				
blue cohosh	*Caulophyllum thalictroides*	f			x			
hackberry	*Celtis occidentalis*	t			x	x		
spotted knapweed	*Centaurea maculosa*	f	x					x
lamb's quarters	*Chenopodium album*	f						x
enchanter's nightshade	*Circaea lutiana*	f			x	x		
canada thistle	*Cirsium arvense*	f	x			x	x	x
thistle	*Cirsium discolor*	f	x					x
virgin's bower	*Clematis virginica*	c						
bindweed	*Convolvulus arvensis*	c						x
horseweed	*Conyza candensis*	f	x			x	x	x
gray dogwood	*Cornus foemina*	s				x		
red osier dogwood	*Cornus sericea*	s		x				
crown vetch	*Coronilla varia*	f	x				x	
dodder	*Cuscuta spp*	f		x				
orchard grass	*Dactylus glomerata*	g	x					x
barnyard grass	*Echinochloa muricata*	g						x
canada wild rye	*Elymus canadensis*	g				x	x	
bottlebrush grass	*Elymus hystrix*	g				x		
horsetail	*Equisetum* spp.	f		x				
philadelphia fleabane	*Erigeron philadelphicus*	f					x	x
daisy fleabane	*Erigeron strigosus*	f						x
boneset	*Eupatorium perfoliatum*	f						
purple node Joe Pye weed	*Eupatorium purpureum*	f				x		
white snakeroot	*Eupatorium rugosum*	f			x	x		
leafy spurge	*Euphorbia esula*	f	x					x
black ash	*Fraxinus nigra*	t		x				
green ash	*Fraxinus pennsylvanica*	t		x	x	x	x	x
cleavers	*Galium aparine*	f			x	x		
northern bedstraw	*Galium boreale*	f				x		
sweet scented bedstraw	*Galium triflorum*	f				x		

Common name	Scientific Name	Lifeform	Exotic	WF	MH	W	PR	OF
wild geranium	*Geranium maculatum*	f			x	x		
avens	*Geum* spp.	f				x		
creeping Charlie	*Glechoma hederacea*	f	x			x		
American stickseed	*Hackelia deflexa*	f				x		
common sneezeweed	*Helenium autumnale*	f					x	
woodland sunflower	*Helianthus strumosus*	f				x		
Jerusalem artichoke	*Helianthus tuberosus*	f					x	
ox-eye	*Heliopsis helianthoides*	f					x	
day lily	*Hemerocallis fulva*	f	x			x		
dame's rocket	*Hesperis matronalis*	f	x			x		
alum root	*Heuchera richardsonii*	f				x		
Virginia waterleaf	*Hydrophyllum virginianum*	f			x	x		
touch-me-not	*Impatiens* spp.	f		x				
pale touch-me-not	*Impatiens pallida*	f		x	x			
black walnut	*Juglans nigra*	t			x	x		
rush	*Juncus tenuis*	g				x		
eastern red cedar	*Juniperus virginiana*	t				x		
wild lettuce	*Lactuca spp*	f					x	x
wood nettle	*Laportea canadensis*	f		x	x			
motherwort	*Leonurus cardiaca*	f		x	x	x		
butter and eggs	*Linaria canadensis*	f	x				x	x
great lobelia	*Lobelia siphilitica*	f		x				
Tartarian honeysuckle	*Lonicera tartarica*	s	x	x	x	x	x	x
bird's foot trefoil	*Lotus corniculatus*	f	x				x	x
American water horehound	*Lycopus americana*	f						
purple loosestrife	*Lythrum salicaria*	f	x					
crabapple	*Malus sp.*	t	x					x
black medic	*Medicago lupulina*	f	x					x
alfalfa	*Medicago sativa*	f	x					x
sweet clover	*Melilotus* spp.	f	x				x	x
bergamot	*Monarda fistulosa*	f				x	x	x
white mulberry	*Morus alba*	t	x			x		
swamp satin grass	*Muhlenbergia frondosa*	g		x				
catnip	*Nepeta cataria*	f	x					x
common evening primrose	*Oenothera biennis*	f					x	x
sweet cicely	*Osmorhiza claytoniana*	f			x	x		
ironwood	*Ostrya virginiana*	t			x			
wood sorrel	*Oxalis spp*	f				x		
switchgrass	*Panicum virgatum*	g					x	x
Virginia creeper	*Parthenocissus inserta*	c		x	x	x		
woodbine	*Parthenocissus quinquifolius*	c		x				
reed Canary grass	*Phalaris arundinacea*	g	x				x	
timothy	*Phleum pratense*	g	x					x
blue phlox	*Phlox divaricata*	f				x		
reed grass	*Phragmites australis*	g					x	
lopseed	*Phryma leptostachya*	f			x	x		
ground cherry	*Physalis* spp	f				x		
clearweed	*Pilea spp*	f		x				
red pine	*Pinus resinosa*	t				x		x
white pine	*Pinus strobus*	t				x		

Common name	Scientific Name	Lifeform	Exotic	WF	MH	W	PR	OF
Scotch pine	*Pinus sylvestris*	t	x			x		
common plantain	*Plantago major*	f	x			x	x	x
canada bluegrass	*Poa compressa*	g					x	x
fowl meadow grass	*Poa palustris*	g						
Kentucky bluegrass	*Poa pratensis*	g					x	x
Solomon's seal	*Polygonatum biflorum*	f			x	x		
black bindweed	*Polygonum convulus*	f					x	x
Virginia knotweed	*Polygonum virginiana*	f				x		
cottonwood	*Populus deltoides*	t		x	x	x		
quaking aspen	*Populus tremuloides*	t			x	x		
black cherry	*Prunus serotina*	t			x	x		
chokecherry	*Prunus virginiana*	s				x		
white oak	*Quercus alba*	t			x	x		
northern pin oak	*Quercus ellipsoidalis*	t			x	x		
bur oak	*Quercus macrocarpa*	t				x		
red oak	*Quercus rubra*	t			x	x		
red - pin oak hybrid	*Quercus rubra x ellipsoidalis*	t			x	x		
small-flowered buttercup	*Ranunculus arbortivus*	f			x			
common buckthorn	*Rhamnus cathartica*	s	x	x	x	x	x	x
smooth sumac	*Rhus glabra*	s				x		
wild black current	*Ribes americana*	s		x				
prickly gooseberry	*Ribes cynosbati*	s				x		
Missouri gooseberry	*Ribes missouriense*	s			x			
black locust	*Robinia pseudoacacia*	t	x		x	x		
water-cress	*Rorrippa nasturtium-aquaticum*	f	x					
prairie rose	*Rosa arkansana*	s						x
raspberry	*Rubus* spp.	s				x	x	
red raspberry	*Rubus occidentalis*	s				x		
black raspberry	*Rubus strigosus*	s				x		
black eyed susan	*Rudbeckia hirta*	f					x	x
golden-glow	*Rudbeckia laciniata*	f		x	x			
curly dock	*Rumex crispus*	f	x				x	x
great water dock	*Rumex orbiculatus*	f		x				
common elder	*Sambucus canadensis*	s		x	x			
little bluestem	*Schizachyrium scoparium*	g				x	x	
soft stem bulrush	*Scirpus validus*	g		x				
figwort	*Scrophularia lanceolata*	f				x		
foxtail	*Setaria* spp.	g				x		
bur-cucumber	*Sicyos angulatus*	c						x
racemose false solomon's seal	*Smilacina racemosa*	f			x			
carrionflower	*Smilax herbacea*	f			x	x		
bittersweet nightshad	*Solanum dulcamara*	f	x	x	x			
Canada goldenrod	*Solidago canadensis*	f				x	x	x
zig-zag goldenrod	*Solidago flexicaulis*	f			x	x		
giant goldenrod	*Solidago gigantea*	f					x	
stiff goldenrod	*Solidago rigida*	f					x	x
sow thistle	*Sonchus uliginosus*	f	x					x
Indian grass	*Sorghastrum nutans*	g				x	x	
prairie dropseed	*Sporobolus heterolepsis*	g					x	
bladdernut	*Staphylea trifolia*	s			x			

