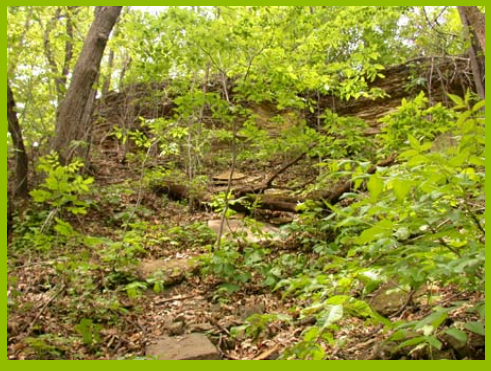
Crosby Farm Regional Park Ecological Inventory and Restoration Management Plan

Prepared for the City of St. Paul
Division of Parks and Recreation
by Great River Greening
January 2005

With assistance from the Ramsey
Conservation District



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Compiled by
Fred Harris
Great River Greening

With assistance from
Tom Petersen, Dave Bauer, Matt Swanson
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Great River Greening (GRG) is a nonprofit organization that restores valuable and endangered natural areas in the greater Twin Cities by engaging individuals and communities in stewardship of the Mississippi, Minnesota and St. Croix river valleys and their watersheds. Greening involves local citizens in hands-on volunteer and training programs on a larger scale than any other Twin Cities organization− 14,000 since inception in 1995. (See Appendix D for more information).

Ramsey Conservation District (RCD) is a special purpose local government agency responsible for promoting the conservation of Ramsey County's natural resources. The district, through its publicly elected board of supervisors and staff, assists private citizens, businesses, and other governmental agencies implement natural resource conservation practices.

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Executive Summary

Crosby Farm Regional Park is the largest natural park within the City of St. Paul. It is also a significant natural area within the State of Minnesota Mississippi River Critical Area Corridor and the Mississippi National River and Recreation Area (MNRRA). The park consists of a large area of floodplain and valley side slopes, the "bluffs," along the Mississippi River near its confluence with the Minnesota River. The park's forests, wetlands and lakes are important refuges for a broad diversity of native wildlife species. As a natural oasis of oak woods, marshes, lakes, floodplain forests and Mississippi River shoreline in a major metropolitan area, the park attracts tens of thousands of local residents throughout the year.

A detailed vegetation inventory, analysis of management problems, and assessment of bluff trails was conducted in 2004. The bluff trails analysis completed in June focuses on recommendations for ameliorating erosion problems and improving trail design. It was published separately in a companion report entitled *Crosby Park Bluff Trail Project: Design Strategies for an Ecologically Sustainable Bluff Trail* (Shaw et al. 2004) also compiled by Great River Greening.

This report on Crosby Farm Regional Park focuses on the following main objectives: A.) preliminary documentation and assessment of bluff erosion problems; B.) detailed inventory and mapping of terrestrial and wetland native plant communities in the park; C.) identification and analysis of problem areas needing management and restoration work; and D.) identification of strategies for managing and reconstructing native plant communities in the park.

Appendices to this inventory and management plan provide technical information to supplement the recommendations, including a checklist of plants seen in the park in 2004, detailed plant species lists of target native plant communities, and information about controlling exotic species.

Preliminary examinations of the bluffs along the north side of Crosby Park reveal numerous examples of erosion from excess storm water runoff and off-trail traffic, ranging from low levels of sandstone weathering to deep canyons incised into the bluff. This erosion is compromising the integrity of the native vegetation of the bluffs, washing out portions of the park's trail system, and depositing silt and sand into the park's lakes.

Crosby Park has a broad range of terrestrial and wetland native plant communities containing over 300 plant species. Vegetation survey highlights include areas of intact sedge meadow, black ash seepage swamps, areas of diverse spring ephemeral wildflowers, a colony of Kentucky coffee trees, and large tracts of intact floodplain forest.

This project was not intended to inventory the wildlife species, aquatic environments or recreation/environmental education values of the park – subjects that should be addressed in future inventory and management plans.

Acknowledgements

This project was made possible with major funding from the Capitol Region Watershed District, the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative Commission on Minnesota Resources, and the U.S. National Park Service via the Mississippi National River and Recreation Area. Additional financial or in-kind contributions to the project were provided by the Ramsey Conservation District, the City of St. Paul Division of Parks and Recreation, the Carolyn Foundation, and Great River Greening.

This project would not have existed without the leadership of Patricia Freeman, Environmental Resource Specialist for St. Paul Parks and Recreation, who initiated the project, brought a diverse group of resource professionals together for input, and organized funding to make it a reality. Dan Tix assisted air photo interpretations, vegetation surveys, and plant identification. Alan Olson and Richard Peterson, Minnesota DNR Foresters, provided extensive advice on strategies for forest restoration. Michael Varien, Melissa Peterson, Katie Anderson, and Adam DeKeyrel mapped the park's buckthorn concentrations. Dan Shaw, Wiley Buck, Cade Hammerschmidt, Patricia Freeman, Mark Doneaux, Cy Kosel, Nancy Duncan, John Grzybek, and Kelly Osborn reviewed and commented on drafts of the report.

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Figure 1: Crosby Farm Regional Park location within the City of St. Paul. (from the St. Paul Parks and Recreation website). Some regional parks on this map are owned and managed by the City of St. Paul and some are owned and managed by Ramsey County.

Description of Project Area

General Location:

Near the end of the last glaciation in Minnesota, the Crosby Park region was buried in glacial till of the Grantsburg Sublobe. This was an extension of the Des Moines Lobe glacier that covered much of western and southern Minnesota. As the glacial period ended, a huge meltwater stream, Glacial River Warren, carved through the glacial till deposits and underlying sedimentary bedrock layers where the park occurs today. A high, level terrace north of Crosby Park, now occupied by Shepard Road and West 7th St., is evidence of this huge glacial stream. Further downcutting by the modern Mississippi River within the glacial river valley cut further into the underlying limestone and sandstone bedrock and formed the smaller valley now occupied by the Mississippi River. The north edge of this valley forms the bluffs along the north edge of Crosby Park.

Geology:

The geology in the Crosby Farm Park area is relatively straightforward. The bluffs are capped by the Platteville Formation, which is relatively resistant to erosion. The slope of the bluffs is underlain by the St. Peter Sandstone. At the base of the bluffs, Holocene (recent) floodplain alluvium laps over the St. Peter. The bedrock units are essentially horizontal, with just a slight regional dip, so structure does not affect outcrop patterns.

As noted, the top of the bluffs is capped by limestone and dolomite of the Platteville Formation. This unit is a light-gray, thin- to medium-bedded dolomitic limestone and dolomite with some discontinuous, very thin shale beds. Where weathered, the Platteville Formation is typically buff to tan in color, with fresher surfaces showing the gray coloring. In the metro area, the Platteville formation may be 30 feet thick or greater (Meyer and Swanson, 1992; Mossler and Tipping, 2000).

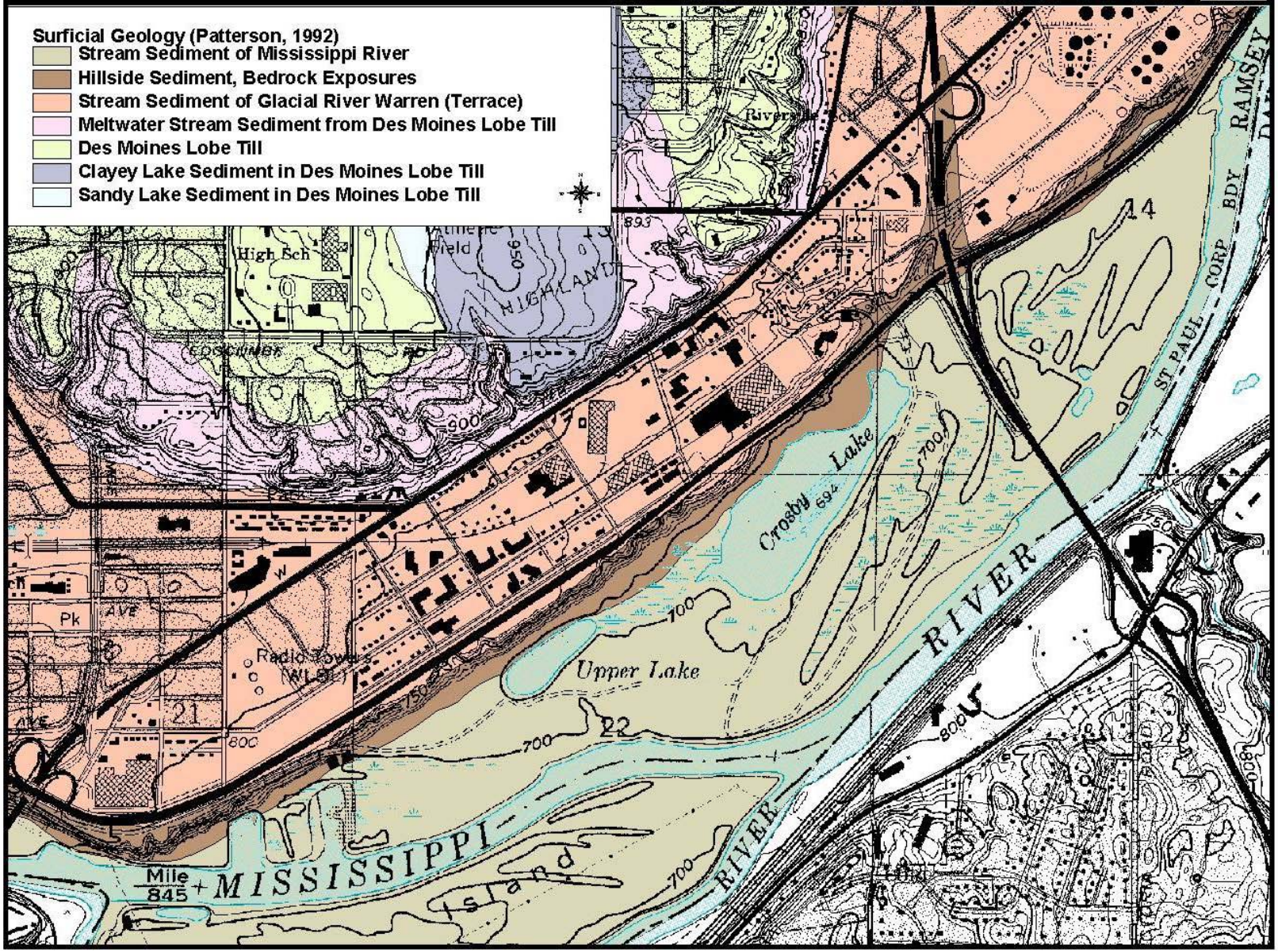
In some locations, the Platteville is underlain by a thin (typically 3 to 5 feet or less), green shale unit known as the Glenwood Formation. The presence of this unit along the bluffs is not always clear, largely because it is much more susceptible to erosion and is likely to have eroded back and be covered with other material. At some locations (e.g., gullies) where there are larger outcrops, the unit appears to be present, but the outcrop could not be reached to confirm this.

The slope of the bluffs is formed on or within the St. Peter Sandstone. In the metro area, the St. Peter is 128 to 166 feet thick, with the upper 100 feet being a light gray to light yellow to white, fine- to medium-grained, poorly cemented sandstone with thick to massive bedding (Mossler and Tipping, 2000). Only this upper portion of the St. Peter Sandstone is present along the Crosby Park bluffs. The unit is generally light gray to light tan or buff when exposed in outcrops at the park. In the past, the St. Peter has been mined for glass sand, and many man-made caves have been dug into the bluffs all along the Mississippi River in St. Paul. One such cave is present across the access road from

the Watergate Marina. Some caves in the St. Peter are also present due to natural erosion by moving water; as a result of being poorly cemented, the St. Peter Sandstone can be vulnerable to erosion. Relative to the Platteville caprock above, the St. Peter is clearly more susceptible to erosion.

Along the base of the bluffs in the Crosby Park area are unconsolidated alluvial deposits. Meyer (1985) mapped this particular area as “floodplain alluvium (clayey)”, described as principally clay and silt, commonly mixed with variable amounts of sand. It may be overlain with fill in developed areas. At the western end of the park, the alluvium is mapped as being dominated by sand. So, most of the material observed at the bottom of the bluffs is floodplain deposits. This is further evidenced by noting that where there is silt- or clay-dominated material at the base of the bluffs, it is much darker than the soils on the bluffs and slopes, owing to the greater organic content typical of alluvial floodplain deposits.

Figure 2: Surficial Geology at Crosby Park



Hydrogeology:

In the geologic units of concern at Crosby Park, the groundwater flow direction is generally toward the Mississippi River, which is the discharge point for the unconsolidated and shallow bedrock aquifers in this area. So, flow is roughly perpendicular to the bluff face. In the bluffs area, the regional water table is very close to the same elevation as the river, or about 690 feet (Meyer and Swanson, 1992). As a result, the water table is roughly 100 feet below the ground surface at the top of the bluffs, and roughly 5 to 10 feet below the surface at the foot of the bluffs, and possibly less depending on the local topography and the river stage.

Some seeps are present along the bluffs. These seeps are present within the St. Peter Sandstone, which is unusual. Typically, springs emerge along the Mississippi River bluffs where a very low-permeability geologic unit underlies a more permeable unit. Water is held up above the low-permeability unit (or "perched"), then where this interface is exposed on the bluffs, the water flows out, with the flow rate determined by several factors. The seeps in Crosby Park are likely to represent instances where cracks provide a localized preferential pathway for migration of small amounts of water that have infiltrated into the St. Peter Sandstone.

As indicated by the name, seeps have relatively little water moving out from the rock to the surface. It is unlikely that flowing water will be observed, unless the climate has been generally wet. In addition, urbanization of the terrace above the bluffs has limited the infiltration of precipitation, reducing the amount of water that can reach these seeps.

Bluff Soils at Crosby Park:

Mapped Soil:
The soil mapped is the Dorerton-Rock outcrop complex, 25 to 65 percent slopes, 1819F (Figure 3). As mapped, the topsoil consists of a very dark gray sandy loam about 4 inches thick over a dark brown fine sandy loam about 6 inches thick. The subsoil is a dark brown gravelly clay loam, often with larger stones. The mapped soil has a medium level of natural fertility, is moderately permeable, has moderate available water capacity, and has rapid surface water runoff (Vinar, 1977).

Field Observations:
Technicians observed soil properties along seven transects from summit to foot slope. The soils identified in the field seemed to fit into the mapped soil with the following variations.
The subsoil seems to be absent in most cases.

As a general rule, soil seemed to be shallower as the steepness increased. Soil also seemed to be shallower near the summit and deeper near the foot slope. Finally, soils tended to be higher in sand content near the foot slope, which lowers the moisture holding ability of the soil.
The soils further varied with four topography classes noted in the field.

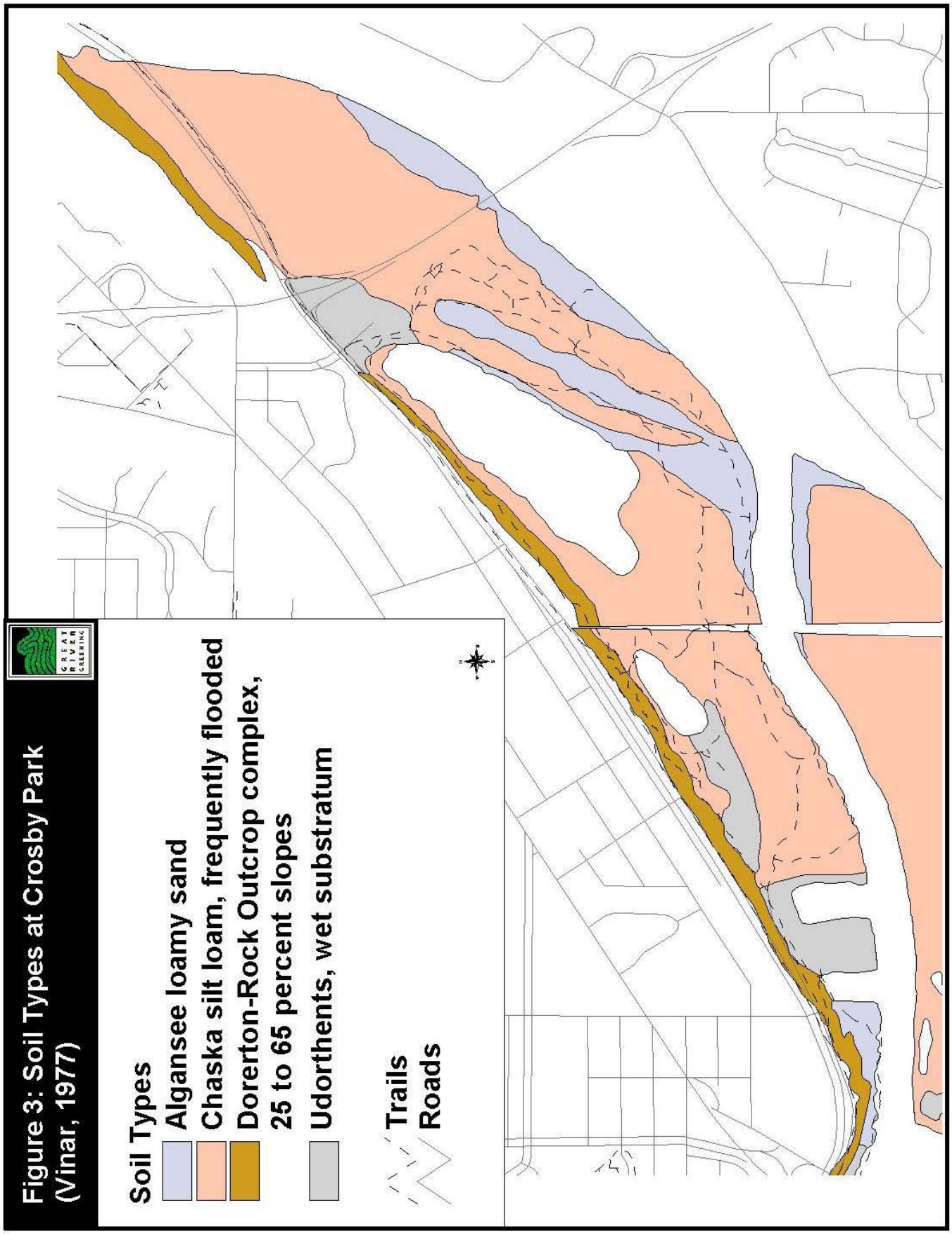


Figure 3: Soil Types at Crosby Park
(Vinar, 1977)
GREAT RIVER GREENING
Soil Types
Alganssee loamy sand
Chaska silt loam, frequently flooded
Dorerton-Rock Outcrop complex,
25 to 65 percent slopes
Udorthents, wet substratum
Trails
Roads

Topography Classes

Sandstone Spurs:
A sandstone spur occurs where the limestone is not exposed at the surface or where the outcrop is set apart from the lower bluff by a gentler slope. The slopes range from 40-80%. These soils are extremely well drained and consists of loam (~20% clay, 40% silt, 40% sand) near the summit and sandy loam (~10% clay, 25% silt, 65% sand) near the foot. Near the summit, there are usually many limestone pieces, with up to 80% surface coverage and rocks make up 50% of the soil. These soils tend to have less moisture nearer the foot slope. The soil depth ranges from less than 12 inches near the summit to greater then 36 inches near the foot.

Float Slopes:
A float slope occurs when a steep slope occurs beneath a limestone outcrop. It is very steep, mostly 70-80% and covered by limestone and sandstone pieces, 40-80%. The soil is less than 12 inches and dominated by 20-50% rock fragments. The soils tend to be loam (~20% clay, 40% silt, 40% sand). Near the foot slope, where the slope is less then 50%, the soil tends to be a sandy loam (~10% clay, 25% silt, 65% sand) and can be more then 20 inches deep with a decrease in rock fragments. This soil tends to have less moisture near the foot slope when compared to soils near the summit.

Gullies:
Gullies are highly eroded and consist mostly of float and debris/fill in the channels and exposed bedrock or very shallow soils on the walls. Most soil that accumulates or forms tends to be washed down slope.

Fill:
Construction of Shepherd Road appears to have been the reason for some areas of fill along the bluff. These soils are variable, but often consist of a sandy clay loam (~25% clay, 15% silt, 60% sand). Depth of fill varies between 12 inches and 24 inches. A buried soil sometimes has been preserved below this layer as another sandy clay loam. Moisture on these features tends to be higher than on other features, but is still low overall. There are many pieces of bricks, asphalt, and other building materials, which is the easiest way to identify this topography in the field.

Pre-settlement Vegetation

In 1930, Frances J. Marschner mapped the pre-settlement vegetation of Minnesota using bearing tree and line notes recorded by surveyors of the Public Land Survey in the mid-1800s as they marked the grid of section lines across the state. Marschner's map (Figure 4) indicates that the pre-settlement vegetation of the Crosby Park area consisted of River Bottom Forest within the floodplain of the Mississippi River and Oak Openings and Barrens on most of the high, glacial river terrace on the north edge of the park above the Platteville Limestone cliffs. An area of "Big Woods," Marschner's generic term for hardwood forest, was mapped farther north on rolling Des Moines lobe deposits outside the glacial river valley (Marschner 1974).

River bottom forest consisted predominantly of floodplain forest dominated by elm, ash, cottonwood, box elder, silver maple, willow, aspen and hackberry. American elms were common bearing trees in this community.

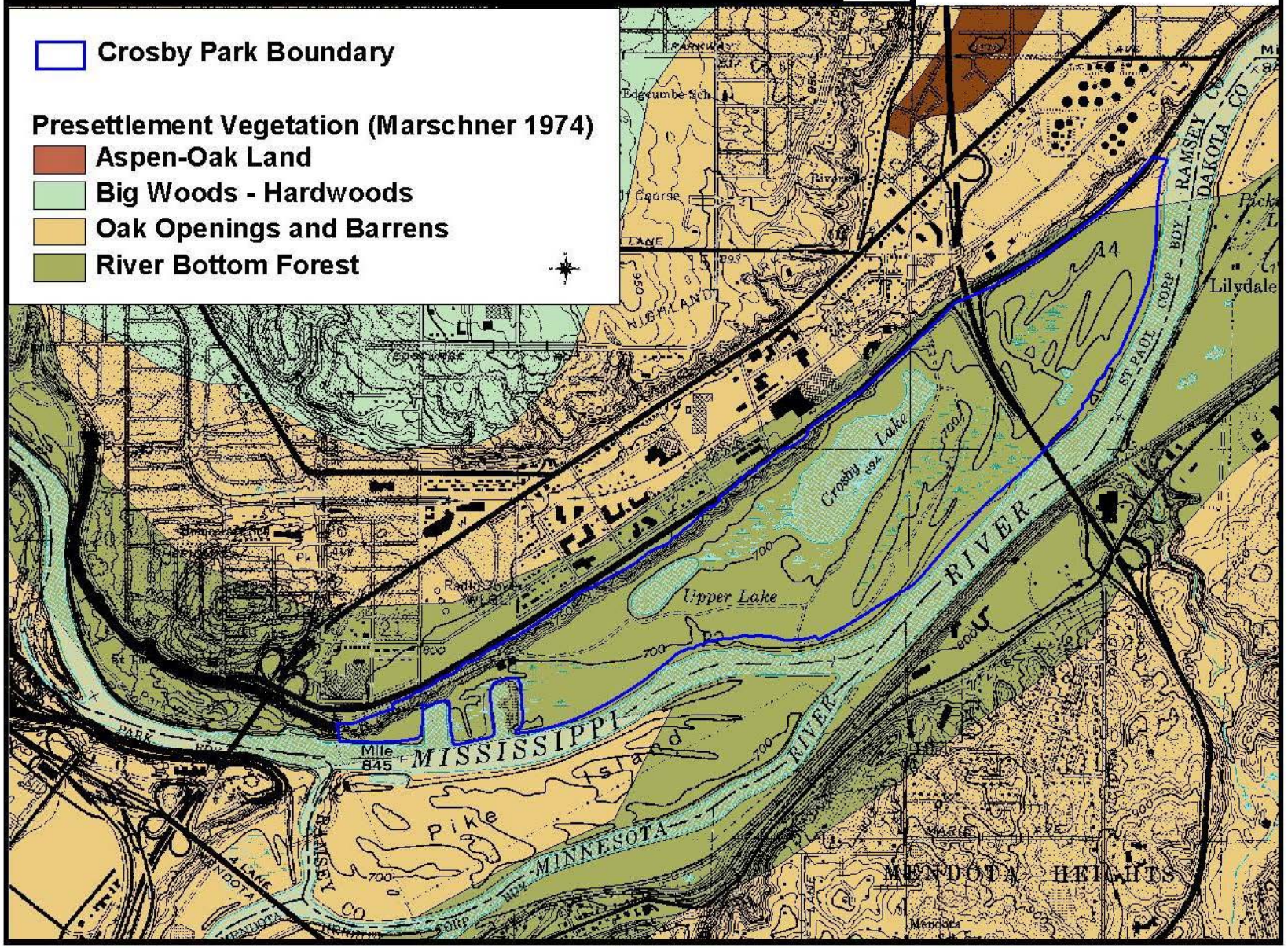
Oak openings and barrens consisted predominantly of scattered trees and groves of oaks in scrubby form with patches of open prairie and areas of brush and thickets. Present day communities in this category include oak savannas and woodlands. Marschner's boundary between river bottom forest and oak openings and barrens along the north side of the park does not coincide exactly with the terrace edge that forms the bluffs along the north edge of the park. This is an error of scale: Marshner's map was created on a very large scale and the boundary lines between vegetation units are not accurate within several hundred feet. The vegetation currently present at Crosby clearly demonstrates that the original vegetation of the bluffs and the terrace above the bluffs was part of the oak openings and barrens region. Prairie plants remaining from past savannas are still hanging on along the tops of the bluffs, particularly above the limestone cliffs by the entrance road at the west end of the park. The lower half of the bluffs may have been more of a mesic forest rather than savanna, as these areas are presently dominated by red oaks and contain a dry-mesic to mesic shade tolerant flora. The pre-settlement river bottom forest was clearly confined to the low floodplain below the bluffs.