Common name	Scientific Name	Lifeform	Exotic	WF	MH	W	PR	OF
porcupine grass	*Stipa spartea*	g				x		
snowberry	*Symphoricarpos albus*	s				x		
skunk cabbage	*Symplocarpus foetidus*	f		x				
dandilion	*Taraxacum officinale*	f	x				x	x
rue anemone	*Thalictrum thalictroides*	f				x		
basswood	*Tilia americana*	t			x	x		
poison ivy	*Toxicodendron radicans*	s			x	x		
spiderwort	*Tradescantia spp*	f					x	
red clover	*Trifolium repens*	f	x				x	x
narrow leaf cattail	*Typha angustifolia*	g	x					
american elm	*Ulmus americana*	t			x	x		
siberian elm	*Ulmus pumila*	t	x					x
slippery elm	*Ulmus rubra*	t			x			
common nettle	*Urtica dioica*	f		x				
large flowered bellwort	*Uvularia grandiflora*	f			x			
mullein	*Verbascum thapsus*	f	x			x		x
vervain	*Verbena hastata*	f						x
Culver's root	*Veronicastrum virginicum*	f				x		
Nannyberry	*Viburnum lentago*	s				x		
high-bush cranberry	*Viburnum opulus*	s		x				
Canada violet	*Viola canadensis*	f			x			
tall yellow violet	*Viola pubescens*	f			x			
common blue violet	*Viola sororia*	f			x			
river grape	*Vitis riparia*	c			x	x		x
cocklebur	*Xanthium strumarium*	f				x	x	x
prickly ash	*Zanthoxylum americanum*	s				x		
wild rice	*Zizania palustris*	g						
golden Alexanders	*Zizia aurea*	f					x	

Appendix B: Plant Species Lists for Native Plant Communities

The species lists below for Oak Savanna are species that can be planted into Mounds Park in Unit M or N, or any other unit where Oak Savanna restoration becomes a target community.

UPs14 Southern Dry Savanna	
Forbs, Ferns & Fern Allies	
Western ragweed	*Ambrosia psilostachya*
Long-headed thimbleweed	*Anemone cylindrica*
White sage	*Artemisia ludoviciana*
Tall wormwood or Tarragon	*Artemisia* spp.
Common milkweed	*Asclepias syriaca*
Heath aster	*Aster ericoides*
Skyblue aster	*Aster oolentangiensis*
Harebell	*Campanula rotundifolia*
Hairy golden aster	*Chrysopsis villosa*
Bastard toad-flax	*Comandra umbellata*
Horseweed	*Conyza canadensis*
Bird's foot coreopsis	*Coreopsis palmata*
Purple prairie clover	*Dalea purpurea*
Silky prairie clover	*Dalea villosa*
Flowering spurge	*Euphorbia corollata*
Mock pennyroyal	*Hedeoma hispida*
Hoary frostweed	*Helianthemum bicknellii*
Stiff sunflower	*Helianthus pauciflorus*
Prairie pinweed	*Lechea stricta*
Round-headed bush clover	*Lespedeza capitata*
Rough blazing star	*Liatris aspera*
Hoary puccoon	*Lithospermum canescens*
Hairy puccoon	*Lithospermum caroliniense*
Horsemint	*Monarda punctata*
Large-flowered beard tongue	*Penstemon grandiflorus*
Virginia ground cherry	*Physalis virginiana*
Tall cinquefoil	*Potentilla arguta*
Rock spikemoss	*Selaginella rupestris*
Starry false Solomon's seal	*Smilacina stellata*
Erect, Smooth, or Illinois carrion-flower	*Smilax* spp.
Missouri goldenrod	*Solidago missouriensis*
Gray goldenrod	*Solidago nemoralis*
Showy goldenrod	*Solidago speciosa*
Bearded birdfoot violet	*Viola palmata*
Grasses & Sedges	
Big bluestem	*Andropogon gerardii*
Side-oats grama	*Bouteloua curtipendula*
Hairy grama	*Bouteloua hirsuta*

Sand reed-grass	*Calamovilfa longifolia*
Hay sedge	*Carex foenea*
Muhlenberg's sedge	*Carex muhlenbergia*
Pennsylvania sedge	*Carex pensylvanica var. pensylvanica*
Purple lovegrass	*Eragrostis spectabilis*
Junegrass	*Koeleria pyramidata*
Fall witch grass	*Leptoloma cognatum*
Scribner's panic grass	*Panicum oligosanthes*
Long-leaved panic grass	*Panicum perlongum*
Switchgrass	*Panicum virgatum*
Little bluestem	*Schizachyrium scoparium*
Indian grass	*Sorghastrum nutans*
Prairie dropseed	*Sporobolus heterolepis*
Porcupine grass	*Stipa spartea*
Woody Vines	
Virginia creeper	*Parthenocissus vitacea or P. quinquefolia*
Semi-Shrubs	
Leadplant	*Amorpha canescens*
Prairie rose	*Rosa arkansana*
Shrubs	
Low or Saskatoon juneberry	*Amelanchier humilis or A. alnifolia*
American hazelnut	*Corylus americana*
Chokecherry	*Prunus virginiana*
Smooth sumac	*Rhus glabra*
Trees	
Jack Pine	*Pinus banksiana*
Northern pin oak	*Quercus ellipsoidales*
Bur oak	*Quercus macrocarpa*
Black oak	*Quercus velutina*

The species lists below for Oak Woodland, Oak Forest and Ash swamp are the most common species for each community type based on the Minnesota DNR publication "Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province." (2005)

These species lists can be used to guide species selection for planting within these appropriate habitats at Indian Mounds Regional Park.

FDs37 Southern Dry-Mesic Oak (Maple) Woodland	
Forbs, Ferns & Fern Allies	
Hog peanut	*Amphicarpaea bracteata*
Wood anemone	*Anemone quinquefolia*
Spreading dogbane	*Apocynum androsaemifolium*
Columbine	*Aquilegia canadensis*
Wild sarsaparilla	*Aralia nudicaulis*
Large-leaved aster	*Aster macrophyllus*
Tail-leaved aster	*Aster sagittifolius*
Lady fern	*Athyrium filix-femina*

Common enchanter's nightshade	*Circaea lutetiana*
Pointed-leaved tick trefoil	*Desmodium glutinosum*
Northern bedstraw	*Galium boreale*
Sweet-scented bedstraw	*Galium triflorum*
Wild geranium	*Geranium maculatum*
Canada mayflower	*Maianthemum canadense*
Clayton's sweet cicely	*Osmorhiza claytonii*
Interrupted fern	*Osmunda claytoniana*
Lopseed	*Phryma leptostachya*
Giant Solomon's seal	*Polygonatum biflorum*
Bracken	*Pteridium aquilinum*
Elliptic shinleaf	*Pyrola elliptica*
Maryland black snakeroot	*Sanicula marilandica*
Common false Solomon's seal	*Smilacina racemosa*
Starry false Solomon's seal	*Smilacina stellata*
Early meadow-rue	*Thalictrum dioicum*
Starflower	*Trientalis borealis*
Large-flowered bellwort	*Uvularia grandiflora*
Pale bellwort	*Uvularia sessilifolia*
Grasses & Sedges	
Pennsylvania sedge	*Carex pensylvanica*
Bottlebrush grass	*Elymus hystrix*
Nodding fescue	*Festuca subverticillata*
Moutain rice grass	*Oryzopsis asperifolia*
Woody Vines	
Virginia creeper	*Parthenocissus spp.*
Wild grape	*Vitis riparia*
Low Shrubs	
Tall blackberries	*Rubus allegheniensis and similar Rubus spp.*
Red raspberry	*Rubus idaeus*
Tall Shrubs	
Juneberries	*Amelanchier spp.*
Gray dogwood	*Cornus racemosa*
Round-leaved dogwood	*Cornus rugosa*
American hazelnut	*Corylus americana*
Beaked hazelnut	*Corylus cornuta*
Bush honeysuckle	*Diervilla lonicera*
Chokecherry	*Prunus virginiana*
Prickly gooseberry	*Ribes cynosbati*
Missouri gooseberry	*Ribes missouriense*
Red-berried elder	*Sambucus racemosa*
Snowberry or Wolfberry	*Symphoricarpos albus or S. occidentalis*
Poison ivy	*Toxicodendron rydbergii*
Nannyberry	*Viburnum lentago*
Downy arrowwood	*Viburnum rafinesquianum*
Prickly ash	*Zanthoxylum americanum*
Trees	
Red maple	*Acer rubrum*

Paper birch	*Betula papyrifera*
Green ash	*Fraxinus pennsylvanica*
Ironwood	*Ostrya virginiana*
Big-toothed aspen	*Populus grandidentata*
Quaking aspen	*Populus tremuloides*
Black cherry	*Prunus serotina*
White oak	*Quercus alba*
Northern pin oak	*Quercus ellipsoidales*
Bur oak	*Quercus macrocarpa*
Northern red oak	*Quercus rubra*
American elm	*Ulmus americana*

MHs38 Southern Mesic Oak-Basswood Forest	
Forbs, Ferns & Fern Allies	
Red baneberry	*Actaea rubra*
Maidenhair fern	*Adiantum pedatum*
Hog peanut	*Amphicarpaea bracteata*
Sharp-lobed hepatica	*Anemone acutiloba*
Wood anemone	*Anemone quinquefolia*
Wild sarsaparilla	*Aralia nudicaulis*
Jack-in-the-pulpit	*Arisaema triphyllum*
Wild ginger	*Asarum canadense*
Lady fern	*Athyrium filix-femina*
Rattlesnake fern	*Botrychium virginianum*
Blue cohosh	*Caulophyllum thalictroides*
Common enchanter's nightshade	*Circaea lutetiana*
Honewort	*Cryptotaenia canadensis*
Pointed-leaved tick trefoil	*Desmodium glutinosum*
Cleavers	*Galium aparine*
Shining bedstraw	*Galium concinnum*
Sweet-scented bedstraw	*Galium triflorum*
Wild geranium	*Geranium maculatum*
White avens	*Geum canadense*
Virginia waterleaf	*Hydrophyllum virginianum*
Canada mayflower	*Maianthemum canadense*
Clayton's sweet cicely	*Osmorhiza claytonii*
Lopseed	*Phryma leptostachya*
Bloodroot	*Sanguinaria canadensis*
Maryland black snakeroot	*Sanicula marilandica*
Common false Solomon's seal	*Smilacina racemosa*
Erect, Smooth, or Illinois carrion-flower	*Smilax* spp.
Zigzag goldenrod	*Solidago flexicaulis*
Early meadow-rue	*Thalictrum dioicum*
Large-flowered bellwort	*Uvularia grandiflora*
Yellow violet	*Viola pubescens*
Grasses & Sedges	
Bearded shorthusk	*Brachyelytrum erectum*
Bland sedge	*Carex blanda*

Long-stalked sedge	*Carex pedunculata*
Pennsylvania sedge	*Carex pensylvanica*
Starry sedge	*Carex rosea*
Bottlebrush grass	*Elymus hystrix*
Nodding fescue	*Festuca subverticillata*
Woody Vines	
Virginia creeper	*Parthenocissus spp.*
Wild grape	*Vitis riparia*
Shrubs	
Pagoda dogwood	*Cornus alternifolia*
American hazelnut	*Corylus americana*
Chokecherry	*Prunus virginiana*
Prickly gooseberry	*Ribes cynosbati*
Missouri gooseberry	*Ribes missouriense*
Poison ivy	*Toxicodendron rydbergii*
Nannyberry	*Viburnum lentago*
Downy arrowwood	*Viburnum rafinesquianum*
Prickly ash	*Zanthoxylum americanum*
Trees Canopy Subcanopy Shrub Layer	
Sugar maple	*Acer saccharum*
Paper birch	*Betula papyrifera*
Blue beech	*Carpinus caroliniana*
Bitternut hickory	*Carya cordiformis*
Green ash	*Fraxinus pennsylvanica*
Ironwood	*Ostrya virginiana*
White pine	*Pinus strobus*
Black cherry	*Prunus serotina*
White oak	*Quercus alba*
Bur oak	*Quercus macrocarpa*
Northern red oak	*Quercus rubra*
Basswood	*Tilia americana*
American elm	*Ulmus americana*
Red elm	*Ulmus rubra*

WFs57 Southern Wet Ash Swamp	
Forbs, Ferns & Fern Allies	
Hog peanut	*Amphicarpaea bracteata*
Jack-in-the-pulpit	*Arisaema triphyllum*
Wild ginger	*Asarum canadense*
Crooked aster	*Aster prenanthoides*
Lady fern	*Athyrium filix-femina*
Common marsh marigold	*Caltha palustris*
Common enchanter's nightshade	*Circaea lutetiana*
Honewort	*Cryptotaenia canadensis*
Bulblet fern	*Cystopteris bulbifera*
Field horsetail	*Equisetum arvense*