Post-settlement Land Use History

Thomas Crosby first established a 160 acre farm at the southwest end of the park in 1858. The area was then continuously farmed until it was purchased for a park in 1962. Crosby raised cattle, dairy cows, horses, pigs and chickens, and grew potatoes and apples (MNRRA 2004).

An aerial photo from 1940 shows the high intensity of farming in the area (figure5). Crosby Lake was considerably smaller than it is today. A farm access road followed the southern edge of the lake. Much of the floodplain southeast and southwest of Crosby and Upper Lakes was cultivated. The lower, more frequently flooded portions of the floodplain north and west of the lakes, as well as much of the east end, were grazed and also largely devoid of trees. Floodplain forest trees were confined to narrow zones within grazed areas near the Mississippi River. Most of the floodplain forest remnants were

Figure 4: Pre-settlement Vegetation at Crosby Park

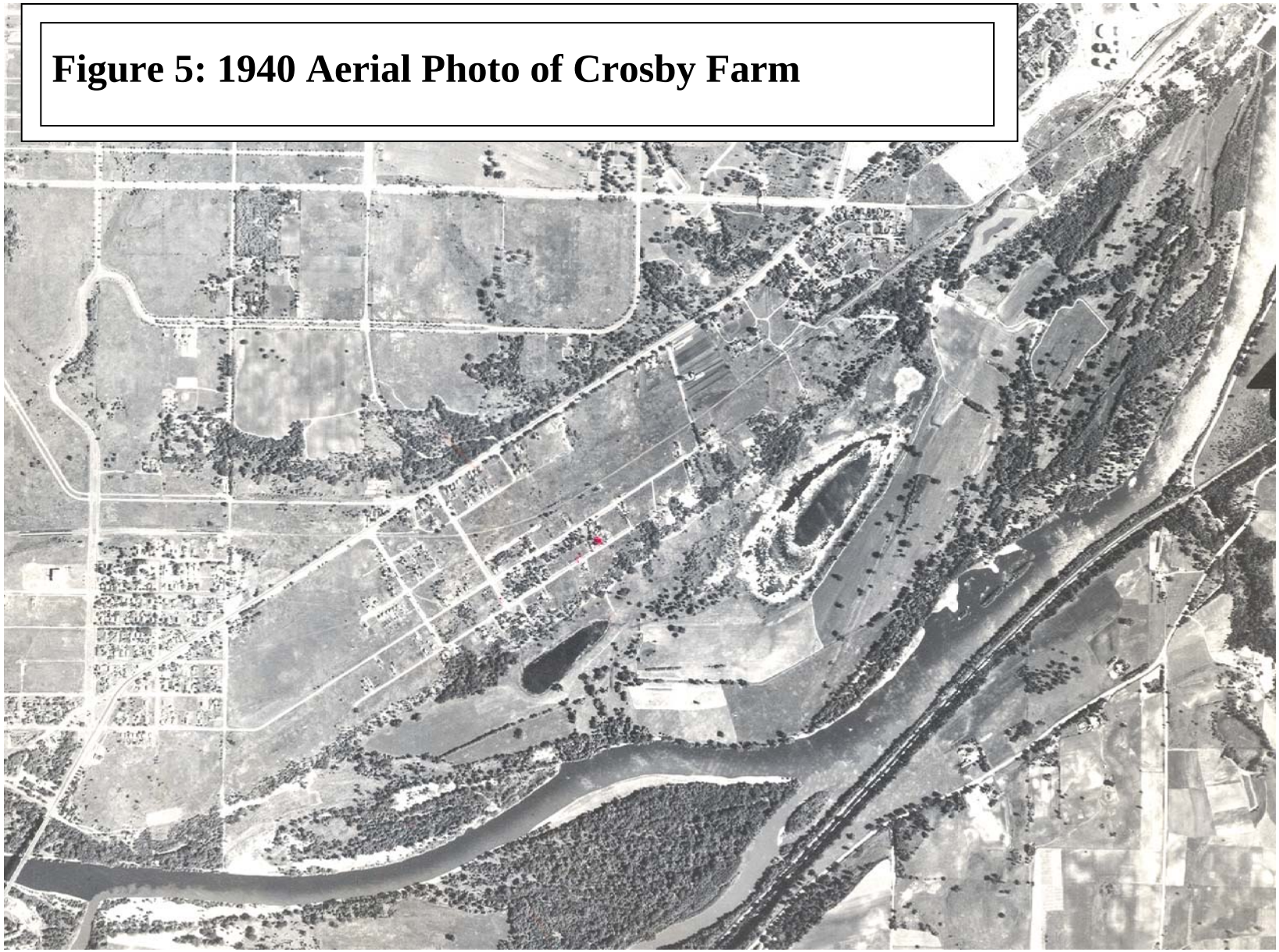


thinned by past logging and many of the trees appear to be very young. The bluff slopes along the north edge of the park had very thin tree cover limited to discrete patches: many of the spur ridges had few or no trees and most trees were confined to ravines. These bluffs were thinned by logging and probably grazed. The far westernmost end of what is today's park was much less disturbed than the rest of the area, as the bluffs and floodplain are heavily wooded there in the 1940 photo. The straight line separating this end from the rest of the present park area suggests that that this western tip was in a different ownership from the Crosby farm.

Since 1962, the former Crosby farm has been managed as a public park. By 1970, many of the formerly cultivated and pastured fields on the floodplain were in the "first stages of reverting to forest" (Blacklock 1970). Blacklock also described areas of floodplain forest that had not been cleared as mature "climax" forest containing dense wood nettle cover – which is much the way these stands appear today. Blacklock observed huge American elms estimated at 14 or more feet in circumference – trees that have since been lost to disease – and occasional huge cottonwoods, many of which still stand in the park. By the 1970s, the farm road south of Crosby Lake cut through young woods not open fields.

Today, 500 acre Crosby Farm Regional Park is the largest natural park within the City of St Paul, and an important natural area within the Mississippi River Critical Area Corridor and the Mississippi National River and Recreation Area. It is an oasis of woods and wetlands along the Mississippi River visited by tens of thousands of people using the park's 6.7 miles of trails throughout the year. Visitors utilize the park for hiking, fishing, running, bicycling, dog walking, bird watching, wildflower watching, picnics, and cross-country skiing. The park is a significant stopover place for migrating songbirds and waterfowl and each of the metro area Audubon chapters hold annual field trips to Crosby Park. The park also serves to capture storm water from adjacent neighborhoods north of the park via storm sewers that end in the bluffs along the park's north edge.

Figure 5: 1940 Aerial Photo of Crosby Farm



Crosby Regional Park Bluff Erosion
A Preliminary Assessment - September 2004
by
Tom P. Petersen
with assistance from
David W. Bauer

Summary of Findings

The overall bluff is undergoing the natural process of geologic erosion. Geologic erosion is necessary for the formulation of mineral soils. The sandstone/limestone matrix of the site's geologic material is inherently susceptible to weathering/destruction by the forces of water (raindrop detachment, sheet and concentrated flow), frost, gravity, vegetation root systems, and acidic precipitation. Theoretically, the increased acidity of precipitation, due to the effects of combusted fossil fuels, may or may not accelerate the geologic erosion of the bluffs. Most likely, however, with or without the presence of humans, the process of geologic erosion will continue until the site is level (zero gradient) millions of years from now.

Evidence of accelerated erosion of the bluff, i.e., human induced, abounds throughout the site. Most can be attributed to either channelized flows of water or foot traffic (trails) destabilizing the soil structure and/or denuding the slope of stabilizing vegetative root networks. Channelized flow is generally the result of storm water systems being outlet at the top of the bluff whether by pipe or channel. The foot traffic erosion (trails) is the result of concentrated human travel corridors destroying vegetation and in some cases creating collection points for sheet flow off the bluffs to become concentrated flow. Trails seem to follow contours of stable gradient, connect points of human interest, e.g., easiest way up or down the bluff to park amenities, or are predetermined by parks personnel as desirable points of human interaction with the bluff.

The accelerated erosion caused by human influences can be managed to minimize further accelerated erosion of the bluff. Controls/management techniques may include: 1. Constructing stable conveyance systems down the slope for storm sewer systems. Pipes, high velocity chutes, and in some instances, vegetated swales may be needed. Reducing the number of storm sewer discharge points by collecting runoff above the bluff to single points of flow down the bluff may be needed. 2. Planting denuded areas (trials and bare slopes) with plant materials that will promote infiltration and stable soil structure. 3. Applying stable materials for foot- paths that will diffuse water flow, resist compaction and disintegration from human foot traffic. 4. Redirecting flows away from trails to avoid concentrated flow.

Several bare soil areas were encountered on the bluff usually associated with bedrock protrusions and/or mast bearing trees, e.g., Oak trees. It is assumed that in the case of the mast bearing trees, squirrels, rodents, wild turkey and/or deer are disturbing the plant

cover in search for nuts and are leaving the slope surface in a near constant state of denuded soils. This is an observation and not necessarily a source of significant erosion.

Survey Methods and Definitions

Staff from the Ramsey Conservation District have identified 39 sites with noticeable soil erosion within the "bluff zone" at Crosby Park in St. Paul. The field assessment was completed in early September 2004 and is intended to provide a "low-tech" cursory assessment and inventory of overall soil erosion conditions on the bluff.

The purpose of this information is intended to assist resource managers in developing a plan for the restoration and management of this resource. To aid in the management process, we have categorized soil erosion as either Severe, Moderate, or Low. Each category may be further modified according to whether erosion is ongoing, the result of a past event, likely source of the erosion, and/or is likely to present future problems with the management of the resource. Also noted are areas where significant sediment has accumulated and may present management problems.

It should be noted that the information contained in this assessment would require a more detailed site-specific assessment to select the appropriate best management practice for the long-term management of the resource. RCD staff are qualified and experienced to assist with this level site management should the City Parks Department desire our assistance. The following are some definitions of terms used in the preliminary erosion assessment:

Severe Erosion:

A condition resulting in accelerated denudification of the slope, the development of severe "rills" and/or "gully" with sidewall cave-in/instability, and the inability of the slope to arrest further deterioration. If not corrected, this condition will have significant impact on the long-term utility of the bluff. For the Crosby Park bluff area, this condition is usually the result of concentrated storm water discharge onto the bluff at its crest. The ongoing effects of this point discharge prevent the establishment of erosion arresting plants and ongoing removal of soil materials. Without corrective actions, usually structural and engineered, the size of the denuded landscape will continue to grow, and in many instances undermine the root system of trees causing further deforestation.

In areas of severe erosion, the Saint Peter Sandstone is exposed or the landscape is dominated by bedrock flagging. Both conditions preclude the ability for plant materials to be re-established.

Moderate Erosion:

A condition where erosion of the landscape is evident but is not at a rate or size that will have long-term effects on the utility of the slope. This condition is most associated with foot- paths and other human activities that collect and direct runoff, from adjacent slopes

to points of concentrated flow. The concentrated flow will cause “rills” and minor sediment deltas that prevent vegetation from establishing and stabilizing the slope.

Diverting and/or collecting runoff from paths prior to discharge onto a slope, and constructing paths on the contour to act as a terrace can usually stabilize these areas. Paths should also be constructed of stable material to maintain their grade.

Low Erosion:

A condition of minor soil exposure usually caused by rodents and birds foraging and digging for mast crop. Can also be a condition where canopy and/or under story vegetation shades the growth of grasses and forbs that can hold soil in place on steep gradients.

Simple techniques of vegetation management are sufficient to stabilize these areas.

It should be noted that many low erosion areas exist on the bluff probable the result of invasive plant species with poor root systems.

Field Notes

The following brief field notes correspond to the numbered red points in Figures 6 and 7. Green triangles in these figures correspond to photo points taken at the top of the bluff. Selected photos taken in the corresponding points are given here. Photos of all the points and a more complete report from this preliminary survey are available from the Ramsey Conservation District.

Point 1 (Fig. 6).
Saint Peter Sandstone outcrop. Human caused erosion due to access up and down slope. Erosion has formed channelized flow in the sandstone and an alluvial fan of sand has been created on the adjacent footpath. No soil remaining, all has eroded away.

Low erosion problem.

Erosion could be eliminated if foot traffic access were eliminated. The alluvial fan can be stabilized with vegetation. If access is required here, use stable train substrate.

No evidence of gully-head from channelized flow over the bluff. Obvious digging/mining of the SPS by park visitors.

Restoration should include long-term elimination or minimization of human access at this site with a minimum of 9 inches of topsoil placed over the exposed SPS and mixed into the SPS alluvial fan. Plant vegetation on topsoil to stabilize.

Special note: Many exposed "noses" of SPS by geologic forces and rodent foraging for mast-crop. Random vegetation best stabilization solution.

Point 2 (Fig. 6).
Two channels start at a common point at the top of the bluff. Limited evidence of foot traffic up and/or down the channel. Estimated flow velocities of 1 to 3 CFS. Gullies form a broad horseshoe valley with very active erosion. Cause is flow from top of bluff. Little contribution of water from the valley sidewalls, however. Severe erosion problem that must be controlled soon. The two channels converge before foot of the bluff and are 2 to 3 feet wide and about 1 foot deep.

Diversion of flow(s) from the top of bluff to stable conveyance system down the bluff is necessary to control erosion. Channels need not be restored just add topsoil, mulch, and plant with vegetation to reclaim the landscape.

Much urban rubble debris found in the vicinity of this site. This suggests dumping from top of bluff. Clean up of debris may be desired to aesthetically restore the site restoration.

Point 3 (Fig. 6).
Exposed "nose" of SPS. Minimal erosion very low erosion problem. Typical of many sites along the entire bluff where the bluff undulates due to geologic erosion. Solve with vegetative planting. Low priority erosion.

Point 4 (Fig. 6).
Severe gully 10 to 12 feet wide with an average depth of 3 feet. Concentrated flow from top of bluff. Very active erosion, many side-slope cave-ins present. High priority for control and restorative work. Two gully branches meeting to form a large channel filled with limestone float. No evidence of seep from bedrock causing or adding to gully erosion problem.

Must control erosion with proper storm water pipe techniques. I recommend an engineer be consulted to solve this severe erosion problem site. Further collapse of the landscape will continue if this is not corrected ASAP.

Point 5 (Fig. 6).
No evidence of human foot travel, i.e., path up and down the bluff. Random bluff profile erosion of low erosion problem. Random planting on exposed soils recommended.

Point 6 (Fig. 6).
Lower end of St. Peter Sandstone "spur". Minimal exposed topsoil. Low erosion problem. Recommend plantings within exposed soil areas. Exposed soils probably the result of rodent activity seeking mast-crop.

Point 7 (Fig. 6).
Lower end of St. Peter Sandstone spur. Low erosion problem. Recommend random plantings on exposed soils.

Point 8 (Fig. 6).
Very severe gully. Large sediment delta at base.

Gully 12 to 15 feet wide. Lower end of gully 5 feet deep. No seep evidence at head of bluff/gully.

Very high erosion problem. Must be controlled to avoid loss of trees and significant loss of bluff landscape. Unknown source of water causing gully. Recommend further survey of gully source(s).

Once source is known, recommendations of stable conveyance will be possible.

Point 9 (Fig. 6).
Exposed soil at base of oak tree. Evidence of rodent digging for mast-crop. Low erosion problem. Random plantings may be appropriate.

Point 10 (Fig. 6).
1 foot deep by 3-foot wide small gully. Minimal erosion with gully extending to top of slope. Source of flow is bluff sidewall. No evidence of storm sewer/culvert outlet storm water flow from top of bluff.

Moderate erosion problem. I recommend further assessment of this site to better determine the source of the runoff. Once this is determined, corrective measures can be recommended.

Point 11 (Fig. 6).
Severe gully with many tree root exposed. Flow from top of bluff, no evidence of seep. Gully 2 feet deep and 6 foot wide.

Suggest diversion at top of bluff to common point for transport down-slope to stable outlet.

High erosion problem site. Recommend stabilizing work ASAP to prevent further loss of bluff landscape.

Point 12 (Fig. 6).
Exposed St. Peter Sandstone knoll with obvious human digging/mining activities. Foot-path up to top of bluff.

Low erosion problem. Recommend diverting human traffic and random planting into exposed soils that have been augmented with an additional 6 to 9 inches of topsoil.

Point 13 (Fig. 6).
Two very active gully channels. The left channel is from an 18 or 24-inch pipe protruding from the top of bluff. The right channel originates at the top of bluff as spill-off from top of bluff.

Long-term management should include filling in of gullies with plantings and engineered diversion of and management of flow down bluff as necessary. High erosion problem area. Restore ASAP to avoid further loss of bluff landscape. Urban rubble present in gullies, as evidence of past gully filling. I recommend further analysis of site to determine best-engineered solution to the gully. Evidence of foot traffic is also present in the east gully. This however, is not exacerbating the gully problem.

Point 14 (Fig. 6).
Backside of point 1. Human path causing channelized flow to begin. Moderate erosion problem. Fill in path/gully and plant to restore.

Point 15 (Fig. 6).
Moderate erosion problem along the upper path. Highly weathered St. Peter Sandstone crumbling along path's up-slope side. Sheet flow off the adjacent bluff channelizing and flowing down the path and depositing sandstone delta.

Recommended restoration, 1. Carry water with drain tile and 2. Place stable path surface with stair system to manage the natural grade.

Point 16 (Fig. 6).
Runoff from foot-path washing over the side of path and creating a collapse of the path. This should be a very high priority problem to address to sustain the current path grade and location.

This is a medium erosion problem but in need of restoration ASAP for the sake of the path.

Point 17 (Fig. 6).
The trail gradient causing erosion. Need stable path surface to stop erosion. Low erosion problem.

Point 18 (Fig. 6).
Human path down slope causing erosion. Low erosion problem. Seems to be a path connecting the lower trail with the upper trail.

Point 19 (Fig. 6).
Shallow gully from the top path to lower path. Not a severe problem , i.e., low erosion problem, because of the terracing effect of the trail. Recommend keeping humans off site and random planting.

Point 20 (Fig. 6).
Shallow gully from top path to lower path. Establish holes in wall with tile to carry water to stable outlet.

Point 21 (Fig. 6).
Severe gully from slope top. 3 feet deep by 20 to 30 feet wide. Side-slopes are collapsing. Retaining wall is being destroyed. High erosion problem.

To restore, continue pipe that is outlet at top of bluff down to base of bluff. Restoration of gully is necessary once drainage issue is controlled to avoid further loss of landscape. Fill in gully and plant.

Point 22 (Fig. 6).
Sheet flow off slope top to the path than directed to the west over the wall. Diversion to capture water flow than down slope via pipe . Severe erosion high priority to fix and restore.

Point 23 (Fig. 6).
Eroding footpath off retaining wall. Low erosion problem. Plantings needed.

Point 24 (Fig. 6).
Pair of eroding St. Peter Sandstone knolls. Sheet flow directed to path than down path to retaining wall. Plant knolls.

Point 25 (Fig. 6).
Footpaths to bluff with water flowing down the path. High erosion Problem. Restore landscape with fill; redirect runoff down to stable slope with pipe, and plant to stabilize.

Point 26 (Fig. 6).
Severe gully with seep. Sediment being deposited on lower path. Severe gully between upper and lower paths. Side slopes are collapsing. Loss of trees expected. Very high erosion problem. Erosion restoration of landscape needed ASAP. Source of erosion t08, i.e., storm water pipe outlet at top of bluff. Pipe water down slope and restore landscape by fill and plantings.

Point 27 (Fig. 7).
Sluff of knoll. Natural geologic erosion. Very low erosion problem.

Point 28 (Fig. 7).
Side-slope slump. Knoll is destabilized by path. Use retaining wall with vegetation to stabilize. High erosion problem. Stabilize and restore ASAP.

Point 29 (Fig. 7).
Bare soil under oak tree on knoll. Minor evidence of overland flow eroding exposed soil. Rodent digging for mast crop exposing soils. Small gully starting at top possibly as a result of water being diverted from upper path. Low erosion problem. Plantings will stabilize.

Point 30 (Fig. 7).
Sheet erosion over train. Low erosion problem. Plant bare soils. Trial erosion needs stable trail surface.

Point 31 (Fig. 7).
Cave digging. Deposits of sandstone dominate the management issues. Eliminate human access to this specific site to avoid further accumulation of sandstone.

Point 32 (Fig. 7).
Large gully carving into St. Peter Sandstone . Very deep 10 to 20 feet wide. Side-hill seeps present. Evidence of very heavy flow. Side walls look stable. No vegetation of sandstone sidewalls. Large canyon looking feature. Source of water is storm water pipe at top of bluff (picture t09). Engineered solution needed to prevent further erosion. May not want to fill gully but leave as an amenity once storm water issue id managed.

Point 33 (Fig. 7).
Trail interchange. Foot/path erosion. The oak tree in the photo is critical to the overall slope stability. Low erosion problem. Plantings needed.

Point 34 (Fig. 7).
Knoll erosion due to vegetation loss possibly because of shading and human foot traffic. A moderate erosion problem exists if foot traffic is allowed onto the slope. Plantings needed to stabilize.

Point 35 (Fig. 7).
Side- slope collapse. Probably caused by a single storm event. May be a random catastrophic collapse of slope. Must vegetate ASAP. High erosion problem.

Point 36 (Fig. 7).
Very pronounced side-slope cave-in. Storm sewer pipe at top of bluff is source of the problem. To manage the problem, must pipe water down slope. High erosion problem. Source of water map site T13

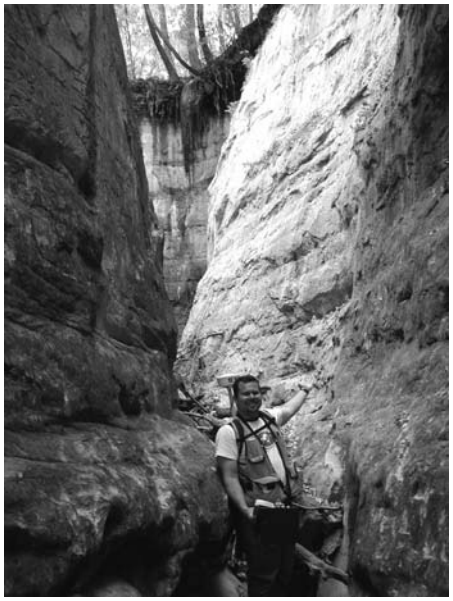
Point 37 (Fig. 7).
Off street flow over bluff minor side hill slump.

Suggest redirect flow at top of bluff to point where stable flow over bluff, i.e., pipe is possible. High erosion problem.

Point 38 (Fig. 7).
Simple knoll erosion down to St. Peter Sandstone. Moderate erosion problem.

Point 39 (Fig. 7).
SUPER Gully!!!

Very active erosion at the "head". Matches to point T11. Very large alluvial fan. Seep at head of gully also present. Massive erosion problem. All movable soil has been eroded. Only erosion of the St. Peter Sandstone is taking place now. May want to consider leaving the gully as is and selecting another site to convey storm water down slope.



Crosby Gully Sites West

1 inch equals 150 feet

2003 Aerial photo

Crosby Gully Sites East

1 inch equals 150 feet

2003 Aerial photo

2004 Detailed Inventory of Upland and Wetland Native Plant Communities in Crosby Park

In 2004, a detailed inventory of native plant communities in Crosby Park was conducted and is summarized below. This inventory was intended to add additional detail to the land cover mapping by the Minnesota Land Cover Classification System (MLCCS) of the Minnesota Department of Natural Resources (MNDNR 2004). This greater level of detail is essential for identifying specific areas for management or restoration attention.

Comparison of 2004 inventory with previous mapping of the area:
The DNR's Minnesota County Biological Survey (MCBS) mapped small portions of the park in its map of remaining, high quality native plant communities and rare species of Anoka and Ramsey Counties (MCBS 1994). This map depicts areas of floodplain forest on the floodplain along the Mississippi River east and west of highway 35E. These areas were identified primarily from air photo interpretation. The scale of the map and the intensity of ground survey work were not sufficient to break out the more disturbed areas of floodplain forest from the higher quality forest. This map also depicts a zone of willow swamp in a low flood channel on both sides of highway 35E – these flood channels still exist but there is no willow swamp left in them.

The Minnesota Land Cover Classification System (MNDNR 2004) mapped all the area's land cover (native plant communities and disturbed areas) in the mid to late 1990s based on aerial photo interpretation and ground survey (figure 8). This mapping effort did not have the benefit of the high resolution, low altitude photography of the park taken in 2003 and used in the 2004 detailed inventory in this report. The MLCCS cover identifies some areas of silver maple-dominated floodplain forest found in the present inventory. Other parts of the floodplain are identified more generically as "floodplain forest" which may denote forest stands dominated by "any combination of silver maple, cottonwood, black willow, American elm, slippery elm, box elder, bur oak and swamp white oak" (MNDNR 2004). In Crosby Park, this unit includes areas ranging greatly from highly disturbed areas with invasive species (box elder, cottonwood) to mature stands with intact canopies dominated by silver maples. Swamp white oak does not naturally occur in the Twin Cities and is not present in Crosby Park. Slippery elm and bur oak are essentially absent from the floodplain forests in the park – they are present on the bluffs. The large willow trees abundant in the park are *Salix x rubra*, a hybrid of black willow (*Salix nigra*) and the exotic weeping willow (*Salix alba*). According to Welby Smith, the Minnesota DNR's Natural Heritage Program Botanist, nearly all of the large willow trees in the Twin Cities are this hybrid.

The MLCCS map correctly identifies the oak forest on the bluffs. The MLCCS cover does not distinguish mesic from dry-mesic oak forest, areas of black ash seepage swamp, and areas of highly eroded cliffs within the forested bluffs. The area of oak forest on the bluffs at the far west end of the park, west of the marina, was also not shown on the MLCCS map.

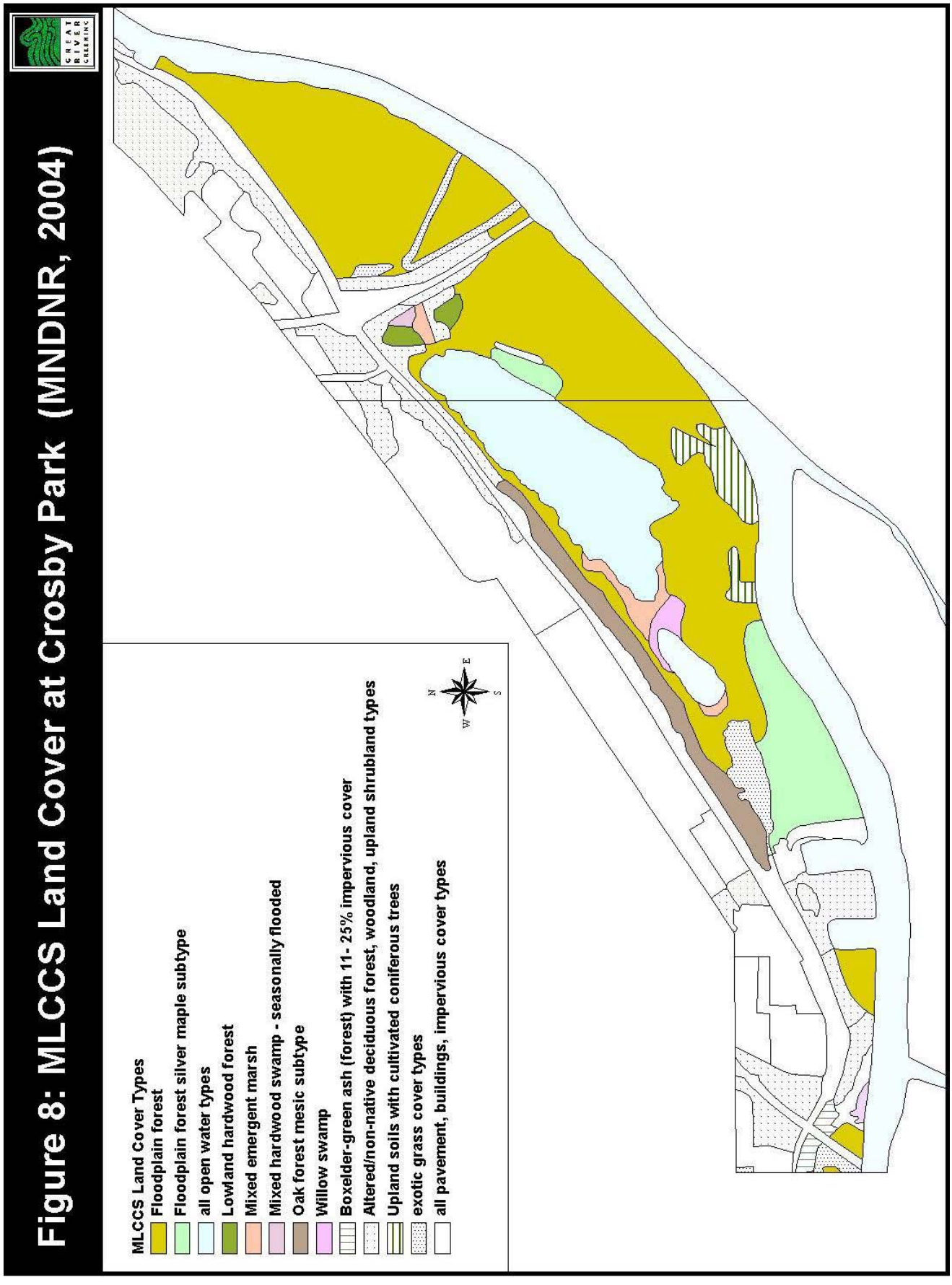


Figure 8: MLCCS Land Cover at Crosby Park (MNDNR, 2004)
GREAT RIVER GREENING
MLCCS Land Cover Types
Floodplain forest
Floodplain forest silver maple subtype
all open water types
Lowland hardwood forest
Mixed emergent marsh
Mixed hardwood swamp - seasonally flooded
Oak forest mesic subtype
Willow swamp
Boxelder-green ash (forest) with 11- 25% impervious cover
Altered/non-native deciduous forest, woodland, upland shrubland types
Upland soils with cultivated coniferous trees
exotic grass cover types
all pavement, buildings, impervious cover types
N
E
W
S

2004 Inventory procedure:
The detailed inventory of the park in 2004 started with a close inspection of color infrared (CIR) photography of the area, using 1:15,840 fall photography from MNDNR Forestry taken in 1994 (figure 9). CIR photography shows different colors corresponding to different plant species, as follows:

- rusty red crowns on slopes = oaks
- blue gray crowns on floodplain = cottonwood
- deep red crowns on floodplain = silver maple
- light yellow/whitish crowns on slopes = basswood and sugar maple
- hot pink wetlands = reed canary grass
- black/dark blue = water
- bright red grass = Kentucky bluegrass
- dark red clusters of small crowns = planted pines

This photography enabled identification of different tree species and allows for a preliminary mapping of native plant community types. Distinct areas of mature and disturbed forest types were identified and digitized in ArcView 3.3 (ESRI). This preliminary land cover was then overlain and adjusted to match the low altitude, color air photography taken in 2003 for the City of St. Paul.

Field visits to the park were started in April 2004 and continued through October 2004 to ground truth aerial photograph interpretations and survey the plant species and the condition of the vegetation units in the park. Field notes and locations of special features and boundaries of native plant community types were determined in the field using a hand-held, Garmin 76 Global Positioning System (GPS) unit. The digital ArcView maps were subsequently revised and descriptions of remaining vegetation in the units were written and are given below. Additional field visits were conducted to map locations of special features and exotic species.

The results of the 2004 inventory are mapped in figure 10. Descriptions of the individual map units are given below. Each polygon in the inventory was assigned a unique identification number. Comments on selected polygons are given in the land cover unit descriptions below and are denoted by inventory polygon numbers that are shown in figure 10. A complete list of the plants that were recorded in the 2004 inventory is given in Appendix A.

Figure 9: 1994 Color Infra Red Photo
(Source: MN DNR Division of Forestry)

Figure 10: 2004 Detailed Land Cover at Crosby Park

Detailed Land Cover Units

- Dry Mesic Oak Forest
- Mesic Oak Forest
- Lowland Hardwood Forest
- Black Ash Seepage Swamp
- Mature Silver Maple - Cottonwood Forest
- Mature Silver Maple Forest
- Cottonwood Disturbed Forest
- Boxelder Disturbed Forest
- Willow Swamp
- Sedge Meadow
- Cattail - Bur Reed Marsh
- Sandy Riverbank
- Planted Pines
- Planted Spruce
- Planted Prairie
- Cliffs and Talus
- Mowed Lawn
- Old Field
- Reed Canary Grass
- Disturbed Woods
- Disturbed Ground
- Developed Land
- Trails
- Roads
- 24 Polygon Numbers

N W E S

Dry Mesic Oak Forest

Dry mesic oak forest in fair condition with a very patchy canopy occurs on spur ridges and upper slopes above and between mesic ravines on the bluffs along the north side of the park. This vegetation originated on slopes that were fairly degraded when the area was farmed. This unit includes some very small mesic ravines that were too small to map separately as mesic oak forest. Open grown bur oaks (with horizontal branches and large crowns) dominate on the uppermost slopes and shallow soils above limestone cliffs on the edge of the valley. Open grown red oak and red oak – pin oak hybrids dominate elsewhere on mid- to upper slopes. True northern pin oaks are also present but not common. Other canopy-size tree species also present include early successional invaders: cottonwood, hackberry and box elder are the most common; green ash and basswood are very infrequent; black cherry is rarely present. Subcanopy size trees include American elm, ironwood, box elder, basswood, and hackberry. Red oak seedlings occur in a few areas but are not common.

The shrub cover in these stands is very high and composed mostly of chokecherry. Gray dogwood is common on upper slopes and ridge tops. Other shrub species include American hazelnut (uncommon), bladdernut (on moist, clayey soils), prickly gooseberry and black raspberry (openings). Common buckthorn has heavily infested these slopes in the past, most of which has been removed by recent management work. Areas of former buckthorn thickets have very few herbs on the ground. Tartarian honeysuckle is also present but not nearly as abundant as buckthorn and tends to be fairly scattered.

The herbaceous layer on these slopes is sparse and has very low diversity. The most common herbs in the dry-mesic slopes include Virginia creeper, white snakeroot, heart-leaved aster, elm-leaved goldenrod, and racemose muhly grass. Virginia waterleaf, bloodroot, carrionflower, stellate false Solomon's seal, and columbine occur in a few places. Pennsylvania sedge is present in a few places but surprisingly not abundant on the bluffs. Pale touch-me-not is abundant in areas of moist, clayey soils at the bases of limestone cliffs and on the tops of some spur ridges. Sprengel's sedge forms dense large patches in a several areas on steep lower slopes on ridges in soft sandy unstable soils.

Several dry-mesic forest herbs are essentially absent from these bluffs, such as hog peanut, (see Appendix B for complete plant species list). Past over-grazing is probably the primary cause for the low diversity of herbs in the woods. Additional, more recent causes include shifting, unstable soils on very steep slopes, sheet erosion from storm water runoff, and recent heavy buckthorn thickets, and possibly acorn foraging by local wildlife. Garlic mustard is highly abundant on most of these slopes. It is much more abundant here than on the floodplain.

Management Comments:

1. An engineering study is needed to identify and assess the causes and solutions to severe slope erosion from storm water runoff on the bluffs. Once a study is completed, these severe erosion problems should be corrected.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs. Off-trail traffic is another significant cause of bluff erosion and promotes exotic species invasions.

3. Continue monitoring and removal of invasive buckthorn and tartarian honeysuckle (see figure 12). Buckthorn populations on the slopes have been greatly reduced by intensive removal efforts in recent years. Buckthorn creates bare soils prone to erosion. Numerous buckthorn seedlings still remain on the slopes, however, and removal work needs to continue every year. Presently, the west end slopes (polygon 1) have the greatest need for immediate buckthorn control.

4. Monitor the woods for oak wilt. Obvious signs of this disease were not detected in 2004.

5. In areas of bare soils not subject to excessive stormwater runoff, plant herbs (forbs and graminoids) to stabilize soils, enhance floristic diversity, and improve habitat for native wildlife species. Forest herbs for planting are listed in the dry-mesic oak forest list in Appendix B. A suggested methodology for this is given in project #4 in the section on recommended restoration projects.

6. Promote shade to deter buckthorn and enhance native habitat. Restoration of native oak forest canopies on the bluffs will improve the park's habitat for forest songbirds. Plant trees into open areas: particularly white oak, bur oak and northern pin oak. Promote oak recruitment: cut and stump treat box elders, aspen, and exotic trees or saplings that may be shading and suppressing oak seedlings. Leave cut trees to rot in place on the ground.

7. Introduce biological control organisms to control garlic mustard when and if they are eventually identified and certified for release.

Mesic Oak Forest

Mesic oak forest occurs in small ravines and portions of toe slopes on the steep bluff slope along the north side of the park. The largest and best examples of this forest were mapped separately from the dry-mesic oak forest (Figure 10). Numerous other very narrow ravines also contain mesic conditions but were not mapped separately from the dry-mesic forest of the slopes. Mesic forest conditions are also localized on areas of clayey soils on spur ridges and below limestone cliffs.

Areas mapped as mesic oak forest in the park are somewhat variable in composition but common dominant trees are red oak, sugar maple, green ash, hackberry, basswood, box elder, and slippery elm. Canopy cover is variable but generally fairly high. Tree seedlings are predominantly green ash, sugar maple, and basswood. Ironwood is also very infrequently present in the subcanopy. Red oak seedlings are not common. Without active management over time, sugar maple, basswood and green ash will be more dominant in the canopy.

The shrub cover is variable in these areas and depends on aspect and amount of shade, with the shadiest areas having little shrub cover. Chokecherry is highly abundant in most of these ravines. Bladdernut, a shrub of moist, well shaded slopes, occurs in several ravines most often on the most sheltered, east-facing slopes. Other shrubs found in the ravines include Missouri gooseberry, prickly gooseberry and red-berried elder. The diversity and abundance of herbs in these ravines is generally quite low.

Mesic forest herbs found in the most sheltered parts of the ravines, most commonly on east-facing slopes of ravines, include Virginia waterleaf, large-flowered bellflower, carrion flower, pale touch-me-not, woodland sedge, columbine, lopseed, Solomon's seal, racemose false Solomon's seal, wild geranium, Canada violet, Sprengel's sedge, zig-zag goldenrod, bloodroot, cleavers, and heart-leaved aster. Virginia creeper is one of the most common plants on the ground in these ravines on stable soils as well as on limestone talus (float slopes) where few other herbs occur.

Garlic mustard is dense in these ravines. It is colonizing large areas of bare soils in the ravines. Buckthorn is also present, but fairly thin in areas of high shade.

Most of these ravines currently have moderate to very severe erosion in channels from storm water runoff (see more detailed notes on erosion in the previous section on bluff slope erosion). Several ravines also have large amounts of limestone talus and or discarded concrete pieces in the middle of the ravines.

- Polygons 7 & 8, at the west end of the park. These ravines, together with the adjacent lowland hardwood forest, have the highest diversity and abundance of spring ephemeral wildflowers in the park. As indicated by the 1940 aerial photo (figure 5), this is the least-disturbed portion of the bluffs in the park. Spring ephemerals include dense, extensive carpets of white trout lily, false rue anemone, Dutchman's breeches, and white toothwort – these species do not occur elsewhere within the park. Other mesic forest herbs in this ravine include Virginia waterleaf, Canada violet, wild ginger, wild geranium, large-flowered bellflower, Sprengel's sedge, common blue violet, wild leek, zig-zag goldenrod, blue cohosh, and enchanter's nightshade. This high diversity of wildflowers indicates that this portion of the park was not grazed in the past. Of the two ravines, polygon 7 is in the best condition and is the best example of mesic hardwood forest in the park. This ravine is threatened, however, by an eroding channel from storm water runoff on the upper west side of the ravine. Polygon 8 also has abundant spring

ephemerals, but has poor canopy cover with young trees. The ravine has some large buckthorn plants that should be removed soon. Heavy garlic mustard cover also exists in both of these ravines.

- Polygon 9. Two small ravines separated by a spur ridge. No gully erosion problems. Small areas of mesic forest herbs.

- Polygons 10, 11 and 12. Mesic forest herbs present at the bases of the ravines. These ravines have heavy gully erosion from storm water runoff. Erosion is taking out soil from tree roots and some trees have toppled over. Lots of bare soils. Frequent buckthorn present. Dense garlic mustard.

- Polygon 13 has marginal tree canopy structure but has one of the better populations of mesic forest wildflowers, dominated by Virginia waterleaf and wild ginger in a large basin at the bottom of the ravine. Low levels of erosion are present on steep side slopes in the ravine. Garlic mustard is very dense in much of the ravine. After the west end ravines, this ravine would be the next highest priority for local garlic mustard control.

- Polygon 14. A small ravine with good quality forest located below a heavy limestone talus pile. The lower half of slope has black ash, American elm and hackberry. Mesic forest herbs are present on the lower part of ravine. Buckthorn seedlings are abundant.

- Polygon 15. This is one of the more intact ravines: narrow and well-forested. Mature slippery elm, basswood and green ash in the tree canopy. Steep sides of the ravines have some bare sandy soils due to the steepness and looseness of the soils.

- Polygon 16. A broad, shallow bowl mostly dominated by hackberry and box elder but also containing slippery elm, basswood, sugar maple and green ash. Much Sprengel's sedge on steep sandy slopes on the east side of the ravine. Low amounts of gully erosion present. Good forest herb cover on lower slopes.

- Polygon 17. Patchy tree canopy and high shrub cover. Sugar maple present. Large patches of Sprengel's sedge on east side of ravine. Good forest herb cover on lower part of ravine.

- Polygon 18. This is a broad ravine with patchy canopy cover of mostly young trees, including much slippery elm, sugar maple, green ash. The upper half of ravine is covered with young, invasive, weedy trees: white poplar, aspen and box elder. Some good forest herb cover at the low end of the ravine.

- Polygon 19. Much green ash and basswood present. Side slopes and bottom of ravine have some mesic forest herbs. Heavy garlic mustard infestation.

Management Comments:

1. An analysis by hydrogeologists and engineers is needed to determine the causes and solutions to numerous instances of excessive bluff erosion from storm water runoff. The highest quality ravines threatened with gully erosion from storm water runoff are Polygons 7 and 13. Excessive bluff erosion is severely compromising the quality of the native habitats on the bluff slopes, the integrity of the trail systems on the bluffs, and the quality of the aquatic habitats in Crosby and Upper Lakes.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

3. Continue monitoring and control of buckthorn and honeysuckle. Expansion of these exotics into thickets will directly threaten forest herb populations and promote bare soils prone to erosion.

4. In areas not prone to excessive stormwater runoff, revegetate bare soils to help stabilize soils and recolonize areas formerly covered by dense buckthorn thickets. A species list of herbs recommended for planting is given in Appendix B; a methodology is given in restoration recommendation #4. Also, try transplanting small amounts of white trout lilies into some of these ravines from its stronghold at the westernmost end of the park. To do this, dig a piece of ground containing trout lilies about 1 foot in diameter and at least 1.5 feet deep, as the bulbs of trout lilies are deep below the ground surface. A shovel full of ground can be dug in the fall and transferred to an equivalent sized hole in the target area. Trout lilies spread vegetatively by stolons. Try this with just a couple of shovels worth of plants and monitor the results. The loss of a couple of shovels worth of plants will not put a dent in the massive population of trout lilies on the west end slopes.

5. Garlic mustard control via weed whipping when plants are in flower (see recommendation #5 in the proposed management and restoration projects section). This may have to be done at least twice during the growing season. Top priority ravines for this would be polygons 7, 8, 13 and 16. Monitor and evaluate this to determine if it is effective in reducing the garlic mustard population. Otherwise, wait for a biological control organism to be identified for garlic mustard control (this is currently being investigated by the DNR's biological control unit (Skinner 2004)).

6. Promote canopy closure and greater shade. This will enhance bird habitat and deter buckthorn, which prefers much light penetration. Accomplish this by removing weedy trees (box elder, cottonwood) that appear to be overly shading seedlings or saplings of trees of more desirable mesic oak forest trees. Plant seedlings or small trees into light gaps, particularly red oak, basswood, slippery elm, and green ash. Do not plant sugar maples, as sugar maple is already seeding itself into these ravines, and dense sugar maple reproduction creates very heavy shade which promotes bare soils prone to erosion.

Lowland Hardwood Forest

Areas mapped as this type occur as a narrow transition zone between steep bluff slopes and wet bottomlands. Unlike floodplain forest, this area is not frequently flooded. Unlike mesic oak forest, these woods lack sugar maples and oaks. This forest is generally well-shaded with continuous to interrupted (50-100%) canopy cover but with occasional areas of thin, gappy canopy cover. Dominant trees in this zone consist of basswood, hackberry, green ash, box elder and cottonwood. Hybrid black willow is often dominant on wetter soils near the margins of lakes. Shrub species include chokecherry, common elder, and Missouri gooseberry. The herb layer includes many mesic forest herbs. These woods are fairly degraded from past grazing and have low native plant species diversity. Very heavy buckthorn concentrations in these woods in the past have also contributed to low herb cover on the ground.

- Polygon 20. This is an area of forest on toe slopes at the west end of the park. These toe slopes are dominated by a mixture of mature hackberry, sugar maple, basswood, cottonwood and box elder. The polygon contains a grove of large, mature Kentucky coffee trees with numerous small saplings formed from root suckering. This species is uncommon in Minnesota, which is at the northern end of its range in North America, and occurrences of it have been tracked by the DNR's Natural Heritage Program for possible status as a listed rare species. The stand also has a very large butternut that lacks signs of butternut canker. Subcanopy size sugar maple trees are present. A fairly high shrub cover consists primarily of bladdernut. This stand is probably the top place in the park to see wildflowers as it has a high diversity of spring ephemeral wildflowers and mesic forest herbs. The herbs include false meadow rue, white trout lily, Dutchman's breeches, toothwort, blue phlox, Canada violet, wild geranium, and wild ginger. The trout lilies are part of a very large and dense patch of tens of thousands of plants that extends along the toe slopes and most of the way up the sides of the bluff face. Buckthorn is common and dense in parts, particularly on the bluff side slopes. Garlic mustard is highly abundant.

- Polygons 21 & 22. This is a long narrow zone of forest extending along the bottom of the bluffs along Upper and Crosby Lakes. The canopy cover is variable and very thin or full of gaps in places. Areas of thin canopy cover or light gaps have dense shrub cover including buckthorn. A grove of young walnut trees occurs along Crosby Lake. This area contains some thickets of dense, large buckthorn along the level ground along the east half of Crosby Lake. Portions of this thicket were cut and treated over the winter in 2004.

<u>Management Comments:</u>

1. Continue to cut and stump treat remaining thickets of buckthorn. A top priority place for this is in the western most part of the park (polygon 20). Also, the heaviest remaining

buckthorn infestation is in the woods bordering the north side of the east half of Crosby Lake (see Figure 12).

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

3. Promote canopy closure to enhance bird habitat and create more shade to deter buckthorn. Cut box elders that may be shading and suppressing seedlings and saplings of more desirable tree species (especially basswood and green ash).

Black Ash Seepage Swamp

Black ash seepage swamps occur in small areas of groundwater seepage on toe slopes at the base of the bluffs along the north side of the park. These swamps occur within the zone of lowland forest along the base of the bluff. The wettest seeps are dominated by small to mid-size black ash with interrupted (50-75%) canopy cover. Soils in these areas are soft, saturated muck. Other trees occasionally present within seeps include American elm and box elder. Shrubs are common in these seeps and include common elder, swamp currant, and common buckthorn. Black ash seedlings are common. The herb layer in wettest areas is dominated by a dense carpet of spotted touch-me-not. Skunk cabbage is a characteristic plant in these seeps that does not occur elsewhere in the park. Other common herbs include marsh marigold, fringed loosestrife, obedient plant, sensitive fern, stellate false Solomon's seal, and lake sedge.

Several species are missing that are present in less disturbed swamps, especially graminoids – see the species list in Appendix A and the list for wet ash swamp in Appendix B. Localized patches of reed canary grass are also present.

- Polygon 25 denotes a cluster of individual black ash swamps. This polygon also includes areas of lowland hardwood forest around the seeps. Recent management activity has cut and treated much large buckthorn within this polygon. The clusters of skunk cabbage in this zone mark the greatest areas of groundwater seepage.

Management Comments:

1. Continue monitoring and removing buckthorn.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

3. Monitor and correct areas of soil erosion that cause soil deposition within these swamps, if they exist. Soil deposition promotes reed canary grass expansion within these swamps.

4. Control reed canary grass patches to keep it out of the swamps:
   - cut reed canary grass down to ground level in June just after it has sent up flowering stems – a brush saw fitted with a grass blade works well – leave cuttings in place
   - follow-up spraying: spot spray or apply with wick application Roundup (or Rodeo if near open water) on to the previously cut reed canary after first frost in the fall (late Sept. or Oct.). Be very careful to avoid spraying other plants.

Cliffs and Talus

This unit consists of large, exposed cliffs of St. Peter Sandstone or Platteville Limestone or large areas of limestone talus accumulation (float slopes) at the foot of cliffs. There are also numerous small areas of exposed St Peter Sandstone on mid- to lower slopes of the bluffs that were too small to map as polygons but are noted in the erosion maps (Figures 6 and 7). Many of these areas are subject to lots of human traffic; small caves are being dug into some of the sandstone exposures.

- Polygon 39, steep cliffs along main entrance road. This area of exposed St. Peter Sandstone and Platteville Limestone along the main entrance road to the park was created by road construction. A cave excavated into the sandstone has doors and is actively used. A steeply sloping float slope of limestone talus occurs along the base of this cliff. This talus has been invaded by trees: mostly cottonwoods, but also with some red oak saplings. Other trees present include the exotics Siberian elm and Russian olive. The ground on the slope is dominated mostly by smooth brome. Some prairie-associated herbs present include Canada goldenrod, tall goldenrod, and false boneset may have colonized from former savanna areas at the top of the cliff. The exotic tree Russian olive is abundant at the base of the talus. Several oak seedlings have successfully invaded and remained rooted in the talus, which suggests that additional oaks may colonize the talus slope or could be planted as acorns.

- Polygon 32, just east of the St Peter Sandstone cliff along the main entrance road. This is an area of super steep, limestone talus. This area has little tree cover consisting of scattered cottonwoods. Beneath the cottonwoods is a very dense thicket of large buckthorn. Highly eroded, bare soils occur underneath the dense buckthorns.