Tall scouring rush	*Equisetum hyemale*
False mermaid	*Floerkea proserpinacoides*
Cleavers	*Galium aparine*
Sweet-scented bedstraw	*Galium triflorum*
Wild geranium	*Geranium maculatum*
White avens	*Geum canadense*
Virginia waterleaf	*Hydrophyllum virginianum*
Touch-me-not	*Impatiens spp.*
Wood nettle	*Laportea canadensis*
Michigan lily	*Lilium michiganense*
Canada mayflower	*Maianthemum canadense*
Ostrich fern	*Matteuccia struthiopteris*
Two-leaved miterwort	*Mitella diphylla*
Sensitive fern	*Onoclea sensibilis*
Clayton's sweet cicely	*Osmorhiza claytonii*
Clearweed	*Pilea spp.*
Hispid buttercup	*Ranunculus hispidus*
Hooked crowfoot	*Ranunculus recurvatus*
Small-leaved water cress	*Rorippa nasturtium-aquaticum*
Dwarf raspberry	*Rubus pubescens*
Tall coneflower	*Rudbeckia laciniata*
Zigzag goldenrod	*Solidago flexicaulis*
Skunk cabbage	*Symplocarpus foetidus*
Early meadow-rue	*Thalictrum dioicum*
Stinging nettle	*Urtica dioica*
Grasses & Sedges	
Bland sedge	*Carex blanda*
Brome-like sedge	*Carex bromoides*
Graceful sedge	*Carex gracillima*
Interior sedge	*Carex interior*
Lake sedge	*Carex lacustris*
Smooth-sheathed sedge	*Carex laevivaginata*
Starry sedge	*Carex rosea or C. radiata*
Awl-fruited sedge	*Carex stipata*
Fowl manna grass	*Glyceria striata*
Woody Vines	
Virginia creeper	*Parthenocissus vitacea or P. quinquefolia*
Shrubs	
Speckled alder	*Alnus incana*
Pagoda dogwood	*Cornus alternifolia*
Chokecherry	*Prunus virginiana*
Wild black currant	*Ribes americanum*
Prickly gooseberry	*Ribes cynosbati*
Missouri gooseberry	*Ribes missouriense*
Poison ivy	*Toxicodendron rydbergii*
Nannyberry	*Viburnum lentago*
Trees	
Sugar maple	*Acer saccharum*

Yellow birch	*Betula alleghaniensis*
Paper birch	*Betula papyrifera*
Blue beech	*Carpinus caroliniana*
Black ash	*Fraxinus nigra*
Green ash	*Fraxinus pennsylvanica*
Bur oak	*Quercus macrocarpa*
Northern red oak	*Quercus rubra*
Basswood	*Tilia americana*
American elm	*Ulmus americana*

Appendix C: Plants Species Added in October 2006

All plants were container grown from Out Back Nursery in Hastings, Minnesota. Bur oak were in 5-gallon containers, shrubs in 2-gallon, and all others were in 1-gallon pots.

		Land Cover Unit		
		P	N (bowl)	N (North slope)
Trees				
Quercus macrocarpa	Bur oak	20		
Shrubs				
Cornus racemosa	Common elderberry			10
Corylus americana	Hazelnut			20
Diervilla lonicera	Bush honeysuckle			20
Forbs				
Aquilegia canadensis	Columbine		40	10
Arisaema triphyllum	Jack-in-the-Pulpit			20
Artemisia ludoviciana	Prairie sage	20		
Aster macrophyllus	Large-leaved aster			40
Aster oblongifolius	Aromatic aster	10		
Aster oolentagiensis	Sky blue aster	10		
Coreopsis palmata	Prairie coreopsis	20		
Galium boreale	Northern bedstraw		40	
Geranium maculatum	Wild geranium		70	
Hydrophyllum virginiana	Virginia waterleaf			40
Liatris aspera	Dotted blazing star	20		
Petalostemum purpurea	Purple prairie clover	20		
Polygonatum biflorum	Giant Solomon's seal		10	40
Smilacina racemosa	False Solomon's seal		10	40
Uvularia grandiflora	Large-flowered bellwort			50
Grasses, Sedges, Rushes				
Andropogon gerardii	Big bluestem	20		
Carex pennsylvanica	Penn sedge		20	50
Hystrix patula	Bottlebrush grass	20	40	
Juncus tenuis	Path rush			40
Koeleria macrantha	June grass		20	
Sorghastrum nutans	Indian grass	20		
Vines				
Celastrus scandens (mix sex)	Bittersweet			25
Clematis virginiana	Virgin's bower			25
Partenocissus inserta	Virginia creeper			10
Vitis riparia	River grape			10
	TOTAL	**180**	**250**	**450**

Appendix D: Fact Sheets for Exotic and Invasive Plants

Throughout the country, existing plant communities are being seriously threatened by invasive plant species. Active management to control invasive plant species is essential to restoring the health of plant communities. Several invasive species are described in the following fact sheets:

Invasive Trees and shrubs

Common buckthorn*	*Rhamnus cathartica*
Siberian elm*	*Ulmus pumila*
Black Locust	*Robinia pseudoacacia*
Tartarian honeysuckle*	*Lonicera tartarica*
Staghorn sumac	*Rhus typhina*
Eastern Red Cedar	*Juniperus virginiana*

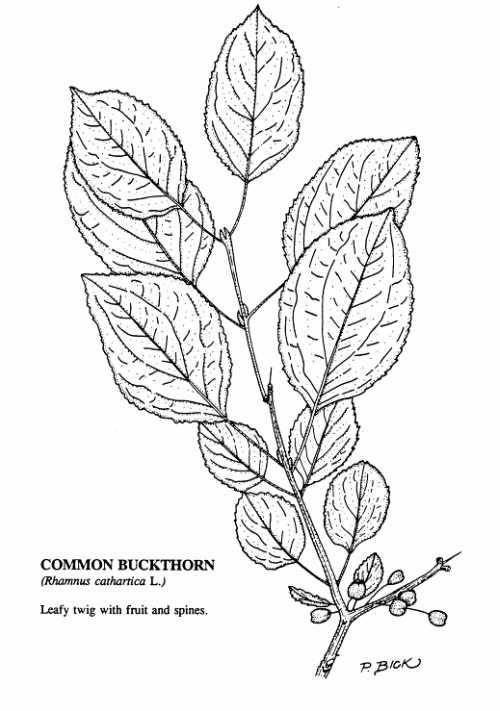
Invasive Forbs

Burdock*	*Arctium minor*
Leafy spurge*	*Euphorbia esula*
Garlic mustard*	*Alliaria pertiolata*
Poison ivy	*Rhus radicans*
Spotted Knapweed*	*Centaurea maculosa*

*exotic species

Effective management of these species is described in the following fact sheets.

Common Buckthorn (*Rhamnus cathartica)*



Effects of Invasion
Common buckthorn is a problem species in the understory of maple-basswood and oak woodlands, oak savannas, and prairies. It is characterized by long-distance dispersal, prolific reproduction by seed, and wide habitat tolerance. The fruit has a severe laxative effect; birds readily distribute its seeds after eating the fruit. Once established, common buckthorn has the potential to spread very aggressively in large numbers because it thrives in habitats ranging from full sun to shaded understory. Common buckthorn leafs out very early and retains its leaves late in the growing season, thereby shading out herbaceous and low-shrub communities and preventing the establishment of tree seedlings.

Size: 18–25 feet in height with a comparable spread.

Habit: Large shrub or low-branched tree with a rounded, bushy crown of crooked, stoutish stems.
Leaves: Dull green, ovate-elliptic-shaped, smooth on both surfaces with minute teeth on the margins, and pointed tips.
Stem: Slender, somewhat grayish, often having thorn-like spurs.
Bark: Generally gray to brown with prominent, often elongate, light-colored or silvery lenticels.
Fruit: Female plants have ¼-inch-diameter clusters of black, rounded fruit.
Origin: Europe and Asia.
Range: Nova Scotia to Saskatchewan, south to Missouri and east to New England.