- Polygons 33, 36, 37, 28, 38, 40, on upper slopes of the bluffs north of Crosby and Upper Lakes. These are areas of heavy limestone talus accumulation as a result of undercutting of the limestone cliffs along the tops of the bluff. These areas occur primarily at the tops of ravines. Headward erosion may have contributed to

accelerated cliff undercutting and erosion within the ravines. Vegetation on these talus slopes is highly disturbed and contains little tree cover. Virginia creeper is common on the talus and may be more able to handle shifting talus piles than other plant species.

- Polygon 34, bluffs at far west end of the park. These bluffs are dominated by steep, eroding cliffs of St Peter Sandstone. The vegetation on the slopes is highly disturbed due to the instability of continually eroding bedrock faces. The slopes have little tree cover, and much buckthorn and other exotic plants on the slopes.

Management Comments:
1. Where possible, ameliorate areas of headward ravine erosion via stormwater runoff that promote undercutting and collapsing of limestone cliffs.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs. Several off-trail areas that attract human traffic are small sandstone exposures on the bluffs that are becoming badly eroded and growing in size. Comments about specific eroded exposures are given in preliminary report on bluff slope erosion given earlier in this report.

Mature Cottonwood – Silver Maple Forest

This community consists of areas of mature, even-aged continuous-canopied floodplain forest dominated by large, tall cottonwoods that form a supercanopy over other trees. A few of the cottonwoods are enormous, open-grown trees with huge trunk diameters and broad, widely spreading crowns. These few trees are progenitors of most of the cottonwoods in the park. They are surprisingly young, however: one that fell down in late summer 2004 was approximately 4 feet in diameter but had only 80 - 90 growth rings. Most of the other large cottonwoods are younger and straight-trunked, indicating that they grew up together in a stand.

Sites mapped with this type are predominantly on floodplain terraces between flood channels. Silver maples form a dense canopy below the cottonwood supercanopy and this type is very similar in composition to the mature silver maple forest type in this inventory. Other tree species in the canopy include green ash, hackberry, and box elder. Subcanopy size trees include silver maple, American elm, box elder and green ash. These woods are generally shaded well enough so that box elder expansion is not a problem. Shrub cover is usually very low in well-shaded areas or moderate in partially shaded areas. Shrubs are generally very scattered and consist mostly of Missouri gooseberry and common elder. Tree seedlings mostly consist of hackberry, green ash, silver maple, and American elm. The groundlayer is dominated by dense cover of wood nettles, particularly in areas of silty soil under canopy thin spots and gaps. Other common groundlayer herbs include white grass, Ontario aster, ambiguous sedge, and

goldenglow. Climbers are abundant, including river grape, Virginia creeper, woodbine, and moonseed.

The dense, multi-layered forest canopy in these stands constitute high quality habitat for forest canopy birds, including many forest songbirds that could potentially be nesting in the park. Restoration of high quality forest canopies in adjacent disturbed areas, mapped in this inventory as box elder disturbed or cottonwood disturbed forest, would greatly enhance the park's potential for sustaining breeding populations of forest interior bird species.

Exotic species include garlic mustard in areas of thin wood nettle cover, such as in densely shaded parts of the forest. Because garlic mustard does not appear to invade heavy wood nettle cover, the garlic mustard infestation is less intense on the floodplain than on the bluff slopes. Several sweeps to remove buckthorn in recent years have reduced buckthorn occurrences, but some areas of buckthorn remain, particularly in areas of little to no shade (see figure 12). Creeping Charlie is an abundant exotic plant on the ground nearly throughout the wood nettle thickets.

Management Comments:
1. Continue monitoring and removal of buckthorn and tartarian honeysuckle.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

Mature Silver Maple Forest

These are even-aged stands with dense canopies of silver maples and are very similar to the Mature Cottonwood – Silver Maple Forest type. These stands occur primarily within channels frequently flooded by the Mississippi. Cottonwoods are sometimes present but are generally not very abundant, as they have a lower tolerance for prolonged flooding than silver maples. These forests have a sparse subcanopy cover of primarily silver maples. Often there is no shrub cover. Areas on upland terraces have dense herb cover dominated by wood nettles. Low, moist ground in flood channels has bare soil. Silver maples typically occur as narrow bands on the margins of the most frequently flooded channels with bare, unvegetated soil in the centers of the channels. In light gaps in wide places in flood channels there are some wet spots dominated by sedges, particularly lake sedge.

Buckthorn tends to be absent from these stands, as it may not withstand prolonged flooding and shaded conditions. Reed canary grass is present in some unshaded areas of moist silty soils. Creeping Charlie is highly abundant outside of frequently flooded channels.

These stands have intact, continuous floodplain forest canopies and are high quality habitats for forest canopy birds. Restoration of high quality forest canopies in adjacent disturbed areas, mapped in this inventory as box elder disturbed or cottonwood disturbed forest, would greatly enhance the park's potential for sustaining breeding populations of forest interior bird species.

- Polygon 52, along the southeast side of Crosby Lake. This is a younger stand than other silver maple stands in the park. It is even-aged and has continuous canopy cover formed by silver maples.

Management Comments:
1. Continue monitoring and removal of buckthorn and tartarian honeysuckle.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

Cottonwood Disturbed Forest

These are stands of disturbed floodplain forest dominated by even-aged, young, straight-trunked cottonwoods on terraces between flood channels that were once cultivated or cleared and grazed. These stands are co-dominated by box elders and are very similar to areas mapped as Box elder Disturbed Forest. In contrast to the box elder disturbed forest, these stands have higher canopy coverage and a higher abundance of late successional tree species in the canopy, particularly silver maple and green ash. Hybrid black willow is co-dominant along the margins of lakes. American elm is abundant in the subcanopy. The herb layer has heavy cover of wood nettles in most of the stands. Areas of much garlic mustard cover are also present, particularly where wood nettle cover is thin. Creeping Charlie is abundant throughout. Other abundant native herbs include Ontario aster, white grass, and goldenglow.

Management Comments:
1. Monitor and control buckthorn and honeysuckle.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

3. Promote replacement of box elders to allow better canopy development by cutting and stump treating large box elders that are shading and suppressing tree seedlings of the following species: silver maple, green ash and basswood (see restoration project #7).

Box elder Disturbed Forest

This type occurs primarily on formerly cultivated areas or cleared and grazed areas on floodplain terraces between frequently flooded channels. The canopy, composed nearly entirely of box elders, is low and very patchy (25-50% cover) with frequent small to large canopy gaps. American elms are frequent as small, subcanopy-size trees in some areas but are absent as large trees. Other tree species in the canopy are very rare in much of the box elder disturbed units - these include silver maple, green ash, hackberry, hybrid black willow, cottonwood and basswood. The herb layer is composed mostly of a dense cover of wood nettles. Native herbs scattered within the heavy nettle cover include goldenglow, Ontario aster, and white grass. Exotic species are common, including creeping charlie, bittercress, and reed canary grass (unshaded depressions). Tree seedlings are often very sparse and consist primarily of hackberry and green ash. Succession to a more natural floodplain forest is proceeding very slowly in much of these areas.

These stands are very poor habitat for forest bird species, particularly canopy-nesting birds. Judging from the very low abundance of tree seedlings in these stands, these areas will take a long time to succeed to better quality forest. These areas would be excellent sites for forest replanting to accelerate conversion to closed canopy forest composed of late successional tree species, particularly green ash, basswood, hackberry, and silver maple. The return to a continuous canopy cover of these areas would greatly enhance the park's habitat for forest birds.

- Polygon 82. Scattered large and much small box elder with lots of light gaps. Occasional large multi-stemmed silver maples. Green ash is present but rare. Deep drifts of river sand in places.

- Polygon 77. Scattered large and much small box elder. Portion north of trail and south of Crosby Lake includes some tall cottonwood and silver maples; green ash and hackberry seedlings present. Dense garlic mustard in shadier areas of diffuse wood nettle cover. South of the trail includes scattered, planted red pines within the box elder matrix. This part is in worse condition with fewer trees and seedlings of species other than box elder or pines.

- Polygon 79. This is the second most disturbed of the box elder stands. Large area of low, scruffy, even-aged box elders with lots of canopy openings filled with dense wood nettle and common nettle cover. Occasional green ash, cottonwood and silver maple. Contains a cluster of a few large and small white pines.

- Polygon 80. This is the most disturbed of the box elder stands. Large gaps are visible in the 2003 photography. Large areas here have no trees in the canopy other than box elder. One small area has a cluster of green ash saplings near a mature green ash tree. Very dense wood nettle cover essentially throughout.

Management Comments:
1. Monitor and control buckthorn and honeysuckle.

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.
3. Promote replacement of box elders to allow better canopy development by cutting and stump treating large box elders that are shading and suppressing tree seedlings of the following species: silver maple, green ash and basswood. In particular, target female box elder trees for cutting and stump treating, as these are the trees that are setting seed.

4. These stands are excellent candidates for planting other tree species to accelerate conversion of the stands to higher quality floodplain forest (see suggested project #7 in the potential management and restoration projects section). A shelterwood approach is recommended, which involves cutting and stump-treating areas of box elder and planting seedlings or saplings of silver maple, green ash, basswood, and hackberry.

Planted Pines

These are areas of well-drained, sandy terraces within the floodplain where red pines were planted many years ago. These islands of river sand are higher in elevation than most of the surrounding floodplain. Pines do not tolerate flooding well and are restricted in the park to high, terraces of river sand that are above extended flood events. These stands have closely spaced young to mid-sized red pine trees. In the densest areas of pines, few other trees and herbs occur and the ground is covered by needle duff. In thinner areas, other trees mixed in with the pines are predominantly box elder, and also include paper birch, hybrid black willow, American elm, cottonwood and green ash. There are some dense thickets of common buckthorn and honeysuckle in areas of thinner pine cover. In silty soils with less river sand these stands also have a lot of garlic mustard and wood nettles. Moonseed is a particularly abundant climber in these stands.

Scattered red pines also occur in other parts of the park, particularly in southwest half of the box elder disturbed forest of polygon 77. These are well spaced trees and occur within a matrix of poor quality woods dominated by box elders.

The dense pine stands are in poor condition due to close spacing (3 to 5 foot spacing): their root systems are too crowded and the trees are shading each other. Many pines are also being shaded by neighboring deciduous trees. The pines in these conditions have very few branches with needles. Thinning the pine stands would allow the remaining trees to have more space to grow, develop stronger root systems and become larger, healthier trees.

A portion of the pine stands are close to cut banks of the Mississippi River, where trees are falling over into the river. Though pine stand thinning will produce stronger healthier trees with larger, more fibrous root systems, it is unlikely that pine stand thinning will

have much influence in deterring riverbank erosion along the Mississippi River's edge, however, as pines are shallow-rooted with roots confined to the top 36 inches of soil (Olson, pers. comm.)

There are a few large white pines also on sandy floodplain terraces but they are widely spaced and were not mapped separately from the surrounding box elder disturbed forest (polygon 79).

Management Comments:
1. Identify and control thickets of common buckthorn and honeysuckle.

2. Thin out dense pine stands to promote healthier trees. 10 x 10 foot spacing between trees will promote healthier stronger trees (see discussion above). Martin and Lorimer (1996) recommend that red pines with a diameter of 6 inches be thinned to 450 trees per acre, which is greater than 10' x 10' spacing between trees. In thinning pines, the smallest and least healthy trees should be cut out. Thinning to 10 x 10 foot spacing will involve removing more than half of the existing trees in the dense pine stands. A small sign explaining to the public that this is for the good of the remaining trees may be a good idea.

Planted Spruce

These are planted stands of white spruce on high, river sand deposits on floodplain terraces. Areas of dense, closely-spaced spruce trees have heavy shade, dense needle litter and few other plant species within them. Many trees are very small and are being over topped and shaded by deciduous trees (American elm, box elder, silver maple, hybrid black willow). Numerous small, shaded spruce in the stands are dead. Other mid-size spruces completely lack needles except for a few small branches at the tops of the trees where they reach small light gaps.

Though the dense spruce stands in the park are larger than the red pine stands, it appears that the spruces are more prone to overtopping and are dying off at a faster rate than the pines. Several dense stands along the paved trails are persisting because they are in permanent light gaps created by the trail corridor.

Management Comments:
1. Monitor and control buckthorn and honeysuckle.

2. Remove dead spruce trees and thin the stands to allow the remaining trees more space and light.

Disturbed Woods

These are highly degraded areas on sites exposed to much human disturbance. In general they consist of a mixture of early successional tree species particularly cottonwood and box elders, large patches of old field exotic grasses, other exotic weeds such as burdock and buckthorn, and patches of brush particularly black raspberry and staghorn sumac.

- Polygon 92. This is an area of young trees and brushy old field on steep slopes constructed for Shepard Road along the east end of Crosby Lake. Young cottonwoods are the most common trees. Other abundant trees are small American elm, green ash, and box elder. Siberian elms are scattered throughout open areas on this slope. Black locust lines the uppermost edges of the slopes and is invading down slope. Garlic mustard is very dense in large parts of the slope. Other exotics present in bromy open areas include: amur maple, burdock, dandelions, and exotic grasses especially smooth brome and Canada bluegrass. Tartarian honeysuckle and buckthorn are scattered throughout. There are large patches of dense shrub thickets, including staghorn sumac clones.

- Polygon 96: west of Watergate Marina. The perimeters of this patch of floodplain consist of earth that was dug out of the river bottom to create the two inlets that border the polygon. These spoils are dominated by the invasive exotic tree black locust, and have abundant other invasive species including siberian elm, box elder, buckthorn and staghorn sumac. The interior of this rectangular polygon contains a remnant of disturbed floodplain forest dominated by cottonwoods, including a small patch of tall, straight trees. Much of the area has dense sub-canopy to canopy sized box elders and a high concentration of buckthorn. This area should be a priority area for buckthorn and other exotic species control (see Figures 12 and 13, and project # 2 in the recommended restoration projects). Planting native floodplain forest trees would greatly improve the condition of the habitat. A management plan for Watergate Marina will be completed in early 2005 that addresses the condition and restoration of this portion of the floodplain forest in much greater detail.

<u>Management Comments for polygon 92:</u>

1. Monitor and control invasive exotics: buckthorn, honeysuckle, Siberian elm, black locust (see Appendix C).

2. Actively discourage off-trail use by visitors and their pets, such as by blocking access to closed travel routes and posting signs.

3. Eliminate brush thickets. For sumac, this involves cutting twice a year at flowering time and treating cut stumps with Roundup (see Appendix C).

4. Plant trees into existing large gaps or gaps created by cutting and stump treating box elder (see potential projects section). Protect the planted trees with tree mats. Plant mostly bur oak and white oak which are less susceptible to oak wilt than red oak.

Management Comments for polygon 96:
Follow the same recommendations as above, but because this stand is on the floodplain the appropriate tree species for planting would be basswood, silver maple, green ash and hackberry. Bur oak could also be planted in unshaded areas on the berms, as it naturally occurs in better-drained portions of floodplain forest stands. Do not plant swamp white oak, a species that does not occur in this portion of the Mississippi River Valley.

Cattail – Bur Reed Marsh

Emergent marshes surround both lakes in the park. Many parts of the marshes were not marshes in 1940, as the photo shows that Crosby Lake was much smaller than it is today (Figure 5). These marshes are dominated primarily by narrow leaf cattail, an invasive species from eastern North America that did not originally occur in Minnesota. Unlike the native broad-leaf cattail, this species forms very dense, mono-specific stands. Its invasion throughout our region has been linked to nutrient enrichment (particularly nitrogen) from storm water runoff. Much of the narrow-leaf cattail thickets have very little plant diversity in the park. Patches of other species are scattered throughout the cattail stands, including frequent patches dominated by giant bur reed, and less frequent areas dominated by lake sedge or broad-leaved arrowhead. Softstem bulrush commonly forms a zone along the edge of open water. Wild rice occurs in deeper water than other emergents in Upper Lake. Other frequent graminoids in the marshes include giant manna grass, bluejoint, and fowl meadow grass. Several wetland forb species are common, including great water dock, tufted loosestrife, swamp milkweed, and water smartweed.

Reed canary grass frequently intermixes with these marshes in the park, particularly on the edges of dense, mono-specific reed canary grass zones. Crosby Lake's water levels in 2004 were significantly lower than in recent previous years, as evidenced by newly exposed mud flats on the margins of the lake, which is causing a shift in cattail marsh and reed canary grass zones. Narrow leaf cattail is colonizing newly exposed lake beds formerly occupied by water lilies on the margins of the lake. Also, it appears that reed canary grass is invading areas of cattails, particularly on higher ground away from the lake where less standing water is present than in previous years.

Purple loosestrife is present in marshes all the way around both lakes. Biological control insects have been released in the past to control this species in the park. It appears that the purple loosestrife population has been set back, as infestations are not as dense as they have been in the past. In 2004, there was evidence that the insects are still actively eating the plants. The populations of control insects and purple loosestrife will follow

boom and bust cycles in the future. Purple loosestrife will never be completely eradicated from the park but the control organisms should keep it from overrunning the park and allow other marsh species to dominate (Skinner, pers. comm.).

- Polygon 107; on the middle of the north side of Crosby Lake. This is a white sand delta formed by storm water erosion into the St. Peter Sandstone on the bluff face. Reed canary grass dominates the highest parts of the delta along the forest margin. Close to the lake, the delta is dominated by *Juncus* sp. with much boneset, giant sunflower, small sand-bar willow, small amounts of narrow leaf cattail, and marsh spike rush. This sandy spit may well undergo succession to shrub swamp dominated by sand bar willow and then eventually be colonized by cottonwoods and hybrid black willows.

Management Comments:
1. Where possible, mitigate areas of silt deposition from storm water runoff by redirecting runoff water. Excessive bluff erosion greatly contributes to siltation in the lake basins and reed canary grass invasion.

Sedge Meadow

A surprising find in this inventory was a few small areas dominated by native wetland sedges. The major dominant sedge species in these areas is lake sedge. Other sedges that are also present in some of these areas include beaked sedge, tussock sedge and aquatic sedge. Accompanying these sedges are other graminoids, including fowl meadow grass, bluejoint, giant manna grass, giant bur reed, and sweet flag. Typical forbs found in these areas include boneset, spotted joe pye weed, tufted loosestrife, spotted touch-me-not, giant water dock, bulbous water hemlock, marsh fern, sensitive fern, and broad-leaved arrowhead. These areas have some reed canary grass infestation and are surrounded by heavy reed canary grass. Because reed canary grass has been in the park's wetlands for a long time, these wet meadows probably represent a few small wetland areas that do not contain ideal conditions for complete reed canary grass invasion. These areas are located away from the lake's edge and are less exposed to lake water fluctuations, silt deposition from storm water runoff, or Mississippi River flooding than other wetlands in the park.

- Polygon 112. This is a small area of wet meadow surrounded on 3 sides by lowland hardwood forest. Reed canary grass occurs on the edges.

- Polygon 113, along the north side of Crosby Lake. This is the largest and highest quality sedge meadow remnant in the park. The meadow occurs on saturated soils with groundwater seepage on the edge of a black ash seepage swamp. This area is dominated mostly by lake sedge with much narrow leaf cattail, bluejoint, fowl meadow grass, sweet flag and sand bar willow. A few plants of the broad-leaved

cattail (*Typha latifolia*), the native, non-invasive cattail species, are also present here. This species was probably one of the dominant emergent marsh plants in the area but has been largely displaced by the invasive narrow-leaf cattail and reed canary grass. Further south, toward the lake, beaked sedge becomes more dominant. Further lakeward, the meadow then grades into a marsh dominated by giant bur reed, narrow leaf cattail, softstem bulrush and marsh spikerush. Reed canary grass is absent from most of the meadow but is abundant on its margins within 20 meters of the lake's edge.

Management Comments:

1. Ameliorate where possible conditions that promote the invasion, expansion and takeover by reed canary in these meadows – particularly in polygon 113. This should include monitoring for silt deposition via erosion from up slope.

2. Selectively remove the scattered reed canary grass in both sedge meadow areas. Good results have been obtained with the following method (Gaynor, 2004):

- cut reed canary grass in June with a brush saw fitted with a grass blade just after it has sent up flowering stems – leave cuttings in place
- if surrounding vegetation arches over the reed canary and shades it, then follow-up spraying might not be necessary
- follow-up spraying: spray or wick apply Roundup (or Rodeo if near open water) to the previously cut reed canary after in Late September or early October

3. Consider selective removal of clumps of narrow leaf cattail. This could be accomplished by winter cutting in areas that flood in the spring (cut as low as possible – water above cut tips in the spring will kill the plants); or by selective application of Roundup (or Rodeo if near open water) onto plants using wick or glove application (method described in fact sheet, Appendix C).

Willow Swamp

Three areas in the park are mapped as willow swamp: one at the far northeast end of the park and two between Upper and Crosby Lakes.

- Polygon 114: This is a small area of willow swamp that has undergone significant reed canary grass and narrow leaf cattail invasion. Away from Upper Lake, common shrubs include sand bar willow, false indigo and red osier dogwood. Lake sedge is present and probably dominated before reed canary and narrow leaf cattail invasion. Tussock sedge dominates along the margin of Upper Lake. Aquatic sedge is also present near the tussock sedge hummocks. Areas of greater standing water have less reed canary grass infestation. Other wetland graminoids present here include softstem bulrush, black bulrush, marsh spikerush, giant bur reed and reed grass. Other wetland plants include broad-leaved arrowhead, bulbous water hemlock, and water smartweed. Purple loosestrife is present.

- Polygon 115: This area sits on wet, sandy soils on the edge of the Mississippi river at the far east end of the park. The site is dominated by a dense thicket of hybrid black willow and sand bar willow saplings averaging approximately 2 meters tall. Lake sedge occurs throughout the thicket. Other plants present include Ontario aster, silver maple seedlings, broad-leaved arrowhead, Virginia wild rye, ironweed, and river grape. This area is being invaded by trees, particularly cottonwood and silver maple, and will succeed to floodplain forest dominated by those two species. This follows the typical process of point bar succession in which trees invade willow thickets, as discussed by Noble (1979).

- Polygon 122: This is a small cluster of sand-bar willows within a dense sward of reed canary grass.

Management Comments:

1. Allow continued succession to cottonwood forest in polygon 115.

Reed Canary Grass

These are large wetland areas that have become completely overrun with the exotic reed canary grass. On the margins of the two lakes, reed canary grass occupies a zone of wet soils that are not flooded throughout the growing season. Thus, it occupies a position between emergent marsh (cattails, bur reed, bulrushes) and edges of the forest. In 2004, this zone appears to be expanding lakeward as the water levels in 2004 are significantly lower than they were in the 2003 aerial photography. Newly exposed mudflats adjacent to the water's edge are losing water lilies and are being invaded by narrow leaf cattail. Former cattail beds in areas that no longer have standing water are being invaded by reed canary grass. Other areas with heavy reed canary grass in the park include several wetland basins on the floodplains and numerous other scattered areas that have little shade and moist silty soils.

Conditions that promote reed canary grass infestation include: frequent large fluctuations in water levels, nutrient enrichment (especially nitrogen) from runoff, silt deposition from upslope erosion or heavy flooding, and import of reed canary grass seed which floats and is readily transported by water. These conditions are all supplied in abundance by storm water flow into the park. To some extent, heavy flooding of the Mississippi and Minnesota Rivers also promotes reed canary grass by adding areas of bare silt. Thus, changes in conditions that promote heavy reed canary grass infestations will require some large scale engineering solutions to storm water runoff that cause erosion and deposition of soil in the wetlands and large scale lake level fluctuations. Until such solutions are implemented it is not feasible to attempt any large scale removal of reed canary grass to convert it to another wetland type.

Planted Prairie

This is an area of prairie plantings adjacent to parking lots at the west end of the park. The soils of this area are mesic to wet-mesic and formed in excavated fill put in place from past construction activities. These plantings have a number of native prairie species mixed with heavy infestations of exotic species (see species list). Exotics include Kentucky bluegrass, smooth brome, quack grass, red top, reed canary grass, Canada thistle, sweet clover, and dandelions. A recommended process for restoring this planting is given as project #9 in the restoration recommendations section, and a list of species recommended for planting is in the mesic prairie list in Appendix B.

Management Comments:

1. Continue to hand pull or spot spray Canada thistle. Canada thistle populations greatly expand in cool wet years and contract in dry years. Thus the summer of 2004 was a good year for it.

2. Monitor and remove buckthorn and honeysuckle.

3. Treat heavy populations of exotic grasses and plant a diverse assemblage of prairie forbs and grasses. Steps to accomplish this are presented in project #9 in the section on proposed restoration projects.

Old Field

Areas of ground dominated primarily by the exotic grasses smooth brome and Kentucky bluegrass.

- Polygon 139. This is a narrow strip of land with shallow soils over limestone bedrock. It is located along the top of the limestone/sandstone cliffs along the entrance to the parking lots at the west end of the park. This area is dominated primarily by smooth brome grass. Several invasive trees and shrubs are scattered throughout this strip: buckthorn, staghorn sumac, Siberian elm, eastern red cedar, Russian olive, and lilacs. Exotic herbs are also common: Canada bluegrass, catnip, butter and eggs, spotted knapweed, and white sweet clover. A small patch of big bluestem is present. Several native prairie plants have also persisted in the strip: false boneset, stiff goldenrod, smooth aster, heath aster, butterfly weed, prairie rose, woodland sunflower, Jerusalem artichoke, and grey coneflower. These plants are evidence of the oak savannas that occupied the high terrace above the bluffs at the time of Euro-American settlement.

- Polygon 148, engineered slope along Shepard Road east of I-35. This slope is dominated by very weedy, invasive exotics including smooth brome, crown vetch, leafy spurge, black locust, reed canary grass, quack grass, Canada thistle, smooth sumac, Siberian elm, parsnip, hoary alyssum and burdock. Big bluestem and wild bergamot are also present.