Mechanical Control

- Prescribed burns in early spring and fall may kill seedlings, larger stems, and top-killed mature buckthorns. Burning is preferable for fire-adapted communities but should not be used if it adversely affects the community. Burning annually or biannually to control buckthorn may need to be continued for several years depending on the extent of establishment and the seed bank, which generally lasts 3–5 years. It is usually difficult to burn in dense buckthorn stands because the understory is typically well shaded, allowing little fuel build-up.

- Hand pull or weed-wrench seedlings.
- Weed wrench saplings up to 1inch in diameter at breast height.
- Trees of 1–3 inches in diameter at breast height may be weed wrenched if they are growing in sandy soils; otherwise, cut and apply herbicide to the stump.

Chemical Control

- Cut and apply herbicide to tree stumps greater than 3 inches in diameter at breast height.
- Basal bark treatment may be used on trees located near power lines, in difficult terrain, or in areas where it is not important to create openings in the woodland floor for reintroduction of native species.
- In high-quality natural areas and aquatic environments where surface water is present, apply a herbicide formulated for use over water.
- Repeat both mechanical and chemical control methods for at least 3–5 years to stop new plants emerging from the seed bank as well as the continual spread of seed from bird droppings. Underplanting disturbed areas with tolerant native species may hinder reinvasion by common buckthorn.

Cut and spray

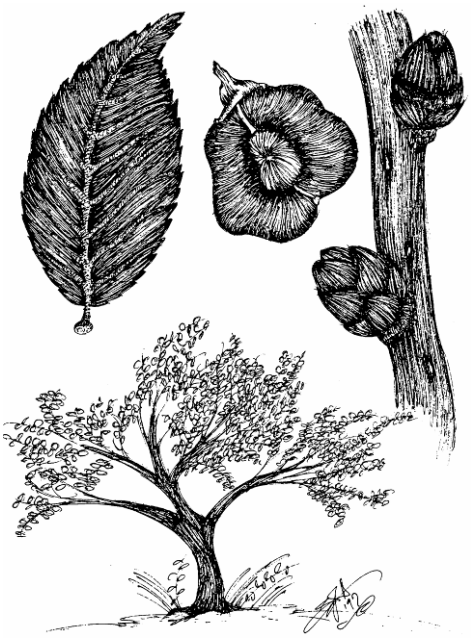
- May to October (between first budding in May, through summer, to hard freeze in fall): Spray 25% Triclopyr diluted in water on cut stumps during the growing season. Herbicide should be sprayed immediately after cutting. Avoid spring sap flow. Chemical treatment is generally less effective during the growing season, and there is more risk of affecting non-target plants.
- Winter (from first hard freeze to first budding in May): Spray 25% Triclopyr (formulated for oil dilution) diluted in diesel fuel or dilutent oil on cut stumps. Herbicide should be sprayed immediately after cutting. Chemical treatment is most effective at this time of year.
- May to October (between first budding in May, through summer, to hard freeze in fall): Apply 25% glyphosate solution formulated for use over water in high-quality natural areas and in aquatic environments where surface water is present. Herbicide should be sprayed immediately after cutting.

Basal bark treatment

- Apply a band of 6% Triclopyr with oil in diesel fuel or dilutent oil on the lower 10 inches of bark, including the root collar.

Source: Wisconsin Department of Natural Resources, 1997.

Siberian Elm (*Ulmus pumila)*



Effects of Invasion: Siberian elm flowers in spring before leaves begin to unfold. The fruits develop quickly and are disseminated by wind, allowing the species to form thickets of hundreds of seedlings in bare ground. Seeds germinate readily and seedlings grow rapidly.

Size: 50-70 feet in height with a 40-50 foot spread. Open, round crown of slender, spreading branches.
Leaves: Small, elliptical, smooth singly toothed leaves that reach lengths of approximately 0.8-2.6 inches. They are tapering or rounded at their asymmetrical base.
Stem: Slender, brittle, gray or gray-green, smooth or slightly hairy, roughened by lenticellar projections.
Bark: Gray or brown, with shallow furrows at maturity.
Fruit: Single winged circular or ovate in shape with smooth surface.
Flower: Greenish, lacks petals, and occurs in small drooping clusters of 2-5 blossoms.
Origin: Eastern Siberia, northern China, Manchuria and Korea.
Range: Minnesota south to Arkansas and west to Utah.

Mechanical Control

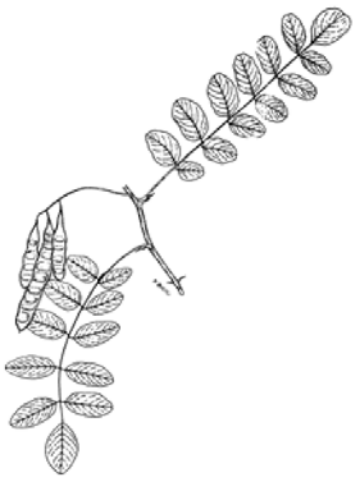
- Girdling: Late spring to mid-summer: girdle trees by removing a band of bark around the tree trunk, just within the bark layer (cambium). Girdling too deeply may lead to resprouting.
- Hand pull or weed wrench seedlings.
- Regular prescribed burns in fire-adapted communities.

Chemical Control:
Cut and Spray

- May to October (Between first budding in May, through summer, to hard freeze in fall): 25% glyphosate solution sprayed on cut stumps. Herbicide should be sprayed immediately after cutting to be effective. The effectiveness of chemical treatment during the growing season is generally lower and may have to be repeated on resprouts.
- Winter (from first hard freeze to first budding in May): 25% Triclopyr (formulated for oil dilution) diluted in diesel fuel or dilutent oil sprayed on cut stumps. Herbicide should be sprayed immediately after cutting to be effective. This is the most effective time of the year for chemical treatment.
- May to October (between first budding in May to hard freeze): 25% glyphosate solution formulated for use over water should be used in high quality natural areas and in aquatic environments where surface water is present.

Source: Wisconsin Department of Natural Resources 1997, Minnesota Department of Natural Resources 1995.

Black Locust *(Robinia pseudoacacia)*



Effects of Invasion
Black locust is a deciduous tree that is frequently found in upland prairies, savannas, old fields, roadsides, and woodlots. It reproduces by root suckering and stump sprouting. Root suckers arise spontaneously from established root systems, sprouting new shoots and interconnecting fibrous roots to form extensive, dense groves of clones. Damage to roots or stems stimulates vigorous sprouting, root suckering, and lateral spread. The range of this species may shift northward with current global warming trends and include Minnesota.

Size: 30–80 feet tall with a spread of 20–35 feet.
Habit: An upright tree with a straight trunk and a narrow oblong crown, becoming ragged and straggly with age. Can be spreading in habit with several trunks.
Leaves: Alternate, pinnately compound with 7–21 leaflets.
Stem: Slender, brittle, often zigzag, light reddish to greenish-brown in color, smooth with paired spines at nodes.
Bark: Young trees have smooth, green bark. Mature trees have furrowed, shaggy dark bark.
Fruit: A flat brown-black 2–4-inch smooth long pod.
Flower: Pea-like, fragrant, white or yellow long drooping racemes.
Origin: Southern Appalachia and Ozarks.
Current range: Most of the eastern U.S. Range expanded due to planting in windbreaks, etc. The range of this species may continue to shift northward with global warming.

Mechanical Control
- Mowing and burning cause the tree to sprout from its root system.

Chemical Control
- Cut-stump treatment with clopyralid (Transline©) is recommended; glyphosate or triclopyr can also be used but seem to be less effective.
- For small isolated plants or thick patches under 5 feet in height (resulting from cutting or fire), treat every branch or stem with a foliar application of clopyralid or triclopyr mixed with water at the end of the growing season.

Sources: Wisconsin Department of Natural Resources, 1997, and Minnesota DNR 2006.

Tartarian Honeysuckle *(Lonicera tartarica)*

Effects of Invasion
Tartarian honeysuckle can live in a broad range of plant communities with varying moisture and shade levels. Woodlands are most affected and are particularly vulnerable if the habitat is already disturbed. The vigorous growth of Tartarian honeysuckle inhibits development of native shrub and ground-layer species; eventually, they may entirely replace native species by shading and depleting soil moisture and nutrients. The early leafing of this species is particularly injurious to spring ephemerals, which have evolved to bloom before trees and shrubs have leafed out.

Size: 3–10 feet in height with a 10-foot spread.
Habit: Upright, strongly multi-stemmed. Upper branches are arched, with the overall effect of a dense, twiggy mass.
Leaves: Smooth, hairless, opposite, simple, smooth beneath, ovate, bluish-green leaves. Leaf development begins early in the spring, before native species.
Stem: Green at first, finally brownish.
Bark: Older stems are shaggy.
Fruit: Red, ¼-inch-diameter berry that colors in late June into July and August.
Flower: Fragrant, tubular pink-to-crimson flowers arranged in pairs.
Origin: Central Asia to southern Russia.
Range: New England south to North Carolina and west to Iowa.

Mechanical Control

- Small to medium-sized plants can often be dug, pulled, or weed-wrenched, especially in spring, when the soil is moist. Mechanical removal can result in profuse re-sprouting of the plant if a portion of the root breaks off and remains in the soil.

Chemical Control

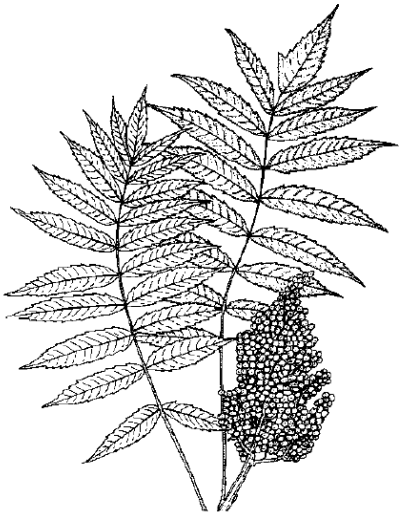
- Cut and apply herbicide to any honeysuckle regardless of size if soil conditions are not appropriate for mechanical control.
- In high-quality natural areas and in aquatic environments where surface water is present, apply a herbicide formulated for use over water.
- Repeat control methods for at least 3–5 years to stop new plants emerging from the seed bank. Underplanting disturbed areas with tolerant native species may hinder reinvasion of Tartarian honeysuckle.

Cut and spray

- May to October (between first budding in May, through summer, to hard freeze in fall): Spray 25% glyphosate solution on cut stumps. Herbicide should be sprayed immediately after cutting. Chemical treatment is generally less effective during the growing season and may have to be repeated on re-sprouts.
- Winter (from first hard freeze to first budding in May): Spray 25% Triclopyr (formulated for oil dilution) diluted in diesel fuel or dilutent oil on cut stumps. Herbicide should be sprayed immediately after cutting. Chemical treatment is most effective at this time of year.
- May to October (between first budding in May, through summer, to hard freeze in fall): In high-quality natural areas and in aquatic environments where surface water is present, apply 25% glyphosate solution formulated for use over water.

Source: Wisconsin Department of Natural Resources, 1997.

Staghorn Sumac *(Rhus typhina)*



Effects of Invasion

Both smooth sumac and staghorn sumac are opportunistic, native prairie shrubs. These aggressive shrubs occur in clones that spread outward by rootstocks or seeds. Sumac sprouts easily and grows rapidly, but requires direct sunlight to persist. Re-sprouts grow rapidly and can reach 3 feet in one year. Sumac can eliminate or reduce the abundance of many other species that cannot persist in the shade sumac creates. Sumac grows in a variety of habitats, including disturbed sites, such as abandoned fields, roadsides, and fence rows. Sumac also grows in native communities, such as upland prairies, oak savanna, and oak woodlands and forests. Because sumac is a native species, the management objective is usually to keep sumac under control, not to eliminate it.

Size: 10 feet in height with a spreading crown of dense, multi-stemmed clones.
Habit: A large, loose, open, spreading shrub with a flattish crown.
Leaves: Pinnately compound with 7–31 leaflets that are green on the upper surface and nearly white on the lower surface. Leaves turn brilliantly red in fall.
Stem: Twigs are smooth, stout, angular, and hairless on smooth sumac and highly pubescent on the staghorn sumac.
Bark: Light brown and smooth on young plants. Pubescent on older stems of staghorn sumac. Smooth sumac has smooth bark on both young and old stems.
Fruit: Red drupes develop at the end of the stems in late summer and persist into winter. Each drupe is round, has short hairs, and contains a single seed.

Flower: Dioecious, greenish yellow, June to early July. Female borne in dense hairy panicles, 4–8" long; male in a bigger, looser, wider panicle.
Origin: Quebec to Ontario, south to Georgia, Indiana, and Iowa.

Mechanical Control

- Double-cut (once in July and once in August). May need to repeat for several consecutive years to effectively control in dense populations.
- Mow with a sickle-bar every year in mid to late July.
- Conduct prescribed burns for prairi es in spring, then hand-cut stems at ground level in July and August. Sumac will re-sprout after each cutting, but dense vegetation may prevent sumac from receiving enough sunlight, causing leaves to turn yellow and eventually die.
- Mow in mid-summer and conduct spring burns to stimulate herbaceous vegetation.
- Keep small populations under control by conducting prescribed burns every 3 or 4 years.

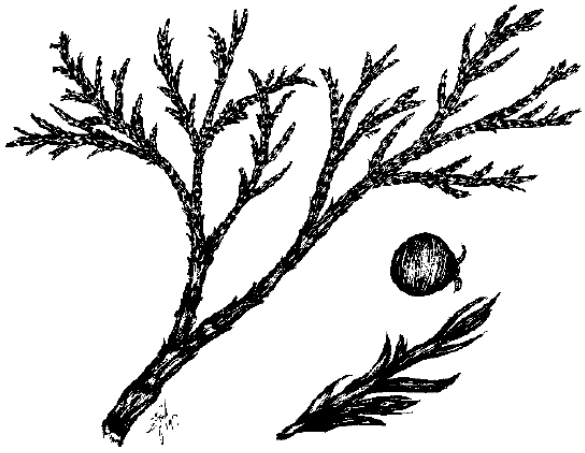
Chemical Control

- During July and August apply a 20% concentration of glyphosate to freshly cut stumps.
- Apply oil-based triclopyr as directed on label to the entire circumference of each stem of the clone, no cutting is done.
- Foliar application of water-based triclopyr as directed on label or 1–2% solution of glyphosate in areas with little to no native vegetation.