Management Comments:

1. Monitor and remove buckthorn and tartarian honeysuckle.

2. Re-construction of oak savanna in old fields between Shepard Road and the bluff slopes would help buffer the native woods on the bluff slopes and enhance the scenery along the bike trail (see project #10 in the proposed projects section).

3. Control invasive exotics in these areas, especially spotted knapweed, leafy spurge and Canada thistle (see Figure 13 and Appendix C).

Disturbed Ground

These are areas that are highly disturbed by human activity, mainly the recent redesign of the I-35 bridge and the storm sewer drainage construction located just west of I-35.

- Polygon 134; long narrow gap cut through floodplain forest east of I-35. This is an open, largely treeless line constructed for a storm sewer line that outlets on the edge of the Mississippi River. Presently the gap is dominated mostly by a dense thicket of invasive and weedy species including much reed canary grass, common nettle, Canada thistle, and burdock. Tree seedlings that have invaded the gap include American elm, green ash and box elder. Over time, this polygon will revert to forest; periodic culling and stump treating of box elder would promote greater green ash and silver maple cover.

- Polygon 151; former bridge construction site along the Mississippi River. Floodplain forest vegetation was removed and the land was compacted with heavy equipment for use as a lot for machinery used in the 2004 reconstruction of the I-35 bridge. The Minnesota Department of Transportation plans to revegetate this area as part of the bridge reconstruction project. Replanting should be to cottonwood-silver maple floodplain forest. After replanting of the site, box elder and buckthorn invasion of the site should be monitored and halted by periodically removing seedlings that invade the site.

Management Comments:
1. Monitor and remove invasive species, particularly buckthorn and honeysuckle.

2. Bridge Construction Site Remediation: Convert this area of bare, highly compacted ground (inventory polygon 151) back to native floodplain forest. This site is already planned for remediation as part of the bridge construction contract.

Recommended Procedure:

Timing	Activity
Before planting	Run over the whole site with a 3 foot chisel plow to loosen the soil. This will be necessary to allow the roots of planted trees to expand horizontally
Late June	Plant containerized or burlapped trees at 8 foot by 10 foot spacing. Water the plants well. Put fabric tree mats around the bases of the planted trees and stake them into the soil. If tree seedlings are used instead, plant at a minimum density of 4 x 5 foot spacing.
	If a native grass cover is needed to stabilize the bare ground after tree planting, choose a native species such as Virginia wild rye.
2-3 weeks later	Re-water the planted trees at least once as needed.
Rest of the season	Mow the area a couple of times to keep weeds down. Or spray out weeds near trees with Roundup.
Year 2	Monitor trees; mow if necessary; replant if some trees fail

Comments:
Time the planting for late June to minimize the chances of a large flood event that would wash trees out of the site. Plant early in the year to give the trees the greatest chance of getting rooted in the ground before the following spring. Desirable species include: Cottonwood, silver maple, green ash, basswood and hackberry. Obtain local genotypes if at all possible. Trees can be obtained from the DNR nursery.

Site acreage = 2.4 acres or 104,544 sq. feet. At 8 x 10 foot spacing, 1307 trees are needed.

At 8 x 10 foot spacing, you should get tree canopy closure within 5 years.

A 4 inch layer of wood chip mulch over the entire site would be a good idea but a high flood event in the following spring would wash the mulch away.

Mowed Lawn

Areas of Kentucky bluegrass that are maintained as lawns.

Developed Land

These areas consist of parking lots, park shelters, I-35 and associated construction, access roads, and boat marina.

Sandy Riverbank

These areas consist of sandy beaches and cut banks along the Mississippi River. Portions of the cut banks are being undercut by the river during river flooding. Trees growing along the river's edge are being undercut and toppling into the river. This is a natural process though it is somewhat accelerated in recent decades by larger more frequent floods as a result of wetland ditching and tile drainage throughout the Mississippi and Minnesota River watershed basins.

Thinning of the dense pine and spruce stands along the river's edge will enable those trees to become healthier and develop larger root systems. These trees are very shallow rooted, however, and stronger root systems are unlikely to have much benefit in resisting severe bank undercutting when the river is in flood.

Open Water

This unit corresponds to open water in Crosby and Upper Lakes in 2003 aerial photography. A survey of the aquatic vegetation of the lakes was not in the scope of this report.

Plant Community Quality Ranks

The condition of land cover types in the 2004 inventory was summarized in a scale ranging from A to D and mapped in figure 11. This scale is loosely based on the methodology used to rank native plant community occurrences by the Minnesota DNR, but does not use the same criteria. The criteria used in this inventory are as follows:

- A: Excellent: Areas of native plant communities undisturbed by modern human activity.
- B: Good: Areas of native plant communities with moderate disturbance but nearly intact species diversity. This includes floodplain forest stands that have recovered continuous tree canopy cover.
- C: Fair: Areas of native plant communities with high past disturbance or invasion of exotic species that has significantly reduced native species diversity and altered community structure.
- D: Poor: Not an example of a native plant community. Dominated by invasive or exotic species with a very low diversity of native species. Includes formerly cultivated, cleared, or constructed sites.

Crosby Park has had moderate to severe disturbance from past human activity. A few places in reasonably good condition (B rank) include the forested areas of high herb diversity at the west end of the park, and tracts of floodplain forest with a continuous canopy of mature silver maples. Most of the bluff slopes are in fair condition (C rank) due to past logging and grazing, buckthorn invasion and slope erosion. D ranked areas include most of the floodplains that were cultivated, the engineered slopes along Shepard road, marshes now dominated nearly exclusively by narrow leaf cattail, and areas of heavy reed canary grass infestation.

Figure 11: Condition of Native Plant Communities at Crosby Park

Potential Management and Restoration Projects

Summary:

Crosby Farm Regional Park was highly degraded in the past by farming and is currently undergoing an onslaught of many different disturbances. This section lists and discusses ten potential management or restoration projects intended to prevent further degradation and maintain and improve the quality of the park as a natural area and place for recreation. The ten projects are listed below in approximate order of their immediate need.

The first two projects are absolutely critical to maintaining the park's existing natural habitats and should be undertaken as soon as possible.

1. Bluff slope erosion control

2. Continued monitoring and control of invasive species

3. Bluff trail redesign and reconstruction

4. Bluff slope revegetation and floristic enhancement

5. Mesic forest ravine garlic mustard control

6. Bluff slope oak forest canopy closure

7. Floodplain forest restoration

8. Forest restoration on the Shepard road bluff slope

9. Parking lot prairie management and enhancement

10. Terrace savanna reconstruction

Project Descriptions:

1. Bluff Slope Erosion Control

Goal: Stop excessive erosion of the bluff slopes from storm water runoff and off-trail traffic. This report documents numerous locations on the bluffs with excessive gullying and erosion (figures 7 and 8). These erosion sites are where storm sewer outlet pipes empty at the top of the bluff slope, where un-piped surface runoff water channelizes and runs into the bluff slope ravines, and where people have repeatedly gone off of the trail on to erosion-prone areas such as sandstone exposures. The bluffs have numerous instances of extreme erosion that is undercutting and toppling trees on the bluffs, washing out portions of the bluff slope trails, denuding native vegetation, promoting exotic plant invasion in the bluffs and wetlands, and depositing large amounts of soil and sand into Crosby and Upper Lakes. Excessive bluff slope erosion needs to be solved before other urgent problems can be solved, most notably the bluff trail reconstruction.

An engineering study of the causes and solutions to the bluff slope erosion from excessive stormwater runoff is urgently needed before major steps to curtail erosion can be undertaken. Potential solutions may involve expanding the stormwater catchment area that feeds into the drains that empty at the bases of the bluffs; piping or otherwise conveying water down the bluff slope from outlets that end at the top of the bluff; and installing pipes to convey to the floodplain channelized surface water not captured in storm sewers.

2. Continued Monitoring and Control of Exotic Species

Goal: Prevent invasions of exotics; reduce/eliminate populations that already exist in the park.

One of the most degrading forces in native habitats is the continual onslaught of exotic plants. These plants crowd out native plants, degrade the quality of the habitats for wildlife, and promote bare soils susceptible to erosion. St. Paul Parks and Recreation staff have made tremendous strides in reducing the load of exotic plants in the park where possible. This work needs to be continued on an annual basis because more individuals of these exotics will continue to invade the park. Limiting off-trail use by walkers, bikers and pets, which degrades native habitats and promotes exotic species establishment, is also an important component of exotic species control in the park. Below is a summary and brief comments about particular species of concern. Fact sheets with detailed information on the control of these species are given in Appendix C.

General approach to invasive management

Management of invasive species, typically exotic, is a major concern of resource managers, and typically requires a great deal of resources. This has been the case for many years, and by all indications will continue to be a major focus and resource drain for managers in years to come. While techniques are improved and efficiency increases, new exotics are reaching the Twin Cities Metro every year. Wild parsnip and Queen Anne's Lace are two examples of exotics working their way up from the south. These are very invasive in Wisconsin and Illinois.

While management of each species is unique, and covered elsewhere in the report, a general approach to exotic management should include preventing exotic species invasions, as prevention is much easier and cost-effective than mop-up. Vigilance, plant identification, and keeping up with new exotics is key. If a new species reaches your site, attacking it fully is recommended. The wisdom of doing so is not always apparent to untrained personnel, so you may have to train and explain. Adopt a zero tolerance mandate for new invasives.

For species already present, a 3- pronged approach is best. Adopt a zero tolerance for an exotic expanding into new areas of your site. This means zero seed set in these expansion areas. The second prong is to start shrinking the range of the exotic. Perimeter populations and newly established populations are easier to control and should be a priority. The third prong is to weaken for several years the core population of an exotic. For prolific seed producing species such as garlic mustard and spotted knapweed, reducing the seed set is key. Zero tolerance at the worst infestations is not reasonable; adopt a more reasonable tolerance level – 90% reduction for example – for several years. If you are able to maintain that level of control, then increase the attack to zero tolerance of the species. These are multi-year approaches.

Great River Greening also believes that in general resource managers do not pay enough attention to seed vectoring. After working a garlic mustard invasion, for example, boots should be cleaned and even footwear should be changed. Contact GRG for more information on our demonstration projects for individual exotic species.

Biological control, while holding much promise, so far has just been one of 3 tools to help control species. Purple loosestrife control is the one that is most advanced in Minnesota – and the experts are predicting that it will follow a boom-and-bust cycle. Repeated releases of bio control may be required after the bust cycle if the bio control does not persist on its own. In short, for now consider bio control as one of your tools, not an ultimate tool.

Comments on specific species

Common buckthorn:
Major progress over several years has been made in removing areas of very dense buckthorn infestation. This is critically important, as buckthorn causes extreme damage to native forest herb communities. Much work remains to be done, as a few dense areas still exist and other areas of young, more scattered plants are common (see figure 12). The continual seed rain of buckthorn seeds via the avian gastro-intestinal route into the park means that this work will have to be continued in the future. Greater tree canopy closure and shade in the park's forests in the future will lessen the extent of buckthorn infestations, as buckthorn is a light dependent species.

Tartarian honeysuckle:
Tartarian honeysuckle is also scattered throughout the park, and tends to co-occur with buckthorn. Large thickets were not seen in the park and so this species was not mapped. Control of this species is also needed. It can be more difficult to kill than buckthorn.

Garlic mustard
Garlic mustard occurs throughout the park and it did not make sense to map it. Levels of infestation are the densest on the bluff slopes. In floodplain forests, garlic mustard occurs primarily in areas of thin wood nettle cover. Overall control of garlic mustard in the park is currently not feasible. Research is currently being conducted to identify a biological control organism for this species – it should be released if and when a suitable organism is eventually identified and available. In the meantime, control of small patches of garlic mustard should be conducted through frequent cutting and/or pulling to prevent it from setting seed. Priority areas for control of small patches are areas of greatest diversity and abundance of spring ephemeral and other forest wildflowers in areas of mesic oak forest (see the mesic ravine project #5 below for discussion on mechanical control of garlic mustard).

Leafy spurge
Leafy spurge occurs primarily on the Shepard Road slopes east of I-35 (figure 13). This species should be treated and removed soon, as it is much easier to control recently established plants than long-established populations.

Siberian elm
This species is scattered along the top edge of the bluffs, in old fields and disturbed woods, and in small openings on the floodplain.

Purple loosestrife
This species is being controlled with biological control organisms. The population will boom and bust according to fluctuations in control organism populations. Priority areas for control should be sedge meadow remnants.

Reed canary grass
This inventory documents large areas of dense reed canary grass infestations. Much of the dense reed canary grass areas on the margins of Upper and Crosby Lakes are here to stay, as they are promoted by large scale conditions of high nutrient inputs, high water fluctuations, invasions of seed, and wetland siltation that are very difficult to resolve. It is, however, a good idea to remove reed canary grass from the small areas of sedge meadows and black ash seepage swamps. These small communities have not yet been overrun by reed canary grass and are some of the more unusual native habitats in the park.

We recommend the following approach to controlling small patches of reed canary grass:

- cut reed canary grass in June with a brush saw fitted with a grass blade just after it has sent up flowering stems – leave cuttings in place
- follow-up spraying: spray the previously cut reed canary in Late September or early October using Roundup (or Rodeo if near open water). Be very careful to make sure herbicide does not touch other species.
- Recheck the areas in following years to assess the effectiveness of this approach and repeat control measures as needed.

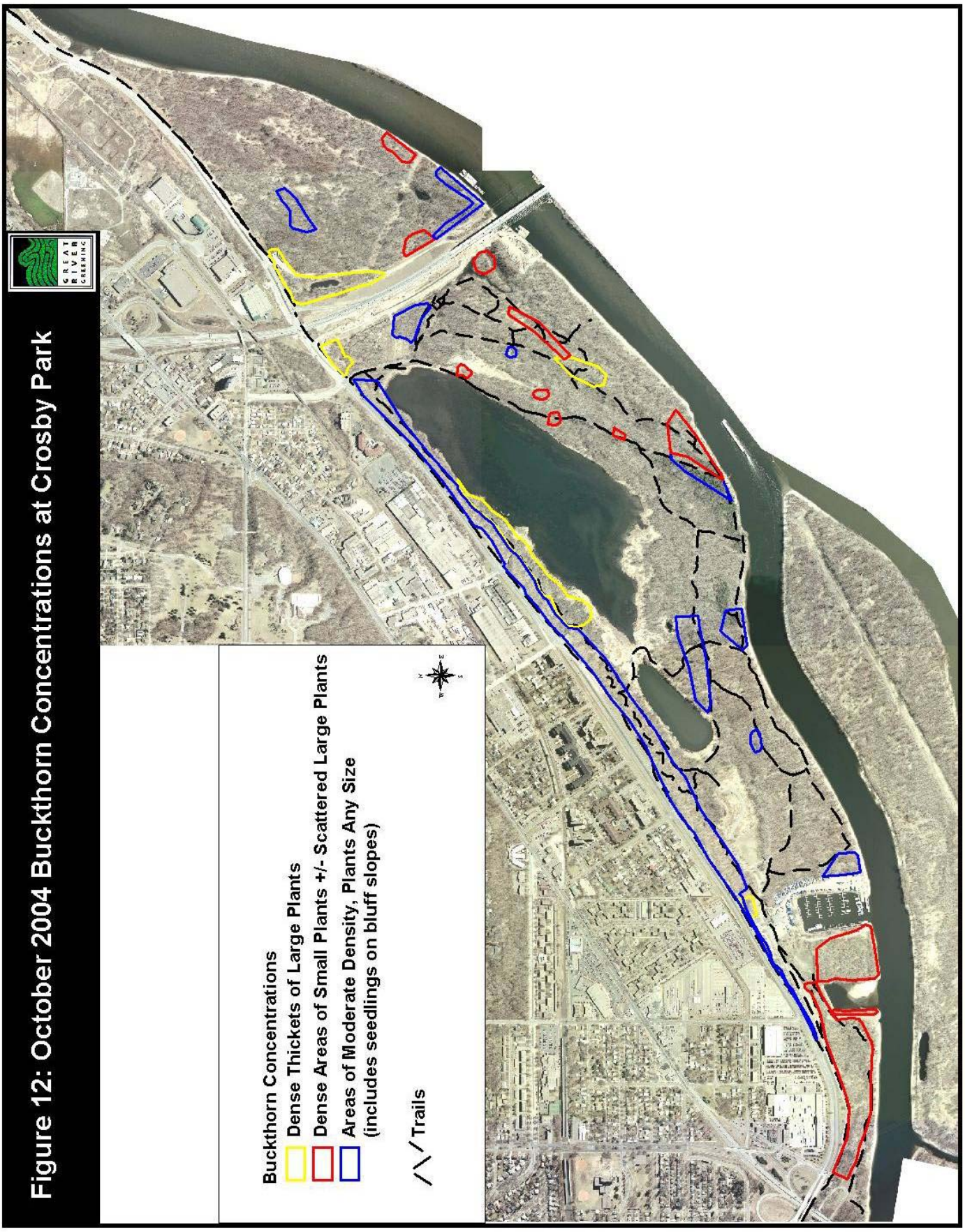


Figure 12: October 2004 Buckthorn Concentrations at Crosby Park
GREAT RIVER GREENING
Buckthorn Concentrations
Dense Thickets of Large Plants
Dense Areas of Small Plants +/- Scattered Large Plants
Areas of Moderate Density, Plants Any Size
(includes seedlings on bluff slopes)
Trails

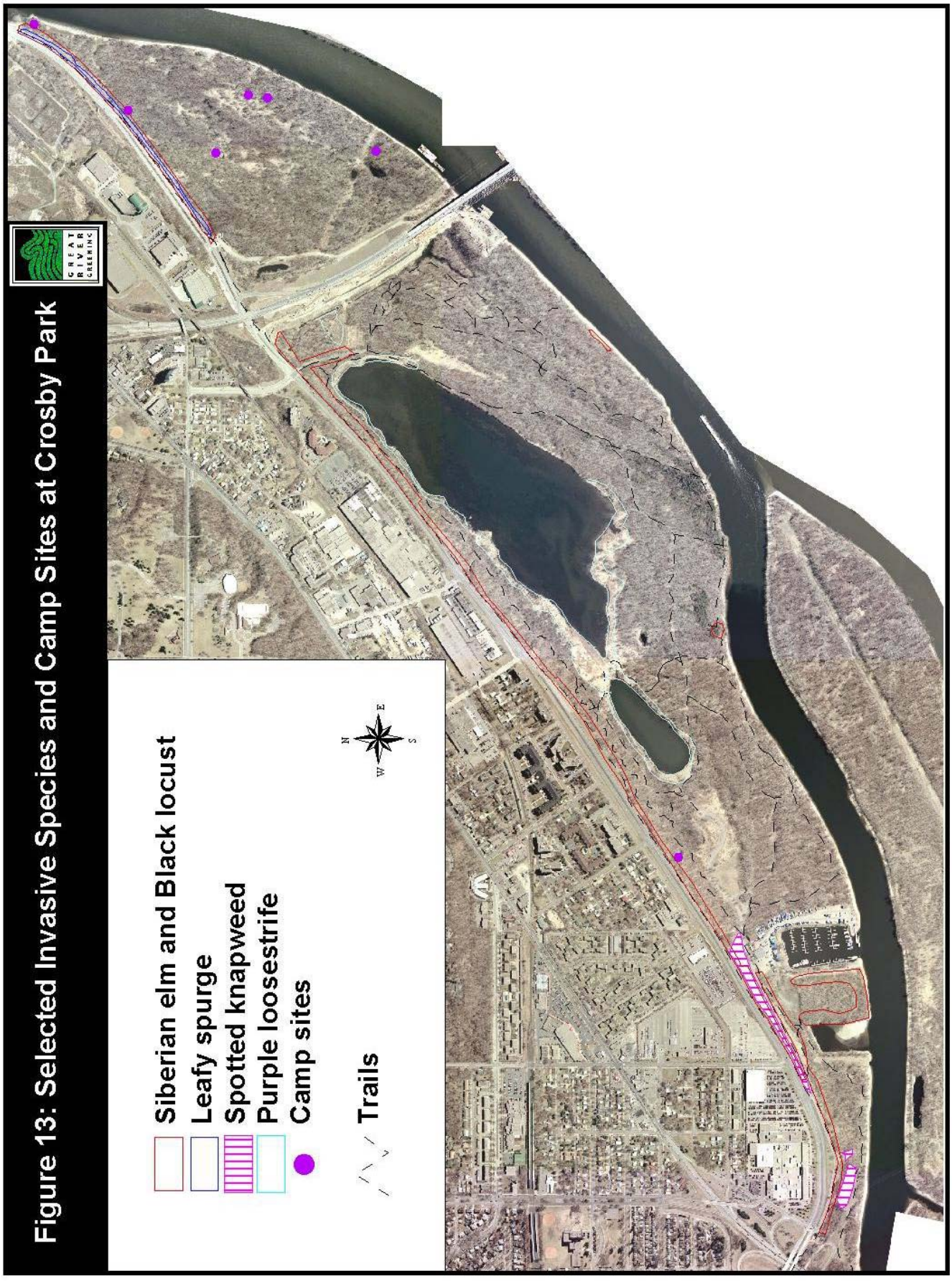


Figure 13: Selected Invasive Species and Camp Sites at Crosby Park
GREAT RIVER GREENING
Siberian elm and Black locust
Leafy spurge
Spotted knapweed
Purple loosestrife
Camp sites
Trails
N
E
W
S

3. Bluff Trail Redesign and Reconstruction

Goal: Rebuild bluff trails that have become severely degraded and close off areas of off-trail traffic that are eroding the bluffs and promoting exotic species invasions.

Portions of the trails on the bluffs on the north side of the park have become degraded from soil erosion and the decomposition of building materials in the trails. These problems stem from excess storm water runoff, heavy trail use and off-trail traffic over 30 years. Please see the companion report to this report entitled "Crosby Park: Bluff Trail Study" (Shaw et al. 2004) for an analysis of the trails and recommendations for their restoration. Much of the trail restoration work depends on first solving large scale problems from storm water runoff.

4. Bluff Slopes Forest Soil Stabilization and Floristic Enhancement

Goal: Plant forest herbs into the woods on the bluff slopes in order to help stabilize the bare soils, enhance the plant diversity and visual appeal of the bluffs, and improve wildlife habitat. This work should not be done in areas where major erosion problems from storm water runoff are promoting erosion of steep slopes until those causes of erosion are resolved.

Where: The best parts of the bluff slopes for planting are areas of the most intact dry-mesic oak forest and mesic ravines that are not undergoing obvious erosion from storm water runoff and are not in the path of human traffic.
Best places to start:

- Inventory polygon 1 (slopes west of the marina)
- Inventory polygon 2 west of Upper Lake

Recommended Procedure:

Timing	**Activity**
	Identify a target area for replanting.
Fall	Cut and treat any buckthorn or honeysuckle that may be present in the target area – even small seedlings
before planting	Add topsoil to areas where surface soils have been washed away.
before planting	On very steep areas with surface erosion, consider placing biodegradable erosion fabric on the site to help stabilize the soil while plants are taking root
late April after thaw	Plant and water bare root seedlings (if available) of woodland herbs (refer to dry-mesic forest species list in Appendix B for suggested species)
2 weeks later	Re-water planted seedlings if necessary – keep plants moist for 3 weeks
May	Cut garlic mustard as it starts to flower with weed whips (see method below)
June	Plant potted seedlings of woodland herbs if bare root seedlings are not available
June	Re check garlic mustard and re-cut if necessary
Following months	Monitor success and establishment of herbs. Note which species are doing the best and which are not establishing
Next May	Return and cut garlic mustard in the plot;

Comments:
There are many areas of fairly bare soils on these bluffs. Many possible causes for these bare soils include: past over-grazing, unstable sandy soils on super steep slopes, sheet erosion by storm water runoff, past heavy buckthorn cover, possible digging by wildlife seeking acorns, herbivory by deer, and earthworms.

Earthworms have received a lot of attention lately as another cause of the loss of forest herbs in many woods in the state, as they consume the organic duff required by many wildflowers. In 2001, a preliminary test for earthworm infestation did not find many earthworms. Also, the highly abundant earthworm castings on the soil surface, typical of a woods with heavy earthworm infestation, was not seen on the bluffs.

Because of the many possible causes for the bare soils, we cannot predict for sure the outcome of planting herbs on these slopes. Nevertheless, it is definitely worth a start in one or two test plots to see what happens. Because this is of some research interest to the larger restoration community, an experimental approach may be a basis for getting funds for the work. Great River Greening is actively testing the methodology and outcomes of forest groundlayer revegetation and can assist with obtaining funding and conducting this work.

Early in the growing season, plant bare root or containerized seedlings of plant species that are suitable for the bluffs. Bare root stock is available from just a few suppliers, such as Prairie Moon Nursery, very early in the spring. Appropriate plants for sandy, well-drained soils on upper slopes and the tops of spur ridges are listed in Appendix B under dry-mesic oak forest. Plants appropriate for moist, clayey soils, mesic ravines and lower slopes are listed in Appendix B under mesic oak forest. Any plants that survive once planted will be useful for stabilizing the soil surface. Plants that may be particularly useful for stabilizing loose soils are species that spread vegetatively above or below the ground surface. Examples of these herb and climbers are:

Species	**Scientific name**	**Microhabitat**
Canada moonseed	*Menispermum canadense*	moist, well shaded ground
Common strawberry	*Fragaria virginiana*	open to semi-shade on dry to dry-mesic ground
Golden alexanders	*Zizia aurea*	dry-mesic ground in open to partial shade
Hog peanut	*Amphicarpaea bracteata*	dry to dry-mesic ground in partial shade
Long-stalked sedge	*Carex pedunculata*	moist, heavy soils in heavy shade
Pennsylvania sedge	*Carex pensylvanica*	dry to dry-mesic ground in partial shade
Spreading dogbane	*Apocynum androsaemifolium*	dry to dry-mesic ground in partial shade to open sun
Sprengel's sedge	*Carex sprengelii*	moist, shaded sandy soil
Virgina waterleaf	*Hydrophyllum virginianum*	moist, well shaded ground
Virginia creeper	*Parthenocissus vitacea*	dry-mesic to moist ground in shade
White trout lily	*Erythronium album*	moist, mesic ground in partial to full shade
Wild ginger	*Asarum canadense*	moist, heavy shade
Wild sarsaparilla	*Aralia nudicaulis*	shaded dry-mesic ground
Zig-zag goldenrod	*Solidago flexicaulis*	dry-mesic to mesic ground in heavy shade

Start this project in a small part of the bluffs and then monitor the planted seedlings to see how well they do. Note which species are the most successful and which are not. Adjust the list of species for future plantings based on the results. Look for the following: evidence of herbivory

by deer, evidence of sheet erosion that has washed out plants, earthworm castings, and other factors that may prohibit herb seedling establishment. Fencing to exclude deer from a planted area would be useful for ruling out deer herbivory.

5. Mesic Forest Ravine Garlic Mustard Control

Goal: Concentrate garlic mustard control in areas of high spring ephemeral and other forest wildflower diversity in order to reduce competition and overcrowding by garlic mustard. Garlic mustard has gained a reputation for crowding out native herbaceous plants.

Where: Selected mesic forest herb ravines on bluff slopes, and lowland hardwood forest west of the marina. Priority areas are: inventory polygons 7, 8, 13 and 16.

Recommended Process:

Timing	Activity
Year 1 May	Cut garlic mustard with a weed whip when it begins to flower. Try cutting each plant into small pieces from the top down rather than just lopping it off at the base. Some practitioners have found that garlic mustard cut this way does not set seed. Pull whole plants out unless it causes too much disturbance to the soil surface. Remove whole plants from the site as they may set seed.
Year 1 3-4 weeks later	Monitor the cut plants 3-4 weeks later, as some managers have found it resprouting and reflowering at that time
Later in season	Check the plots to see how well garlic mustard was killed
Years 2-4	Return to the ravine and repeat above. You will be exhausting the native seed bank of garlic mustard, which may take a while because garlic mustard seed can be viable up to 5 years.
Years 2-4	Re-assess the results. Compare areas of garlic mustard control with areas of no garlic mustard control. Is this making any difference? Are the herbs in areas with no control disappearing?
Eventually	Release biocontrol insects for controlling garlic mustard; breathe a sigh of relief; hope for the best; now look for the next exotic invader...

This will have to be repeated several years in a row as the seed bank is exhausted. Because the area is saturated by the prolific garlic mustard, it will continue to seed itself into the control areas.

Eventually, release biocontrol organisms to control garlic mustard. Research to identify such organisms is currently underway at the MN DNR and Cornell University.

6. Bluff Slope Oak Forest Canopy Closure

Goal: Promote greater canopy cover in areas of dry-mesic and mesic oak forest.

This would enhance the native habitat for forest wildlife, especially forest-nesting songbird, help prevent invasion and expansion of buckthorn (a light-dependent species), and help stabilize bluff slopes. This work could be undertaken by identifying and working on 1-2 small target areas at a time. You could progress from one end of the bluff slopes to another. Planting more oaks would be an important step in revegetating areas of slope erosion after remediation.

Recommended Procedure:

Identify target areas to do this. These are:

- Places where oak seedlings or saplings are being overly shaded by invasive trees.
- Places where there are existing large canopy gaps or concentrations of invasive tree species lacking any oak cover.

Cut and stump treat invasive species in target areas: particularly box elder, cottonwood, white poplar, aspen

- Small trees can be left as standing dead trees. Standing dead trees are good for wildlife.
- In the case of aspen, aspen can be girdled or cut and stump sprayed with herbicide. Girdling is less labor intensive and done with a tool called a 'spud' made from a leaf spring or any similar tool that will not damage the meristem of the tree yet remove a strip of bark all the way around the tree.
- Larger trees should be cut down, particularly where they might fall on trails. With cut trees, leave large cut parts on the ground to decay and remove and pile slash for later burning

Plant seedlings or seeds of trees to fill in gaps where necessary. Priority species should be oaks: bur oak, white oak, northern pin oak on better-drained soils; red oak and white oak for more mesic areas. Basswood would be another species to consider planting. Do not plant sugar maple, as it is seeding itself in anyway and dense maple reproduction promotes bare soils.

- An excellent resource for information on tree seeding is in a recent publication from the MNDNR Division of Forestry entitled *Direct Seeding of Native Hardwood Trees: An Innovative Approach to Hardwood Regeneration* (MNDNR 2003).
- Some considerations:
    - Oaks need to be planted in open areas with a lot of sunlight
    - Collect large numbers of acorns in the fall when they drop from the trees (about August 20 for bur oak; later for red and white oak); soak them in water for 24 hours; then refrigerate the acorns until planting that fall
    - you should plan for animal foraging and plant at least ten times more acorns than you want trees.

Planting maintenance will be needed:

- Keep the sprouting trees from being shaded out
- Monitor and control weeds that may be out competing the seedlings for moisture

- Protect trees from herbivory by installing wire fencing around the tree and put protection devices (bud caps) on the terminal buds to keep them from being eaten by deer during the winter

Throughout the bluffs: locate, cut and stump treat female box elder trees. These trees are setting the seed that is invading and sprouting in gaps on the slopes.

7. Floodplain Forest Restoration

Goal: Replant formerly cultivated areas of the floodplain.

Large portions of the river bottoms south of Crosby and Upper Lakes, and east of I-35, were cultivated in the mid-1900s. Following release from cultivation, these areas were colonized primarily by box elder. Present day box elder stands in these areas contain very few seedlings or trees of tree species that compose an intact floodplain forest. As such, these areas constitute very poor quality habitat for native forest wildlife species. Also, natural succession to intact floodplain forest is occurring at a very slow pace – this appears to be due mostly to a lack of green ash, silver maple, hackberry and basswood trees that would be seeding in new trees.

This project would greatly accelerate the conversion of disturbed box elder stands on rises between flood channels to native floodplain forest. Recreating the native floodplain forest will substantially improve the quality and quantity of the park's habitat for forest wildlife by expanding the areas of continuous canopied forest and by reducing the fragmented nature of the currently existing floodplain forest stands. The recommended process (Olson 2004, Peterson 2004) involves planting floodplain forest trees into gaps cleared in the matrix of box elders. As the planted trees mature, they will shade out the gaps where they are planted and seed themselves into intervening spaces between planted areas. Areas where substantial shade is created will be released from invasion by box elder and buckthorn, which are very light dependent species. Choose target areas that lack seedlings of green ash, hackberry basswood, or silver maple.

Where: box elder disturbed and cottonwood disturbed forest stands:

- Priority 1: polygon 82: easiest access not blocked by flooded channels; can plant bare root trees here; most visible to the public; will directly buffer large stands with intact canopies (polygons 54, 44, 48)

- Priority 2: polygon 69: cottonwood disturbed stand adjacent to box elder stand 82; accessible in spring and can plant bare root trees. There will be fewer areas of box elder dominance to clear out in this stand than in the box elder disturbed stands.

- Priority 3: polygon 77: the next stand to the east; access also will not be blocked by flooded channels; can plant bare root trees here. Plant mostly in the portion of the polygon south of the trail that lack ash and hackberry seedlings.

- Priority 4: polygon 79: this is the second most disturbed of the 4 box elder disturbed stands. Access may be blocked by flooded channels in the spring; plant tree seedlings in late June after floodwaters have abated.

- Priority 5: polygon 80, located east of I-35: this is the most disturbed of the four box elder stands; most difficult access ; least used by the public. Access may be blocked by flooded channels in the spring; plant tree seedlings in late June after floodwaters have abated.

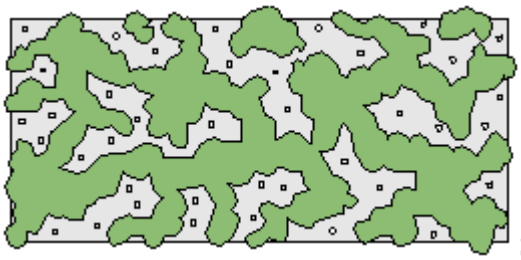
Recommended Procedure:

Timing	**Activity**
Year 1 winter	Locate and mark areas for box elder clearing. These should be places that lack trees or seedlings of desirable species (particularly silver maple, green ash, basswood).
Year 1 winter, early spring	In marked areas, cut and stump-treat box elders to open up large gaps in the disturbed woods. Box elder cover should be reduced to narrow zones between large opened spaces planted with trees.
Year 1 June	Collect silver maple seeds as they mature and drop from trees in the park. Put large tarps on the ground to catch the seeds. Collect seeds from the tarps and store them in a refrigerator in burlap or other breathable bags. Plant seeds soon after collecting.
Year 1 June	2 weeks before planting, spray out herbaceous vegetation with Roundup in the cleared areas where you will be planting seedlings and seeds.
Year 1 Late June	Plant trees into the cleared areas. Silver maple seeds can be broadcast and then raked into the ground surface. To supplement silver maple seeds, plant tree seedlings of other tree species into the cleared areas. Spread these seedlings out among the areas in which seeds have been planted. DNR foresters recommend 6 x 10 foot spacing (700seedlings/acre) of tree seedlings. Water them well. To suppress competing weeds, install fabric tree mats around the bases of the trees and stake into the ground (purchase material as a roll and cut into 1 sq meter size pieces).
Year 1, 2-3 weeks after planting	Re-water trees if necessary.
Year 1, rest of season	Monitor planted trees and identify/ correct problems. Post signs to inform the public about the goal and significance of the project.
approx 1 month after planting	Spray planted areas with Roundup to set back herbaceous plants that compete for moisture with the tree seedlings. Avoid the planted trees.
Year 2	Monitor the plantings and apply weed control measures to reduce competition for moisture
Year 3	Monitor the plantings and apply weed control measures to reduce competition for moisture

Comments:
Eventually the planted trees will create enough shade to shade out the light-dependent box elders. This approach of partially clearing a forest for planting is called a shelterwood pattern

(figure 14). The standing trees that are left will help to protect the newly planted tree seedlings. The purpose is to establish nodes of desirable tree species throughout the disturbed woods. These nodes will greatly increase the seed sources for desirable species and greatly accelerate the conversion of the woods into a native floodplain forest. Once the areas of planted trees are a few feet high, the process can be completed for the previously uncut belts of box elder trees – thus the process could be described as a two-stage shelterwood method. For a more complete discussion of the shelterwood method, see Baughman and Jacobs, 1992.

Figure 14: Shelterwood harvesting method of opening canopy for tree planting. Small squares represent stumps from tree clearing. (modified from Baughman & Jacobs, 1992).


Shelterwood

Apply Garlon3a or TordonRTU onto cut stumps after cutting, as box elder vigorously stump sprouts. Use a heavy, oil-based formulation (Garlon 4) when cutting and applying in the winter. Cut tree crowns so that pieces are in contact with the ground. Leave cut wood in place to decay – preferably as large pieces that will not lend themselves readily as firewood for men camping out in the woods. Box elder wood is generally undesirable as firewood and most firewood dealers will not accept it. Much of the slash can be piled up and burned.

Tree planting would be an excellent activity for a large group of volunteers. Large numbers of local people cherish Crosby Park and may volunteer for an event. Each volunteer can plant about 25-30 tree seedlings in a single 4 hour volunteer event. For each tree, volunteers will have to dig a small hole, plant tree, water tree, and add fabric to reduce weeds.

It is recommended that this project be done as a multi-year process in waves starting with the west end of the first priority area of polygon 82. Each successive area of planting would then add on to previously planted areas. Given that there are scattered keeper trees of silver maple and green ash present in the woods, and that the planting would be in a shelterwood pattern, then it would take approximately a 60 to 100 acre area of woods for 30 acres of planting space.

A challenge for planting in portions of the floodplain is flooded river channels in the spring. The channels can be quite deep and uncrossable. For areas blocked by flooded channels, plant on rises between channels in late spring or early summer when the flood waters have abated. Plant as soon as possible after the waters recede in order to maximize growing season time for the newly planted trees and to avoid working within a dense thicket of nettles. Planting at this time will require planting either tree seedlings or containerized/burlapped stock, as bare root stock requires early spring planting.

Avoid planting into deep drifts of river sand.

Tree options:

- Seeds – see MNDNR brochure on direct seeding of native hardwoods (MNDNR 2003).
- Seedlings: much less expensive than containerized stock and you can purchase and plant many more trees. The problem is that you will have to return to the site to control weed competition. The best method is to cut 1 meter square swatches of tree mat fabric and stake these mats around each planted seedling. Tree seedlings may be obtained from the MN DNR nurseries.
- Another possible source of trees would be bare root stock: young trees removed from the ground at a nursery in early spring while they are still dormant. These must be planted in very early spring as soon as possible after the ground thaws. The taller trees have fewer problems with weed competition than seedlings. These trees are more expensive than seedlings and may not be practical for large areas. For a detailed, step by step outline of how to plant bare root stock, see the website for the National Arbor Day Foundation: http://www.arborday.org/trees/NineNum8.cfm.
- Containerized/burlapped stock (not recommended): much more expensive and you will not be able to plant enough to fill much space. The advantage of these is that they are tall enough so that overcrowding/shading by nettles will not be a problem.

Species to plant: Plant the following species in the approximate ratios:

Green ash: 25%
Silver maple: 25%
Hackberry: 10%
Basswood: 20%
Cottonwood: 10%
Bur oak: 10%

Add bur oak to the list for higher, sandy areas of floodplain terrace such as in the vicinity of the pine and spruce plantations. It naturally occurs in some floodplains.

8. Forest Reconstruction on the Shepard Road Bluff Slope

Goal: Reconstruct native forest cover on the engineered slope along the northeast side of Crosby Lake (inventory polygon 92). This will eliminate large gaps that are prone to heavy buckthorn invasion and increase the amount of the park's cover of oaks, which are an important food source for many wildlife species. This would make an excellent event for volunteers.

Recommended Procedure:

Timing	Activity
Year 1 summer, fall, winter	Create large, open gaps between strips of existing trees by removing invasive trees and brush: black locust, Siberian elm, box elder, staghorn sumac, black raspberries, and amur maple (see appendix C for control methods for these species). You may also have to remove an occasional cottonwood. Cut wood can be left on the ground to decay. Remove excess slash and pile for later burning.
2 weeks before planting	Spray out old field grasses with Roundup in open areas that are to be planted.
Year 2, May or June	Plant oaks into large open gaps. Plant seed or seedling following process outlined in project #6. Plant mostly bur oak near the top of the slope. At and below mid slope, plant bur oak, white oak, northern pin oak and red oak. These trees need full sunlight to grow. Water the trees well at planting time. Put tree mats around the bases of the tree seedlings to reduce competition.
Year 2, 2-3 weeks later	Water well 2-3 weeks after planting
Fall year 1, and possibly fall year 2	If the terminal buds of the planted trees can be reached by deer, then put some protection on the buds to protect them from winter browsing. Bud caps are commercially available.

Comments:
Tree seeds and seedlings are most economical and best choices for local genetic ecotypes. Other options include planting bare root trees in early spring or containerized trees. See the discussion for floodplain forest restoration (project #7) for a discussion of these different options.

9. Parking Lot Prairie Management and Enhancement

Goal: Control and remove the exotic species that currently dominate the plantings. Add additional native prairie species to enhance the diversity and visual appeal of the planting.

Where: Polygons: 135 (1.7 acres) & 136 (2.9 acres)

Recommended Procedure:

Timing	Activity
Before mowing	Identify and mark with stakes small concentrations or "nodes" of planted species you wish to keep. Leave out areas of scattered plants within heavy exotic grass cover.
Late June	Cut reed canary grass plants with a brush saw fitted with a grass blade as the plants begin to form flowering stems
Year 1 August	Mow all of the area including the marked nodes, removing the clippings. You will have to remove and replace the stakes during the mowing
Year 1 Sept.	After 1 month, spray all the mowed areas outside nodes with Roundup. The intent is to kill regrowing exotics, particularly Canada thistle, quack grass and reed canary grass. Spot spray individual weeds like Canada thistle that are in the nodes.
Year 2 May	After spring green up by early season grasses: spray the whole area with Roundup**.**
Year 2 Sept.	Till all of the ground outside of the nodes on the level ground. On side slopes don't till in order to avoid erosion and soil washing off into the surrounding areas.
Year 2 Oct.	Prior to seeding the site, till the ground again on level ground.
Year 2 Oct.	Seed all of the tilled areas in mid to late October. We recommend drilling prairie grass on the level upland then following by broadcasting forb seed on the ground surface. Use a no-till drill to seed the slopes with prairie grasses.
Year 3, 4	Maintenance: monitor for weeds; mow above seedlings to set back weeds if necessary; spot spray if necessary for exotic grasses and Canada thistle
Year 5 May	Early spring controlled burn: time it to set back early season exotic grasses.

Comments:
A major problem for this project will be to remove the extensive cover of Kentucky bluegrass, quack grass, reed canary grass and Canada thistle in this site. Quack grass, Canada thistle and reed canary grass are particularly difficult to eliminate. For these reasons, we recommend a whole year of treatments to eliminate weeds in preparation for replanting.

Seeding Rates: Please seed at a high density of at least 60 seeds per square foot so as to minimize unoccupied space that can be colonized by weeds.

A traditional seeding would be a 50:50 ratio of grass to forb seeds. Recent studies of prairie restorations have found that this ratio results in over-dominance by grasses after a period of several years. Grasses are invigorated by controlled burning and easily crowd out many forbs.

Instead, consider a lower proportion of grass seed, such as a ratio of 25:75 grass to forb seeds (by number, not weight).

A list of recommended plant species to plant is given in the list for mesic prairie in Appendix B. This list identifies a subset of species that are appropriate for planting in the shallow, wet depressions within this site. We recommend planting a high diversity of prairie forb species.

10. Terrace Savanna Reconstruction

Goal: recreate native savanna in brome-dominated old field areas above the bluffs in order to enhance the aesthetic appeal of the park and buffer the bluff woods with native species.

Where: old fields:

- Polygon 147 (0.8 acres);
- Polygon 143 (0.2 acres);
- Polygon 146 (0.4 acres);
- Polygon 141 (0.2 acres);

Recommended Procedure for seeding:

Timing	Activity
Year 1, Late Fall	Mow the site
Year 2, Spring when new growth is 10-12" tall	Spray out the area with roundup [alternative: cover with heavy black plastic or mulch for an entire growing season – a problem with the method is stormwater runoff]
10 days later	Cultivate or rototill the site if possible.
2-3 weeks later	Monitor for regrowth. Spot spray re-growing plants when they reach 10-12"
1 week later	Seed with mesic prairie species – refer to list of recommended species and planting density below
first 3 years	Monitor for weed growth. Mow at height of approx 1 foot if weed growth exceeds Mow before invasive species and weeds are able to set seed
Spring 3 years after planting	Controlled burn to set back early season exotic grasses and invigorate planted species
at least 3 years later	Plant bur oak trees – spaced at least 30-40 feet apart
following years	Maintenance: controlled burn every 3-5 years. An alternative would be to mow the planting in late fall after seed has shattered (mid to late October) and remove the cuttings.

Recommended Procedure for planting plugs or containerized seedlings:

Timing	Activity
Year 1, Late Fall	Mow the site
Year 2, Spring when new growth is 10-12" tall	Spray out the area with roundup [alternative: cover with heavy black plastic or mulch for an entire growing season]
Before planting	Cover the site with 2- 4 inches of wood chip mulch
Year 2, June	Plant plugs of prairie plants. Plant at a high density so as to minimize space for weed invasion: 3 plants per square foot if possible. Water plants well
Year 2, 2-3 weeks later	Re-water plants
Year 2, rest of season	Monitor for weed invasion. Spot spray specific weeds if necessary.
at least 3 years later	Plant bur oak trees – spaced at least 30-40 feet apart
following years	Maintenance: controlled burn every 3-5 years. An alternative would be to mow the planting in late fall after seed has shattered (mid to late October) and remove the cuttings.

Comments:
Seed the area (or plant seedlings) with mesic prairie species. See the list for mesic prairie in Appendix B for species recommended for planting. Plant at a high density in order to minimize space for exotics to invade. Seedling density = 3 per square foot; seed density = at least 60 seeds per square foot.

Planting plugs or small pot seedlings would make an excellent volunteer event.

Maintenance: in seeded sites, monitor and control exotics by mowing with the mower set so that it is higher than the planted seedlings (generally 1 foot above the ground surface). Mow areas of thistles or other undesirable species 2-3 times per year for 3 years.

3 years later, burn the site in early spring. An early spring burn will set back exotic, cool season grasses that have persisted or reinvaded the site. It will also invigorate the native grasses. Any burn would have to be done with a strong wind out of the north to direct smoke away from Shepard Road.

Mowing is a viable alternative to burning but does not have the benefit of setting back early season grasses gained by early spring burning. Mowing should be done late in October and clippings should be removed.

Re-introduction of oaks: add scattered, widely spaced bur oaks several years later, as they will get in the way of mowing or burning in the early stages of the planting.

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Appendix A:
Upland and Wetland Plant Species of Crosby Park
Great River Greening, 2004

KEY:
Lifeform: c climber, f forb, g graminoid, s shrub, t tree
Exotic: Exotic Species (includes some invasive native spp. not native to Minnesota)
EM: Emergent Marshes and Wet Meadows
FF: Floodplain Forests (terraces and channels)
BA: Black Ash Seepage Swamps
MH: Mesic Oak and Lowland Hardwood Forests
BS: Dry-Mesic Oak Forest on Bluff Slopes
PR: Prairie Planting
OF: Old Fields and Disturbed Places (includes brome- dominated areas above limestone cliffs)

Common name	Scientific Name	Lifeform	Exotic	EM	FF	BA	MH	BS	PR	OF
amur maple	*Acer ginnala*	t	x							x
boxelder	*Acer negundo*	t			x	x	x	x		
red maple	*Acer rubrum*	t					x			x
silver maple	*Acer saccharinum*	t			x	x	x			
sugar maple	*Acer saccharum*	t					x			
yarrow	*Achillea millefolium*	f							x	x
sweet flag	*Acorus calamus*	g		x						
red baneberry	*Actaea rubra*	f			x					
common agrimony	*Agrimonia gryposepala*	f			x		x	x		
quack grass	*Agropyron repens*	g	x		x				x	x
redtop	*Agrostis stolonifera*	g	x				x		x	x
water plantain	*Alisma subcordatum*	f		x						
garlic mustard	*Alliara petiolata*	f	x		x	x	x	x		
wild leek	*Allium tricoccum*	f					x			
common ragweed	*Ambrosia artemesiifolia*									
giant ragweed	*Ambrosia trifida*	f							x	x
false indigo	*Amorpha fruticosa*	s		x						
hog peanuts	*Amphicarpea bracteata*	f			x		x	x		
big bluestem	*Andropogon gerardii*	g							x	x
Canada anemone	*Anemone canadensis*	f		x	x					
hemp dogbane	*Apocynum cannabinum*	f						x		x
columbine	*Aquilegia canadensis*	f					x	x		
burdock	*Arctium minus*	f	x		x	x	x	x	x	x
jack in the pulpit	*Arisaema triphyllum*	f			x		x	x		
absinthe wormwood	*Artemisia absinthium*	f	x							x
biennial wormwood	*Artemisia biennis*	f			x			x		
wild ginger	*Asarum canadense*	f					x			
marsh milkweed	*Asclepias incarnata*	f		x						
common milkweed	*Asclepias syriaca*	f			x				x	x
butterfly weed	*Asclepias tuberosa*	f								x
whorled milkweed	*Asclepias verticillata*	f								x
heart-leaved aster	*Aster cordifolius*	f						x		
heath aster	*Aster ericoides*	f								x
smooth aster	*Aster laevis*	f						x		x
ontario aster	*Aster ontarionis*	f			x		x			
hoary alyssum	*Berteroa incana*	f	x		x					x
white birch	*Betula papyrifera*	t			x					
beggar ticks	*Bidens*	f			x					
false nettle	*Boehmeria cylindrica*	f			x					
smooth brome	*Bromus inermis*	g	x					x	x	x
woodland brome	*Bromus latiglumis*	g						x		