Caution: The sap of sumac species may cause dermatitis in some individuals.

Source: Wisconsin Department of Natural Resources, 1997

Eastern Red Cedar *(Juniperus virginiana)*



Effects of Invasion
Eastern red cedar was rarely found in Minnesota at the time of European settlement. It occurred in remote, fire-free places such as exposed cliff faces. After settlement, fires were greatly suppressed, thus removing the primary limiting factor for red cedar establishment. In the absence of fire, red cedar can dominate natural communities. Large trees and dense stands shade or otherwise inhibit growth of desired herbaceous vegetation Red cedar is pollinated by wind; male and female flowers are on different trees. The seeds develop and mature from July through November. Seed crops vary annually, with peaks every two to three years. Trees initiate seed bearing at about 10 years of age. Peak seed production occurs between 25 and 75 years. Scattered and long-distance establishment of red cedar is primarily due to birds. Most seeds are dispersed by birds like cedar waxwings, thrushes (especially robins), kingbird, and downy woodpeckers.

Establishment of red cedar is slow because seeds are not produced in the first 10 years. However, habitat modification accelerates once seeds are produced and scattered, and culminates in a canopy of red cedar with bare ground underneath.

Size: Eastern red cedar is a coniferous tree that rarely exceeds 30 feet high in Wisconsin.
Habit: Mature trees typically have an ovoid or pyramidal crown.
Leaves: Leaves are opposite, scale-like, tightly appressed and overlapping.
Stem: A single tree can have multiple trunks with a wide range of diameters
Bark: Red cedar has a thin red bark that sheds or comes off in long strips
Fruit: The blue-black, often glaucous (having a whitish, powdery coating) fruit is a fleshy, berry-like cone. Each fruit usually contains one to two seeds
Origin: Eastern red cedar is native to eastern North America. It was an important component of cedar glades, which typically do not experience fires. Although its optimal growth occurs on well-drained, alluvial soils, red cedar is most competitive on dry sites. It is most commonly found in prairies or oak barrens on thin soils, old pastureland, or on dry, limestone hillsides where competition has been reduced. It is a problem because it has rapidly invaded some grasslands and savannas mostly due to fire suppression.

Mechanical Control

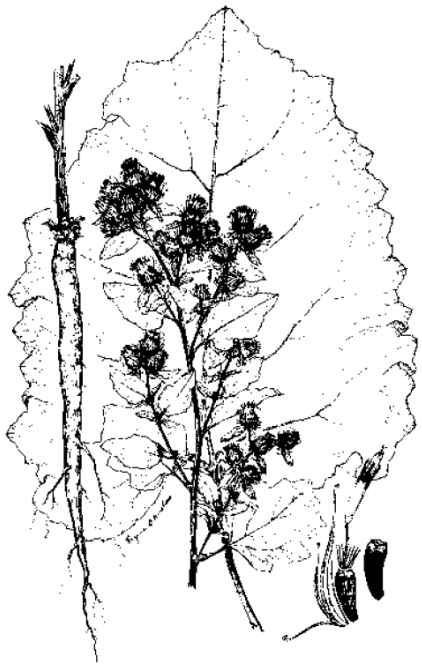
- Fortunately, red cedar is very easy to control. The problem is not in the control methods, but in failing to recognize the consequences of doing nothing. Prevention is always the best control method. Monitoring red cedar establishment and removing trees when found will prevent the total loss of a natural community later.
- Prescribed fires are the easiest and most cost-effective control method for red cedar if they are able to pass through the stand, which often resists fires. Small trees are killed if enough fuel surrounds the tree. Because the bark is very thin, red cedar is extremely sensitive to fire.
- Large trees should be cut and burned, or the dead trees will persist for decades and cause shading effects. It does not resprout after complete cutting or burning.

Chemical Control

- Most herbicides are ineffective or erratic in control of red cedar

Source: Wisconsin Department of Natural Resources, 1999; The Nature Conservancy, 2000

Burdock *(Arctium minor)*



Effects of Invasion
Burdock is an opportunistic species native to the United States. Extremely prolific, it will inhabit many environments disturbed by humans. Burdock produce burs about 1 inch in diameter in the fall. Burdock is aggressively opportunistic on disturbed soil and tends to shade out smaller, herbaceous flora. Burdock can be easy to control because they reproduce only by seed and take 2 years to become mature plants.

Size: 1–5 feet in height.
Habit: Large leaves with flower heads in spike-like clusters.
Leaves: Up to 12–14 inches across, dark green, dull somewhat heart shaped.
Flower: Small, lavender or pink, and similar in shape to thistle blossoms.
Origin: Europe.

Mechanical Control

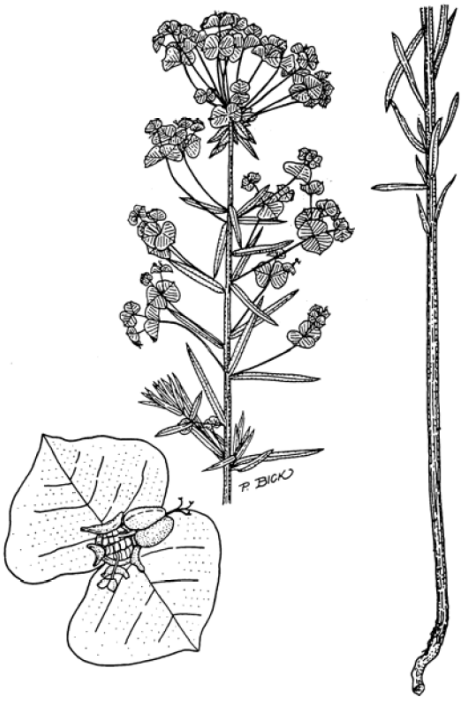
- Repeated tilling is effective in controlling the biennial plant.
- Burdock roots can be severed below ground to kill the plant.
- Mowing will eliminate above-ground growth, but the foliage will quickly grow back.

Chemical Control

- Burdock produces a rosette during its first year and develops a large tap root the second. Tardon herbicide or 2-4,D can be used to kill the above-ground growth in either the rosette or second-year growth.

Source: Wisconsin Department of Natural Resources, 1997.

Leafy Spurge *(Euphorbia esula)*



Effects of Invasion
Leafy spurge is alleleopathic and spreads rapidly, crowding out desirable species. A number of spurges hybridize with leafy spurge; they are all referred to as leafy spurge. The plant can reach densities of up to 1,800 stems per square yard. The plant's deep root system makes eradication difficult. The plant can expel its seed up to 15 feet by explosive ejection from the seed capsule. The seed of leafy spurge has a high germination rate, and the established plant spreads rapidly through vegetative reproduction. Leafy spurge can be catastrophic to grasslands for both economic and ecological reasons. In only a few years spurge can displace native grasses and forbs by shading them out and dominating available moisture and nutrients.