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Common name	Scientific Name	Lifeform	Exotic	EM	FF	BA	MH	BS	PR	OF
bluejoint	*Calamagrostis canadensis*	g		x						
marsh marigold	*Caltha palustris*	f				x				
american bell flower	*Campanula americana*	f			x		x	x		
harebell	*Campanula rotundifolia*	f						x		
hemp	*Cannabis sativa*	f	x		x					
five parted toothwort	*Cardamine concatenata*	f					x	x		
pennsylvania bitter cress	*Cardamine pensylvanica*	f		x	x		x			
musk thistle	*Carduus nutans*	f	x		x					
ambiguous sedge	*Carex amphibola*	g			x					
water sedge	*Carex aquatilis*	g		x						
woodland sedge	*Carex blanda*	g			x		x	x		
	Carex brevior	g								x
	Carex comosa	g		x						
riverbank sedge	*Carex emoryii*	g			x		x			
	Carex granularis	g					x			
bottlebrush sedge	*Carex hystricina*	g					x			
lake sedge	*Carex lacustris*	g		x						
pennsylvania sedge	*Carex pensylvanica*	g						x		
? Several	*Carex cf. tenera*	g		x						
sprengel's sedge	*Carex sprengelii*	g					x	x		
awl-fruited sedge	*Carex stipata*	g		x						
tussock sedge	*Carex stricta*	g		x						
beaked sedge	*Carex utriculata*	g		x						
catalpa	*Catalpa speciosa*	t	x		x					
blue cohosh	*Caulophyllum thalictroides*	f					x			
hackberry	*Celtis occidentalis*	t			x		x	x		
sand bur	*Cenchrus longispinus*	g			x					x
spotted knapweed	*Centaurea maculosa*	f	x							x
celandine	*Chelidonium majus*	f	x		x					
turtlehead	*Chelone glabra*	f		x						
lamb's quarters	*Chenopodium album*	f			x					
bulbose water hemlock	*Cicuta bulbifera*	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					x
virgin's bower	*Clematis virginica*	c						x		
bindweed	*Convolvulus arvensis*	c					x			
horseweed	*Conyza candensis*	f	x		x					x
alternate-leaved dogwood	*Cornus alternifolia*	s					x			
gray dogwood	*Cornus foemina*	s						x		
red osier dogwood	*Cornus sericea*	s		x			x			
crown vetch	*Coronilla varia*	f	x							x
american hazelnut	*Corylus americana*	s						x		
honewort	*Cryptotaenia canadensis*	f			x		x			
dodder	*Cuscuta spp*	f			x					
nutsedge	*Cyperus sp.*	g								
orchard grass	*Dactylus glomerata*	g	x					x		x
dutchman's britches	*Dicentra cucullaria*	f					x			
wild yam	*Dioscorea villosa*	c					x			
barnyard grass	*Echinochloa muricata*	g		x						
wild cucumber	*Echinocystis lobata*	c		x						
russian olive	*Eleagnus angustifolia*	t	x							x
needle-like spike-rush	*Eleocharis acicularis*	g		x						
water spike rush	*Eleocharis palustre*	g		x						

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Common name	Scientific Name	Lifeform	Exotic	EM	FF	BA	MH	BS	PR	OF
canada wild rye	*Elymus canadensis*	g								x
minnesota wild rye	*Elymus diversiglumis*	g						x		
streambank wild rye	*Elymus riparius*	g			x					
virginia wild rye	*Elymus virginica*	g			x			x		
marsh horsetail	*Equisetum fluviatile*	f		x						
horsetail	*Equisetum hyemale*	f			x					
philadelphia fleabane	*Erigeron philadelphicus*	f			x				x	
daisy fleabane	*Erigeron strigosus*	f								x
white trout lily	*Erythronium album*	f					x	x		
wahoo	*Euonymus atropurpureus*	s						x		
spotted joe pye weed	*Eupatorium maculatum*	f		x						
boneset	*Eupatorium perfoliatum*	f		x						
purple node joe pye weed	*Eupatorium purpureum*	f						x		
white snakeroot	*Eupatorium rugosum*	f			x		x	x		
leafy spurge	*Euphorbia esula*	f	x					x		x
nodding fescue	*Festuca subverticillata*	g						x		
black ash	*Fraxinus nigra*	t				x				
green ash	*Fraxinus pennsylvanica*	t			x	x	x	x		
cleavers	*Galium aparine*	f			x		x			
sweet scented bedstraw	*Galium triflorum*	f					x	x		
wild geranium	*Geranium maculatum*	f					x			
white avens	*Geum canadense*	f			x		x			
creeping charlie	*Glechoma hederacea*	f	x		x		x	x		
giant manna grass	*Glyceria grandis*	g		x						
fowl manna grass	*Glyceria striata*	g				x				
kentucky coffee tree	*Gymnocladus dioica*	t					x			
common sneezeweed	*Helenium autumnale*	f		x						
woodland sunflower	*Helianthus strumosus*	f					x	x		
jerusalem artichoke	*Helianthus tuberosus*	f						x		x
ox-eye	*Heliopsis helianthoides*	f						x	x	
day lily	*Hemerocallis fulva*	f	x					x		
cow parsnip	*Heracleum lanatum*	f			x					
dame's rocket	*Hesperis matronalis*	f	x					x		x
alum root	*Heuchera richardsonii*	f					x	x		
virgina waterleaf	*Hydrophyllum virginianum*	f					x			
spotted touch-me-not	*Impatiens capensis*	f		x	x	x				
pale touch-me-not	*Impatiens pallida*	f			x		x	x		
southern blue flag	*Iris virginica*	f		x						
false meadow rue	*Isopyrum biternatum*	f					x			
butternut	*Juglans cinerea*	t					x			
black walnut	*Juglans nigra*	t					x			
?	*Juncus spp*	g		x						
rush	*Juncus tenuis*	g		x						
eastern red cedar	*Juniperus virginiana*	t						x		x
false boneset	*Kuhnia eupatorioides*	f								x
wild lettuce	*Lactuca spp*	f			x			x		x
wood nettle	*Laportea canadensis*	f			x		x			
rice cut grass	*Leersia oryzoides*	g		x						
white grass	*Leersia virginica*	g			x		x			
motherwort	*Leonurus cardiaca*	f			x		x			
butter and eggs	*Linaria canadensis*	f	x							x
tatarian honeysuckle	*Lonicera tartarica*	s	x		x		x	x		
bird's foot trefoil	*Lotus corniculatus*	f	x							x
american water horehound	*Lycopus americana*	f		x						

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Great River Greening, 2004

Common name	Scientific Name	Lifeform	Exotic	EM	FF	BA	MH	BS	PR	OF
common water horehound	*Lycopus asper*	f		x						
fringed loosestrife	*Lysimachia ciliata*	f				x				
tufted loosestrife	*Lysimachia thyrsiflora*	f		x						
purple loosestrife	*Lythrum salicaria*	f	x	x						
crabapple	*Malus sp.*	t	x		x					
chamomile	*Matricaria spp.*	f			x					x
black medic	*Medicago lupulina*	f	x							x
alfalfa	*Medicago sativa*	f	x					x	x	x
white sweet clover	*Melilotus alba*	f	x						x	x
moonseed	*Menispermum canadense*	c			x		x			
wild mint	*Mentha arvensis*	f			x					
monkey flower	*Mimulus ringens*	f			x					
bergamot	*Monarda fistulosa*	f						x	x	x
white mulberry	*Morus alba*	t	x		x					
swamp satin grass	*Muhlenbergia frondosa*	g		x						
marsh muhly grass	*Muhlenbergia glomerata*	g		x						
racemose muhly	*Muhlenbergia racemosa*	g						x		
?	*Mustard (? fh 037)*	f				x				
forget-me-not	*Myosotis scorpioides*	f	x		x	x	x			
catnip	*Nepeta cataria*	f	x							x
common evening primrose	*Oenothera biennis*	f								x
sensitive fern	*Onoclea sensibilis*	f			x		x			
sweet cicely	*Osmorhiza claytoniana*	f					x	x		
long-styled sweet cicely	*Osmorhiza longistylis*	f					x			
ironwood	*Ostrya virginiana*	t					x	x		
wood sorrel	*Oxalis spp*	f			x			x		
scribner's panicum	*Panicum oligosanthes*	g								x
switchgrass	*Panicum virgatum*	g								x
virginia creeper	*Parthenocissus inserta*	c			x	x	x	x		
woodbine	*Parthenocissus quinquifolius*	c			x					
parsnip	*Pastinaca sativa*	f	x					x		x
reed canary grass	*Phalaris arundinacea*	g	x	x	x	x	x		x	
timothy	*Phleum pratense*	g	x						x	x
blue phlox	*Phlox divaricata*	f					x			
reed grass	*Phragmites australis*	g		x						
lopseed	*Phryma leptostachya*	f					x	x		
obedient plant	*Physostegia virginiana*	f			x					
white spruce	*Picea alba*	t			x					
clearweed	*Pilea spp*	f			x					
red pine	*Pinus resinosa*	t			x					
white pine	*Pinus strobus*	t			x					
common plantain	*Plantago major*	f	x	x	x			x	x	x
canada bluegrass	*Poa compressa*	g						x		x
fowl meadow grass	*Poa palustris*	g		x						
kentucky bluegrass	*Poa pratensis*	g							x	x
solomon's seal	*Polygonatum biflorum*	f					x	x		
water smartweed	*Polygonum amphibium*	f		x						
black bindweed	*Polygonum convulus*	f			x					
dotted smartweed	*Polygonum punctatum*	f		x						
?	*Polygonum spp*	f		x						
?	*Polygonum spp (fh 038)*	f		x						
?	*Polygonum spp fh 046*	f		x						
white poplar	*Populus alba*	t	x		x			x		
cottonwood	*Populus deltoides*	t			x		x	x		

Appendix A:
Upland and Wetland Plant Species of Crosby Park
Great River Greening, 2004

Common name	Scientific Name	Lifeform	Exotic	EM	FF	BA	MH	BS	PR	OF
big tooth aspen	*Populus grandidentata*	t					x			
quaking aspen	*Populus tremuloides*	t						x		
black cherry	*Prunus serotina*	t						x		
chokecherry	*Prunus virginiana*	s			x		x	x		
white oak	*Quercus alba*	t						x		
northern pin oak	*Quercus ellipsoidalis*	t						x		
bur oak	*Quercus macrocarpa*	t						x		
red oak	*Quercus rubra*	t						x		
red - pin oak hybrid	*Quercus rubra x ellipsoidalis*	t						x		
small-flowered buttercup	*Ranunculus arbortivus*	f			x		x	x		
cursed crowfoot	*Ranunculus sceleratus*	f	x	x						
common buckthorn	*Rhamnus cathartica*	s	x		x	x	x	x		x
smooth sumac	*Rhus glabra*	s						x		x
staghorn sumac	*Rhus typhina*	s								x
wild black current	*Ribes americana*	s				x				
prickly gooseberry	*Ribes cynosbati*	s			x		x	x		
missouri gooseberry	*Ribes missouriense*	s			x		x	x		
black locust	*Robinia pseudoacacia*	t	x					x		x
water-cress	*Rorrippa nasturtium-aquaticum*	f	x	x						
common yellow-cress	*Rorrippa palustris*	f		x						
prairie rose	*Rosa arkansana*	s								x
red raspberry	*Rubus idaeus*	s					x	x		
black raspberry	*Rubus occidentalis*	s						x		x
black eyed susan	*Rudbeckia hirta*	f								x
golden-glow	*Rudbeckia laciniata*	f			x		x			
curly dock	*Rumex crispus*	f	x	x					x	
golden dock	*Rumex maritimus*	f	x	x						
great water dock	*Rumex orbiculatus*	f		x						
broad-leaved arrowhead	*Sagittaria latifolia*	f		x						
sand bar willow	*Salix exigua*	s		x						
slender willow	*Salix gracilis*	s		x						
hybrid black willow	*Salix x rubra*	t	x	x	x		x			
common elder	*Sambucus canadensis*	s			x	x	x			
red-berried elder	*Sambucus pubens*	s					x	x		
bloodroot	*Sanguinaria canadensis*	f					x	x		
black snakeroot	*Sanicula marilandica*	f					x	x		
little bluestem	*Schizachyrium scoparium*	g						x		x
black bulrush	*Scirpus atrovirens*	g		x						
river bulrush	*Scirpus fluviatile*	g		x						
soft stem bulrush	*Scirpus validus*	g		x						
figwort	*Scrophularia lanceolata*	f			x				x	
mad dog skullcap	*Scutellaria lateriflora*	f			x					
ragwort	*Senecio spp*	f		x						
bur-cucumber	*Sicyos angulatus*	c			x					
bladder campion	*Silene cserei*	f	x		x					
white campion	*Silene latifolia*	f	x							x
cup plant	*Silphium perfoliatum*	f					x			
racemose false solomon's seal	*Smilacina racemosa*	f					x	x		
stellate false solomon's seal	*Smilacina stellata*	f		x	x			x		
carrionflower	*Smilax herbacea*	f					x			
bristly greenbriar	*Smilax hispida*	f			x					
bittersweet	*Solanum dulcamara*	f	x	x	x		x			
canada goldenrod	*Solidago canadensis*	f						x		x
zig-zag goldenrod	*Solidago flexicaulis*	f					x			

Appendix A:
Upland and Wetland Plant Species of Crosby Park
Great River Greening, 2004

Common name	Scientific Name	Lifeform	Exotic	EM	FF	BA	MH	BS	PR	OF
giant goldenrod	*Solidago gigantea*	f			x				x	
stiff goldenrod	*Solidago rigida*	f								x
elm-leaved goldenrod	*Solidago ulmifolia*	f			x		x	x		
sow thistle	*Sonchus uliginosus*	f	x	x						
indian grass	*Sorghastrum nutans*	g							x	
giant bur-reed	*Sparganium eurycarpum*	g		x						
bladdernut	*Staphylea trifolia*	s					x			
giant chickweed	*Stellaria aquatica*	f	x	x						
snowberry	*Symphoricarpos albus*	s						x		x
skunk cabbage	*Symplocarpus foetidus*	f				x				
lilac	*Syringia sp.*	t	x					x		
dandilion	*Taraxacum officinale*	f	x		x					
germander	*Teucrium canadense*	f			x					
tall meadow rue	*Thalictrum dasycarpum*	f						x	x	
meadow rue	*Thalictrum dioicum*	f			x		x			
marsh fern	*Thelypteris palustris*	f		x						
basswood	*Tilia americana*	t		x			x	x		
poison ivy	*Toxicodendron radicans*	s			x			x		
spiderwort	*Tradescantia spp*	f							x	
red clover	*Trifolium repens*	f	x						x	
narrow leaf cattail	*Typha angustifolia*	g	x	x						
broad-leaved cattail	*Typha latifolia*	g		x						
american elm	*Ulmus americana*	t			x		x			
siberian elm	*Ulmus pumila*	t	x	x				x		x
slippery elm	*Ulmus rubra*	t					x			
common nettle	*Urtica dioica*	f		x	x					
large flowered bellwort	*Uvularia grandiflora*	f					x			
mullein	*Verbascum thapsus*	f	x							x
vervain	*Verbena hastata*	f								x
ironweed	*Vernonia faciculata*	f								x
water speedwell	*Veronica anagallis-aquatica*	f	x	x						
culver's root	*Veronicastrum virginicum*	f						x		
canada violet	*Viola canadensis*	f			x		x			
tall yellow violet	*Viola pubescens*	f					x			
common blue violet	*Viola sororia*	f					x			
river grape	*Vitis riparia*	c			x		x	x		x
cocklebur	*Xanthium strumarium*	f			x					x
prickly ash	*Zanthoxylum americanum*	s						x		x
wild rice	*Zizania palustris*	g		x						
golden alexanders	*Zizia aurea*	f							x	

Appendix B: Species Lists for Restoration of Native Plant Communities at Crosby Park

The descriptions and lists given here are from Dunevitz and Lane (2004) and were edited by the author of this report to more specifically fit the geographic location and conditions at Crosby Farm Park. The original lists and accompanying text may be viewed in the Great River Greening website (www.greatrivergreening.org) under the heading "East-Central Minnesota Species Lists."

For the purpose of analysis, species too taxonomically similar to confidently separate were lumped into species complexes which are abbreviated according the following table (from Dunevitz and Lane 2004):

Complex name	Species included in complex
***Agrimonia* cmx**	***A. gryposepala, striata***
***Amelanchier* cmx**	**Species with shrub forms: *A. laevis, interior, humilis, arborea***
Crataegus cmx	**C. punctata, macracantha, succulenta, calpodendron**
***Epilobium* cm1**	**E. coloratum, glandulosa**
***Epilobium* cm2**	*E. leptophyllum, palustre, strictum*
***Hackelia* cmx**	**H. deflexa, virginiana**
***Impatiens* cmx**	*I. capensis, pallida*
***Nymphaea* cmx**	*N. odorata and tuberosa*
***Oxalis* cmx**	*O. acetosella, stricta, dillenii*
***Parthenocissus* cmx**	*P. quinquefolia, vitacea*
***Pilea* cmx**	**P. fontana, pumila**
***Rosa* cmx**	*R. acicularis, blanda*
***Rubus* cm1**	Tall blackberries: *R. allegheniensis* and similar species
***Rubus* cm2**	Trailing blackberries: *R. flagellaris* and similar species
***Senecio* cmx**	**S. aureus, pseudaureus**
***Symphoricarpos* cmx**	**S. albus, occidentalis**
***Smilax* cmx**	
***Viola* cm1**	Herbaceous species: *S. ecirrata, herbacea, illinoensis* Stemless blue violets: *V. cucullata, missouriensis, nephrophylla,*
***Viola* cm2**	*nova-angliae, pratincola, sororia*
***Viola* cm3**	Small white violets*: V. incognita, macloskeyi*
***Viola* cm4**	Small blue violets with cauline leaves: *V. adunca, conspersa,*
***Zigadenus* cmx**	*labradorica* Large violets with cauline leaves: *V. canadensis, pubescens* **Z. elegans, glaucus**

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC PRAIRIE (modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = spp recommended for planting in parking lot prairie; w= plant only in wet spots; dnp = do not plant**	*** = spp recommended for planting in terrace oak savanna reconstruction; dnp = do not plant**
Understory Trees				
Acer	*negundo*	Box elder	dnp	dnp
Juniperus	*virginiana*	Red cedar	dnp	dnp
Populus	*tremuloides*	Quaking aspen	dnp	dnp
Quercus	*macrocarpa*	Bur oak		*
Quercus	*ellipsoidalis*	Northern pin oak		
Tilia	*americana*	Basswood	dnp	dnp
Ulmus	*rubra*	Slippery elm	dnp	dnp
Shrubs				
Cornus	*racemosa*	Gray dogwood		
Cornus	*sericea*	Red-osier dogwood		
Corylus	*americana*	American hazelnut		*
Prunus	*americana*	Wild plum		
Prunus	*virginiana*	Chokecherry		
Prunus	*pumila*	Sand cherry		
Rhus	*glabra*	Smooth sumac	dnp	dnp
Rhus	*typhina*	Staghorn sumac	dnp	dnp
Rosa	*arkansana*	Prairie rose		*
Rosa	cmx.	Smooth wild rose		
Salix	*humilis*	Prairie willow		
Spiraea	*alba*	Meadowsweet	*w	
Symphoricarpos	cmx.	Snowberry		
Low Shrubs				
Amorpha	*canescens*	Lead-plant	*	*
Amorpha	*nana*	Fragrant false indigo	*	
Artemisia	*frigida*	Prairie sagewort		
Rubus	*occidentalis*	Black raspberry	dnp	dnp
Rubus	*idaeus*	Red raspberry	dnp	dnp
Toxicodendron	*rydbergii*	Poison ivy	dnp	dnp
Vines				
Parthenocissus	cmx.	Virginia creeper	dnp	dnp
Clematis	*virginiana*	Virgin's bower	dnp	dnp
Vitis	*riparia*	Wild grape	dnp	dnp
Forbs				
Achillea	*millefolium*	Yarrow		
Allium	*stellatum*	Prairie wild onion		*
Allium	*canadense*	Wild garlic		
Ambrosia	*artemisiifolia*	Common ragweed	dnp	dnp
Ambrosia	*psilostachya*	Western ragweed	dnp	dnp
Anemone	*cylindrica*	Long-headed thimbleweed		*
Anemone	*virginiana*	Virginia thimbleweed		
Anemone	*canadensis*	Canada anemone	*w	
Antennaria	*spp.*	Pussytoes		
Apocynum	*androsaemifolium*	Spreading dogbane		*
Apocynum	*sibiricum*	Clasping dogbane		
Artemisia	*ludoviciana*	Western mugwort		
Artemisia	*dracunculus*	Estragon	dnp	dnp
Artemisia	*campestris*	Tall wormwood	dnp	dnp
Asclepias	*tuberosa*	Butterfly-weed		*
Asclepias	*syriaca*	Common milkweed	dnp	dnp
Asclepias	*ovalifolia*	Oval-leaved milkweed		

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC PRAIRIE (modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = spp recommended for planting in parking lot prairie; w= plant only in wet spots; dnp = do not plant**	*** = spp recommended for planting in terrace oak savanna reconstruction; dnp = do not plant**
Aster	*oolentangiensis*	Sky-blue aster	*	*
Aster	*ericoides*	Heath aster	*	*
Aster	*lanceolatus*	Panicled aster	*w	
Aster	*novae-angliae*	New England aster	*w	
Aster	*laevis*	Smooth aster	*	*
Astragalus	*agrestis*	Field milk-vetch		
Astragalus	*canadensis*	Canada milk-vetch	*	
Campanula	*rotundifolia*	Harebell		
Chrysopsis	*villosa*	Prairie golden aster		
Cirsium	*muticum*	Swamp thistle		
Cirsium	*flodmani*	Prairie thistle		
Comandra	*umbellata*	Bastard toad-flax		
Conyza	*canadensis*	Horseweed	dnp	dnp
Coreopsis	*palmata*	Stiff tickseed		
Cuscuta	*spp.*	Dodder		
Dalea	*purpurea*	Purple prairie-clover	*	*
Dalea	*candida*	White prairie-clover		*
Desmodium	*canadense*	Canadian tick-trefoil	*	*
Erigeron	*strigosus*	Daisy fleabane		*
Euphorbia	*corollata*	Flowering spurge		
Euthamia	*graminifolia*	Grass-leaved goldenrod		
Fragaria	*virginiana*	Common strawberry	*	*
Galium	*boreale*	Northern bedstraw		*
Galium	*triflorum*	Three-flowered bedstraw		
Gentiana	*billingtonii*	Closed gentian		
Geum	*triflorum*	Prairie smoke		*
Glycyrrhiza	*lepidota*	Wild licorice	*	
Hedeoma	*hispida*	Mock pennyroyal		
Helenium	*autumnale*	Autumn sneezeweed	*w	
Helianthus	*maximiliani*	Maximilian's sunflower	*	*
Helianthus	*giganteus*	Giant sunflower	*w	
Helianthus	*pauciflorus*	Stiff sunflower		*
Heliopsis	*helianthoides*	Ox-eye	*	*
Heuchera	*richardsonii*	Alum-root		*
Hypoxis	*hirsuta*	Yellow star-grass		
Krigia	*biflora*	Two-flowered Cynthia		
Kuhnia	*eupatorioides*	False boneset		*
Lactuca	*spp.*	Wild lettuce		
Lathyrus	*palustris*	Marsh vetchling		
Lathyrus	*venosus*	Veiny pea		
Lespedeza	*capitata*	Round-headed bush-clover	*	*
Liatris	*aspera*	Rough blazing star		*
Liatris	*ligulistylis*	Northern plains blazing star	*	
Liatris	*pycnostachya*	Gayfeather	*w	
Lilium	*philadelphicum*	Wood lily		
Lithospermum	*canescens*	Hoary puccoon		*
Lithospermum	*caroliniense*	Hairy puccoon		
Lobelia	*spicata*	Rough-spiked Lobelia	*	
Mirabilis	*hirsuta*	Hairy four-o'clock		
Monarda	*fistulosa*	Wild bergamot	*	*
Oenothera	*biennis*	Common evening-primrose	*	*

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC PRAIRIE (modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = spp recommended for planting in parking lot prairie; w= plant only in wet spots; dnp = do not plant**	*** = spp recommended for planting in terrace oak savanna reconstruction; dnp = do not plant**
Oxalis	cmx.	Wood-sorrel		
Pedicularis	*canadensis*	Wood-betony		
Pediomelum	*argophyllum*	Silvery scurf-pea	*	
Phlox	*pilosa*	Prairie phlox	*	
Physalis	*heterophylla*	Clammy ground-cherry		
Physalis	*virginiana*	Ground-cherry		
Polygala	*sanguinea*	Purple milkwort		
Polygonatum	*biflorum*	Giant Solomon's-seal		
Potentilla	*simplex*	Old-field cinquefoil		
Potentilla	*arguta*	Tall cinquefoil	*	*
Prenanthes	*racemosa*	Smooth rattlesnake-root	*	*
Pycnanthemum	*virginianum*	Virginia mountain-mint	*w	
Ratibida	*pinnata*	Gray-headed coneflower	*	*
Rudbeckia	*hirta*	Black-eyed Susan	*	*
Scutellaria	*leonardi*	Leonard's skullcap		
Silphium	*perfoliatum*	Cup-plant	*w	
Sisyrinchium	*campestre*	Field blue-eyed grass		
Smilacina	*stellata*	Starry false Solomon's-seal		*
Smilacina	*racemosa*	Racemose false Solomon's-seal		
Solidago	*rigida*	Stiff goldenrod	*	*
Solidago	*canadensis*	Canada goldenrod	dnp	dnp
Solidago	*gigantea*	Giant goldenrod	*w	
Solidago	*nemoralis*	Gray goldenrod		*
Solidago	*missouriensis*	Missouri goldenrod		
Solidago	*ptarmicoides*	Upland white aster	*	*
Solidago	*speciosa*	Showy goldenrod		*
Stachys	*palustris*	Woundwort	*w	
Thalictrum	*dasycarpum*	Tall meadow-rue		
Tradescantia	*bracteata*	Bracted spiderwort		*
Vernonia	*fasciculata*	Bunched ironweed	*w	
Veronicastrum	*virginicum*	Culver's root	*	*
Vicia	*americana*	American vetch		
Viola	*pedatifida*	Prairie bird-foot violet		
Viola	*pedata*	Bird-foot violet		
Viola	cm4	Violet		
Viola	cm1	Violet		
Zizia	*aptera*	Heart-leaved alexanders	*	*
Zizia	*aurea*	Golden alexanders	*	*
Grasses, Rushes and Sedges				
Andropogon	*gerardii*	Big bluestem	*	*
Bromus	*kalmii*	Kalm's brome	*	*
Carex	*bicknellii*	Bicknell's sedge		
Carex	*muhlenbergii*	Muhlenberg's sedge		
Carex	*meadii*	Mead's sedge		
Carex	*tenera*	Marsh-straw sedge		
Carex	*scoparia*	Pointed-broom sedge	*w	
Carex	*siccata*	Hay sedge		
Elymus	*wiegandii*	Canada wild rye		*
Elymus	*trachycaulus*	Slender wheatgrass		