Habit: An erect, deep-rooted Eurasian perennial.
Size: 6–36 inches in height.
Leaves: Linear, alternate and apetiolate, bluish-green in color.
Stem: Erect and hairless
Fruit: Ovoid, minute mottled-brown seeds contained within a capsule.
Flower: A loose umbel consisting of 2 kidney-shaped flower leaves on a short stem that are topped by 2 yellowgreen petal like bracts around tiny flowers.
Origin: Europe and Asia.

Mechanical Control

- No mechanical control methods have been found to be effective.

Biological Control

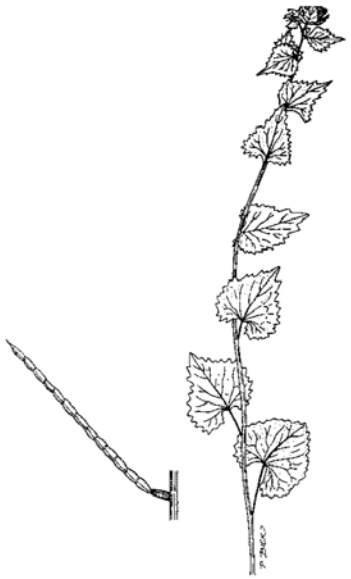
- Pasturing goats in areas infested with leafy spurge.
- Experimental insect control with beetles and a midge species is reducing populations.
- The allelopathic effects of black walnut inhibit plant growth.

Chemical Control

- Scattered patches can be treated at an application rate of 2 lbs./acre of picloram in the late spring and early fall. Do not use in high-quality natural areas that lie within 30 feet of area.
- A 70% reduction of large infestations can be achieved with an annual application of .5lbs./acre of picloram in the late spring.
- An application rate of 5.7 lbs./acre of quinclorac plus a 2.8 lbs./acre picloram will provide 85% control of leafy spurge after 9 months.
- An application rate of .12lbs/acre of quinclorac applied immediately after cutting the shoot tops.
- A 90% reduction within 1 year was achieved with a 3% solution of fosamine applied to blooming plants in June and July. Follow-up application annually for 3–4 years is required.
- Repeated application of glyphosate may be used to treat small patches.

Source: Wisconsin Department of Natural Resources, 1997.

Garlic Mustard *(Alliaria pertiolata)*



Effects of Invasion
Garlic mustard is a rapidly spreading woodland weed that displaces native woodland wildflowers. It dominates the forest floor and can displace most native herbaceous species within 10 years. Garlic mustard is a biennial that produces hundreds of seeds per plant. Seeds are dispersed on the fur of mammals, by water, and by humans. The seeds can remain viable for 5 years.

Size: 12–48 inches in height as an adult flowering plant.
Leaves: First-year plants consist of a cluster of 3 or 4 round, scallop-edged, dark green leaves rising 2–4 inches in a rosette. Second-year plants have alternate, round, scallop-edged, dark green leaves progressing up the 1 or 2 stems.
Stem: Second-year plants generally produce 1 or 2 flowering stems.
Fruit: Slender capsules 1–2.5 inches long that produce a single row of oblong black seeds with ridged seed coats.
Flower: Second-year plants have numerous small white flowers that have 4 separate petals.
Root: Slender, white taproot with an S-shaped top.
Origin: Europe

Mechanical Control

- Hand pull at or before the onset of flowering, making sure to remove at least the upper half of the root to eliminate budding at the root crown.
- Cut the flower stalk as close to the soil surface as possible just as flowering begins. Cutting prior to flowering may promote re-sprouting.
- Burn in fall or early spring (before wild flower growth). Burn annually for 3 to 5 years until depletion of the seed bank.

Chemical Control

- Apply a 1–2% glyphosate solution to the foliage during the late fall or early spring before wild flower growth.
- Apply a 1% Tryclopyr solution to the rosettes in early spring before wild flower growth.

Source: Wisconsin Department of Natural Resources, 1997.

Poison Ivy *(Rhus radicans)*

Effects of Invasion

Although poison ivy is not harmful to other native flora, it can cause severe irritation to humans. It is commonly found in disturbed areas such as trails, parks, yards, and recreation areas where human contact is most likely to occur.

Habit: Occurs as an upright growing woody shrub or as a vine that climbs the trunks of trees or grows along the ground.
Size: 24 inches in height in the shrub form.
Leaves: Compound with 3 large shiny leaflets that are variable in outline.
Stem: Erect on the shrub form; supported by aerial roots on the vine form.
Fruit: Yellowish-white berries.
Flower: Clusters of up to 25 yellow-green flowers blooming from leafless lateral branches.
Origin: North America.

Mechanical Control

- Uproot individual plants in the fall, either before or after the leaves have fallen. Remove entire root to avoid re-sprouting. Repeat for several years to deplete seed bank. Caution: Wear gloves and protective clothing. Do not compost or burn plants.

Chemical Control

- In the late spring or early summer apply glyphosate or 2, 4-D to the foliage with a sponge or sprayer as recommended on the label. Repeat several years to deplete seed bank.

Source: Wisconsin Department of Natural Resources, 1997.

Spotted Knapweed *(Centaurea maculosa)*

Effects of Invasion

Spotted knapweed attains high densities on sunny sites, reducing the frequency of native species. Infestation can also contribute to poor water quality and erosion by increasing run-off and sedimentation. Plants average 1,000 seeds per plant. Seeds are viable for 7 years and germinate throughout the growing season.

Size: 3–4 feet in height.
Leaves: Alternate, pale, rough 1–3 inches in length. Leaf margins on lower leaves are divided about halfway to the midrib. Upper leaves are more linear in shape.
Stem: Slender, hairy, erect, growing in a branched pattern, 2 feet in height on drier sites and up to 4 feet in height on moister sites.
Seeds: ¼ inch and brownish. Notched on one side of the base with a short tuft of bristles at the tip.
Flower: Flower head has stiff bracts marked with fine, vertical streaks and tipped in with dark, comb-like fringes.
Root: Stout, elongated root.
Origin: Eurasia.

Mechanical Control

- Dig or pull the entire root.
- Conduct prescribed burn followed by selective pulling or digging**.**

Chemical Control

- Use foliar application of a 3% water-soluble solution of Triclopyr with dye. To protect native fauna, avoid getting herbicide on the flowers.
- Apply .2–.5 lbs./acre of Piclorum for 2–3 years in the fall when the plant is in the rosette growth stage or in spring during the bud-to-bloom stage. Do not use Piclorum near water or on sandy soils with ground water 10 feet or less below the surface.
- Apply 1–2 lbs/acre of Dicamba for at least 2 years.
- Apply .25 lbs./acre of Clopyralid or a mixture of .19 lbs./acre of Clopyralid and 1 lb./ac of 2,4-D.
- During the rosette stage, spray a 2,4-D low-volatile ester, oil-soluble amine, or water-soluble amine formulation at 2 lbs./acre.

Biological Control

- Experimental results have yielded a 95% reduction using two seed-head attacking flies *Urophora affinia* and *U. quadrifasciata*. Consult the USDA for more information about biological controls and their availability.

Source: Wisconsin Department of Natural Resources, 1997.
Minnesota Department of Natural Resources, 1995.
United States Department of Agriculture, 1971.