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC PRAIRIE (modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = spp recommended for planting in parking lot prairie; w= plant only in wet spots; dnp = do not plant**	*** = spp recommended for planting in terrace oak savanna reconstruction; dnp = do not plant**
Eragrostis	*spectabilis*	Purple lovegrass		
Juncus	*greenei*	Greene's rush		
Koeleria	*pyramidata*	June-grass		*
Muhlenbergia	*mexicana*	Mexican satin-grass		
Muhlenbergia	*glomerata*	Clustered muhly grass		
Muhlenbergia	*frondosa*	Swamp satin-grass		
Muhlenbergia	*racemosa*	Marsh muhly grass		
Panicum	*oligosanthes*	Few-flowered panic grass		
Panicum	*leibergii*	Leiberg's panic grass	*	*
Panicum	*virgatum*	Switchgrass	*w (not cultivar)	
Panicum	*perlongum*	Long-leaved panic grass	dnp	dnp
Panicum	*commonsianum*	White-haired panic grass	dnp	dnp
Panicum	*capillare*	Witch grass	dnp	dnp
Schizachyrium	*scoparium*	Little bluestem		*
Sorghastrum	*nutans*	Indian grass	*	*
Spartina	*pectinata*	Prairie cord-grass	*w	
Sporobolus	*heterolepis*	Prairie dropseed	*	*
Stipa	*spartea*	Porcupine-grass		*
Ferns and Fern Allies				
Equisetum	*laevigatum*	Smooth scouring-rush		
Equisetum	*hyemale*	Tall scouring-rush	dnp	dnp
Equisetum	*arvense*	Field horsetail	dnp	dnp
Exotic Invasive Species - Do Not Plant				
Asparagus	*officinalis*	Asparagus	dnp	dnp
Bromus	*inermis*	Smooth brome	dnp	dnp
Cirsium	*arvense*	Canada thistle	dnp	dnp
Elytrigia	*repens*	Quack grass	dnp	dnp
Hieracium	*kalmii*	Hawkweed	dnp	dnp
Lonicera	*tatarica*	Tartarian Honeysuckle	dnp	dnp
Melilotus	*spp.*	Sweet clover	dnp	dnp
Phalaris	*arundinacea*	Reed canary-grass	dnp	dnp
Phleum	*pratense*	Cultivated timothy	dnp	dnp
Poa	*pratensis*	Kentucky bluegrass	dnp	dnp
Poa	*compressa*	Canada bluegrass	dnp	dnp
Polygonum	*convolvulus*	Black bindweed	dnp	dnp
Prunella	*vulgaris*	Heal-all	dnp	dnp
Rhamnus	*cathartica*	Common buckthorn	dnp	dnp
Setaria	*glauca*	Yellow foxtail	dnp	dnp
Taraxacum	*spp.*	Common dandelion	dnp	dnp
Tragopogon	*dubius*	Yellow goat's-beard	dnp	dnp
Trifolium	*pratense*	Red clover	dnp	dnp
Vicia	*angustifolia*	Narrow-leaved vetch	dnp	dnp
State Listed Rare Species - Do Not Plant Without a Permit				
Eryngium	*yuccifolium*	Rattlesnake-master	dnp	dnp

Appendix B:
Species Lists for Restoration

SOUTHERN DRY-MESIC OAK FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
Canopy Trees (>10m)			
Quercus	*rubra*	Northern red oak	
Quercus	*alba*	White oak	
Ulmus	*americana*	American elm	
Tilia	*americana*	Basswood	
Carya	*cordiformis*	Bitternut hickory	
Acer	*negundo*	Box elder	dnp
Celtis	*occidentalis*	Hackberry	
Betula	*papyrifera*	Paper-birch	
Fraxinus	*pennsylvanica*	Green ash	
Prunus	*serotina*	Black cherry	
Quercus	*ellipsoidalis*	Northern pin oak	
Quercus	*macrocarpa*	Bur oak	
Understory Trees			
Carya	*cordiformis*	Bitternut hickory	*
Tilia	*americana*	Basswood	*
Prunus	*serotina*	Black cherry	
Ostrya	*virginiana*	Ironwood	
Ulmus	*rubra*	Slippery elm	
Ulmus	*americana*	American elm	
Acer	*negundo*	Box elder	dnp
Acer	*saccharum*	Sugar maple	dnp
Quercus	*rubra*	Northern red oak	*
Celtis	*occidentalis*	Hackberry	
Fraxinus	*pennsylvanica*	Green ash	*
Quercus	*alba*	White oak	*
Betula	*papyrifera*	Paper-birch	
Carpinus	*caroliniana*	Blue beech	
Shrubs			
Cornus	*racemosa*	Gray dogwood	*
Corylus	*americana*	American hazelnut	*
Prunus	*virginiana*	Chokecherry	*
Ribes	*cynosbati*	Prickly gooseberry	
Symphoricarpos	*cmx*	Snowberry	
Viburnum	*rafinesquianum*	Downy arrow-wood	*
Viburnum	*lentago*	Nannyberry	*
Forbs			
Actaea	*rubra*	Red baneberry	*
Amphicarpaea	*bracteata*	Hog-peanut	*
Anemone	*quinquefolia*	Wood anemone	*
Anemonella	*thalictroides*	Rue-anemone	*
Apocynum	*androsaemifolium*	Spreading dogbane	*
Aquilegia	*canadensis*	Columbine	*
Aralia	*nudicaulis*	Wild sarsaparilla	*
Aralia	*racemosa*	American spikenard	
Arisaema	*triphyllum*	Jack-in-the-pulpit	*
Asclepias	*exaltata*	Poke milkweed	*
Aster	*cordifolius*	Heart-leaved aster	*
Campanula	*rotundifolia*	Harebell	*
Caulophyllum	*thalictroides*	Blue cohosh	
Circaea	*lutetiana*	Canada enchanter's nightshade	*
Cryptotaenia	*canadensis*	Honewort	
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	*
Eupatorium	*rugosum*	Common snakeroot	*

Appendix B:
Species Lists for Restoration

SOUTHERN DRY-MESIC OAK FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
Fragaria	*vesca*	Wood strawberry	
Fragaria	*virginiana*	Common strawberry	*
Galium	*triflorum*	Three-flowered bedstraw	
Galium	*concinnum*	Elegant bedstraw	
Galium	*boreale*	Northern bedstraw	*
Geranium	*maculatum*	Wild geranium	*
Geum	*canadense*	White avens	
Helianthus	*strumosus*	Woodland sunflower	*
Hydrophyllum	*virginianum*	Virginia waterleaf	*
Lathyrus	*ochroleucus*	Pale vetchling	*
Maianthemum	*canadense*	Canada mayflower	*
Mitella	*diphylla*	Two-leaved miterwort	
Osmorhiza	*claytonii*	Clayton's sweet cicely	*
Phryma	*leptostachya*	Lopseed	*
Polygonatum	*biflorum*	Giant Solomon's-seal	*
Prenanthes	*alba*	White wild lettuce	*
Ranunculus	*abortivus*	Kidney-leaf buttercup	
Sanguinaria	*canadensis*	Bloodroot	*
Sanicula	*marilandica*	Maryland black snakeroot	*
Sanicula	*gregaria*	Gregarious black snakeroot	*
Smilacina	*racemosa*	Racemose false Solomon's-seal	*
Solidago	*flexicaulis*	Zig-zag goldenrod	*
Solidago	*ulmifolia*	Elm-leaved goldenrod	*
Smilax	*herbacea*	Carrion-flower	*
Thalictrum	*dioicum*	Early meadow-rue	*
Uvularia	*grandiflora*	Yellow bellwort	*
Veronicastrum	*virginicum*	Culver's root	*
Viola	*cm4*	Violet	
Zizia	*aurea*	Golden alexanders	*
Grasses, Rushes and Sedges			
Carex	*pensylvanica*	Pennsylvania sedge	*
Carex	*blanda*	Woodland sedge	*
Carex	*gracillima*	Graceful sedge	
Carex	*sprengelii*	Sprengel's sedge	*
Carex	*peckii*	Peck's sedge	*
Carex	*deweyana*	Dewey's sedge	*
Carex	*radiata*	Stellate sedge	*
Elymus	*hystrix*	Bottlebrush grass	*
Festuca	*subverticillata*	Nodding fescue	*
Oryzopsis	*asperifolia*	Mountain rice grass	*
Ferns and Fern Allies			
Athyrium	*filix-femina*	Lady-fern	*
Botrychium	*virginianum*	Rattlesnakefern	
Osmunda	*claytoniana*	Interrupted fern	*
Climbers			
Parthenocissus	*inserta*	Virginia creeper	*
Exotic Invasive Species - Do Not Plant			
Arctium	*minus*	Common burdock	dnp
Lonicera	*tatarica*	Tartarian Honeysuckle	dnp
Prunella	*vulgaris*	Heal-all	dnp
Rhamnus	*cathartica*	Common buckthorn	dnp
Taraxacum	*spp.*	Common dandelion	dnp

Appendix B:
Species Lists for Restoration

SOUTHERN DRY-MESIC OAK FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
State Listed Rare Species - Do Not Plant Without a Permit			
Juglans	*cinerea*	Butternut	dnp

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC OAK - BASSWOOD FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
Canopy Trees (>10 m)			
Acer	*saccharum*	Sugar maple	dnp
Betula	*papyrifera*	Paper-birch	
Carya	*cordiformis*	Bitternut hickory	
Fraxinus	*pennsylvanica*	Green ash	
Fraxinus	*nigra*	Black ash	
Populus	*tremuloides*	Quaking aspen	dnp
Prunus	*serotina*	Black cherry	
Quercus	*rubra*	Northern red oak	
Quercus	*alba*	White oak	
Quercus	*macrocarpa*	Bur oak	
Tilia	*americana*	Basswood	
Ulmus	*americana*	American elm	
Ulmus	*rubra*	Slippery elm	
Understory Trees			
Acer	*saccharum*	Sugar maple	dnp
Acer	*negundo*	Box elder	dnp
Betula	*papyrifera*	Paper-birch	
Carpinus	*caroliniana*	Blue beech	
Carya	*cordiformis*	Bitternut hickory	*
Celtis	*occidentalis*	Hackberry	
Fraxinus	*pennsylvanica*	Green ash	*
Fraxinus	*nigra*	Black ash	
Ostrya	*virginiana*	Ironwood	
Populus	*grandidentata*	Big-toothed aspen	dnp
Populus	*tremuloides*	Quaking aspen	dnp
Prunus	*serotina*	Black cherry	
Quercus	*rubra*	Northern red oak	*
Quercus	*macrocarpa*	Bur oak	*
Quercus	*alba*	White oak	*
Tilia	*americana*	Basswood	*
Ulmus	*rubra*	Slippery elm	*
Ulmus	*americana*	American elm	
Shrubs			
Amelanchier	cmx.	Juneberry	*
Cornus	*alternifolia*	Pagoda dogwood	*
Cornus	*racemosa*	Gray dogwood	*
Corylus	*americana*	American hazelnut	*
Dirca	*palustris*	Leatherwood	
Lonicera	*prolifera*	Grape honeysuckle	
Prunus	*virginiana*	Chokecherry	
Ribes	*cynosbati*	Prickly gooseberry	
Ribes	*missouriense*	Missouri gooseberry	
Sambucus	*racemosa*	Red-berried elder	
Symphoricarpos	cmx	Snowberry	
Viburnum	*rafinesquianum*	Downy arrow-wood	*
Viburnum	*lentago*	Nannyberry	*
Viburnum	*opulus*	High-bush cranberry	
Zanthoxylum	*americanum*	Prickly ash	dnp
Low Shrubs			
Rubus	cm1	Blackberry	dnp
Rubus	*idaeus*	Red raspberry	dnp

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC OAK - BASSWOOD FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
Toxicodendron	*rydbergii*	Poison ivy	dnp
Vines			
Celastrus	*scandens*	Climbing bittersweet	
Clematis	*virginiana*	Virgin's bower	*
Menispermum	*canadense*	Canada moonseed	*
Parthenocissus	*inserta*	Virginia creeper	*
Smilax	*hispida*	Green-briar	*
Vitis	*riparia*	Wild grape	dnp
Forbs			
Actaea	*rubra*	Red baneberry	*
Allium	*tricoccum*	Wild leek	
Amphicarpaea	*bracteata*	Hog-peanut	*
Anemone	*quinquefolia*	Wood-anemone	*
Anemone	*acutiloba*	Sharp-lobed hepatica	*
Anemonella	*thalictroides*	Rue-anemone	
Aplectrum	*hyemale*	Putty-root	
Apocynum	*androsaemifolium*	Spreading dogbane	
Aquilegia	*canadensis*	Columbine	*
Aralia	*nudicaulis*	Wild sarsaparilla	*
Aralia	*racemosa*	American spikenard	*
Arisaema	*triphyllum*	Jack-in-the-pulpit	*
Asarum	*canadense*	Wild ginger	*
Asclepias	*exaltata*	Poke milkweed	
Aster	*cordifolius*	Heart-leaved aster	*
Aster	*lateriflorus*	Side-flowering aster	*
Campanula	*americana*	Tall bellflower	*
Cardamine	*concatenata*	Cut-leaved toothwort	*
Caulophyllum	*thalictroides*	Blue cohosh	*
Circaea	*lutetiana*	Canada enchanter's nightshade	*
Corallorhiza	spp	Coral-root	
Cryptotaenia	*canadensis*	Honewort	*
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	*
Dicentra	*cucullaria*	Dutchman's-breeches	
Dioscorea	*villosa*	Wild yam	
Erythronium	*album*	White trout lily	*
Eupatorium	*rugosum*	Common snakeroot	*
Fragaria	*virginiana*	Common strawberry	*
Galium	*triflorum*	Three-flowered bedstraw	*
Galium	*aparine*	Cleavers	*
Galium	*concinnum*	Elegant bedstraw	*
Geranium	*maculatum*	Wild geranium	*
Geum	*canadense*	White avens	
Hackelia	cmx.	Stickseed	
Hydrophyllum	*virginianum*	Virginia waterleaf	*
Impatiens	cmx.	Spotted touch-me-not	
Lactuca	*spp.*	Wild lettuce	
Laportea	*canadensis*	Wood-nettle	dnp
Lilium	*michiganense*	Michigan lily	
Maianthemum	*canadense*	Canada mayflower	
Mitella	*diphylla*	Two-leaved miterwort	
Monotropa	*uniflora*	Indian pipe	

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC OAK - BASSWOOD FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
Orchis	*spectabilis*	Showy orchis	
Osmorhiza	*claytonii*	Clayton's sweet cicely	*
Phlox	*divaricata*	Blue phlox	*
Phryma	*leptostachya*	Lopseed	*
Polygonatum	*pubescens*	Hairy Solomon's-seal	*
Polygonatum	*biflorum*	Giant Solomon's-seal	*
Prenanthes	*alba*	White rattlesnake-root	*
Pyrola	*elliptica*	Common pyrola	
Ranunculus	*abortivus*	Kidney-leaf buttercup	
Ranunculus	*recurvatus*	Hooked crowfoot	
Rudbeckia	*laciniata*	Goldenglow	
Sanguinaria	*canadensis*	Bloodroot	*
Sanicula	*marilandica*	Mariland black snakeroot	*
Sanicula	*gregaria*	Gregarious black snakeroot	*
Smilacina	*racemosa*	Racemose false Solomon's-seal	*
Smilax	*herbacea*	Carrion-flower	
Solidago	*flexicaulis*	Zig-zag goldenrod	*
Thalictrum	*dioicum*	Early meadow-rue	*
Trillium	*cernuum*	Nodding trillium	
Trillium	*grandiflorum*	Large-flowered trillium	
Triosteum	*perfoliatum*	Horse-gentian	
Uvularia	*grandiflora*	Yellow bellwort	*
Veronicastrum	*virginicum*	Culver's root	
Viola	*candensis*	Canada violet	
Viola	*pubescens*	Downy yellow violet	
Viola	*sororia*	Common blue violet	
Zizia	*aurea*	Golden alexanders	*
Grasses, Rushes and Sedges			
Brachyelytrum	*erectum*	Bearded shorthusk	*
Bromus	*altissimus*	Broad-glumed brome	
Carex	*pedunculata*	Long-stalked sedge	*
Carex	*pensylvanica*	Pennsylvania sedge	*
Carex	*blanda*	Woodland sedge	*
Carex	*gracillima*	Graceful sedge	*
Carex	*deweyana*	Dewey's sedge	
Carex	*sprengelii*	Sprengel's sedge	*
Carex	*leptonervia*	Fine-nerved sedge	*
Carex	*hirtifolia*	Hairy-leaved sedge	*
Carex	*radiata*	Stellate sedge	*
Carex	*rosea*	Rolled-up sedge	*
Elymus	*hystrix*	Bottlebrush grass	*
Festuca	*subverticillata*	Nodding fescue	*
Milium	*effusum*	Woodland millet grass	*
Oryzopsis	*racemosa*	Black-fruited rice-grass	*
Oryzopsis	*asperifolia*	Moutain rice-grass	*
Schizachne	*purpurascens*	False melic grass	*
Ferns and Fern Allies			
Adiantum	*pedatum*	Maidenhair fern	*
Athyrium	*filix-femina*	Lady-fern	*
Botrychium	*virginianum*	Rattlesnakefern	
Cystopteris	*fragilis*	Fragile bladder-fern	*
Dryopteris	*carthusiana*	Wood fern	*

Appendix B:
Species Lists for Restoration

SOUTHERN MESIC OAK - BASSWOOD FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = recommended for planting and slope stabilization; dnp = do not plant**
Osmunda	*claytoniana*	Interrupted fern	*
Exotic Invasive Species - Do Not Plant			
Alliaria	*petiolata*	Garlic-mustard	dnp
Phalaris	*arundinacea*	Reed canary-grass	dnp
Polygonum	*convolvulus*	Black bindweed	dnp
Rhamnus	*cathartica*	Common buckthorn	dnp
Solanum	*dulcamara*	Bittersweet nightshade	dnp
Taraxacum	*spp.*	Common dandelion	dnp
Verbascum	*thapsus*	Common mullein	dnp
State Listed Rare Species - Do Not Plant Without a Permit			
Carex	*laxiculmis*	Loose-culmed sedge	
Juglans	*cinerea*	Butternut	
Panax	*quinquefolium*	American ginseng	

Appendix B:
Species Lists for Restoration

SOUTHERN WET ASH SWAMP				
(modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = invasive**	**[5]Index**
Canopy Trees (>10 m)				
Fraxinus	*nigra*	Black ash		3400
Ulmus	*americana*	American elm		480
Tilia	*americana*	Basswood		360
Acer	*saccharum*	Sugar maple		300
Fraxinus	*pennsylvanica*	Green ash		80
Ulmus	*rubra*	Slippery elm		60
Salix	*nigra*	Black willow		20
Betula	*papyrifera*	Paper-birch		20
Understory Trees				
Fraxinus	*nigra*	Black ash		1400
Ulmus	*americana*	American elm		660
Tilia	*americana*	Basswood		400
Fraxinus	*pennsylvanica*	Green ash		320
Ostrya	*virginiana*	Ironwood		320
Acer	*negundo*	Box elder	*	300
Acer	*saccharum*	Sugar maple		300
Ulmus	*rubra*	Slippery elm		300
Betula	*papyrifera*	Paper-birch		100
Celtis	*occidentalis*	Hackberry		60
Populus	*tremuloides*	Quaking aspen		20
Shrubs				
Cornus	*sericea*	Red-osier dogwood		1040
Viburnum	*lentago*	Nannyberry		720
Ribes	*americanum*	Wild black currant		360
Cornus	*rugosa*	Round-leaved dogwood		300
Ribes	*missouriense*	Missouri gooseberry		120
Viburnum	*opulus*	High-bush cranberry		100
Prunus	*virginiana*	Chokecherry		60
Cornus	*alternifolia*	Pagoda dogwood		60
Cornus	*racemosa*	Gray dogwood		60
Zanthoxylum	*americanum*	Prickly ash		60
Sambucus	*racemosa*	Red-berried Elder		20
Low Shrubs				
Toxicodendron	*rydbergii*	Poison ivy	*	60
Vitis	*riparia*	Wild grape		80
Menispermum	*canadense*	Canada moonseed		60
Rubus	*idaeus*	Red raspberry	*	20
Vines				
Parthenocissus	cmx.	Virginia creeper		300
Forbs				
Symplocarpus	*foetidus*	Skunk-cabbage		4320
Impatiens	cmx.	Touch-me-not		2000
Caltha	*palustris*	Swamp marsh-marigold		960
Laportea	*canadensis*	Wood-nettle		560
Rudbeckia	*laciniata*	Goldenglow		400
Pilea	cmx.	Clearweed		360
Asarum	*canadense*	Wild ginger		360
Smilacina	*stellata*	Starry false Solomon's-seal		320
Cryptotaenia	*canadensis*	Honewort		320
Lemna	*spp.*	Lesser duckweed		300
Stachys	*hispida*	Smooth hedge-nettle		300
Boehmeria	*cylindrica*	False nettle		300
Arisaema	*triphyllum*	Jack-in-the-pulpit		300
Geranium	*maculatum*	Wild geranium		240

Appendix B:
Species Lists for Restoration

SOUTHERN WET ASH SWAMP				
(modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = invasive**	**[5]Index**
Osmorhiza	*claytonii*	Clayton's sweet cicely		240
Galium	*aparine*	Cleavers		240
Ranunculus	*recurvatus*	Hooked crowfoot		180
Maianthemum	*canadense*	Canada mayflower		180
Iris	*versicolor*	Northern blue Flag		160
Galium	*triflorum*	Three-flowered bedstraw		120
Solidago	*flexicaulis*	Zig-zag goldenrod		120
Cardamine	*rhomboidea*	Spring cress		120
Eupatorium	*rugosum*	Common snakeroot		120
Sanicula	*gregaria*	Gregarious black snakeroot		120
Lilium	*michiganense*	Michigan lily		120
Sanguinaria	*canadensis*	Bloodroot		120
Circaea	*lutetiana*	Canada enchanter's nightshade		120
Thalictrum	*dasycarpum*	Tall meadow-rue		120
Hydrophyllum	*virginianum*	Virginia waterleaf		120
Geum	*canadense*	White avens		100
Ranunculus	*hispidus*	Hispid buttercup		100
Galium	*obtusum*	Obtuse bedstraw		100
Rubus	*pubescens*	Dwarf raspberry		80
Scutellaria	*lateriflora*	Mad-dog skullcap		80
Typha	*spp.*	Cattail	*	60
Aralia	*nudicaulis*	Wild sarsaparilla		60
Angelica	*atropurpurea*	Angelica		60
Rumex	*orbiculatus*	Great water dock		60
Anemone	*quinquefolia*	Wood-anemone		60
Ranunculus	*abortivus*	Kidney-leaf buttercup		60
Polygonum	*virginianum*	Virginia knotweed		60
Polygonatum	*pubescens*	Hairy Solomon's-seal		60
Aster	*ontarionis*	Ontario aster		60
Anemone	*acutiloba*	Sharp-lobed hepatica		60
Cicuta	*bulbifera*	Bulb-bearing water-hemlock		60
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil		60
Sagittaria	*latifolia*	Broad-leaved arrowhead		60
Aster	*firmus*	Red-stemmed aster		60
Galium	*asprellum*	Rough bedstraw		60
Galium	*concinnum*	Elegant bedstraw		60
Cardamine	*pensylvanica*	Pensylvania bitter cress		60
Campanula	*aparinoides*	Marsh bellflower		60
Boltonia	*asteroides*	Boltonia		60
Lycopus	*uniflorus*	Northern bugleweed		60
Lysimachia	*ciliata*	Fringed loosestrife		60
Mitella	*nuda*	Naked miterwort		60
Eupatorium	*purpureum*	Sweet Joe-pye weed		60
Sparganium	*eurycarpum*	Giant bur-reed		60
Urtica	*dioica*	Stinging nettle		60
Uvularia	*grandiflora*	Yellow bellwort		60
Solidago	*gigantea*	Giant goldenrod		60
Uvularia	*sessilifolia*	Pale bellwort		60
Cuscuta	*spp.*	Dodder		20
Oxalis	cmx.	Wood-sorrel		20
Ranunculus	*sceleratus*	Cursed crowfoot		20
Cirsium	*muticum*	Swamp thistle		20
Prenanthes	*alba*	White rattlesnake-root		20

Appendix B:
Species Lists for Restoration

SOUTHERN WET ASH SWAMP				
(modified from Dunevitz and Lane 2004)				
Genus	**Species**	**Common Name**	*** = invasive**	**[5]Index**
Sanicula	*marilandica*	Mariland black snakeroot		20
Saxifraga	*pensylvanica*	Swamp saxifrage		20
Erigeron	*philadelphicus*	Philadelphia fleabane		20
Grasses, Rushes and Sedges				
Carex	*lacustris*	Lake-sedge		420
Carex	*stricta*	Tusssock-sedge		360
Scirpus	*microcarpus*	Small-fruited bulrush		300
Carex	*stipata*	Awl-fruited sedge		240
Glyceria	*striata*	Fowl manna-grass		240
Carex	*hystericina*	Porcupine sedge		160
Elymus	*virginicus*	Virginia wild rye		120
Carex	*blanda*	Charming sedge		120
Carex	*lupulina*	Hop-sedge		100
Poa	*sylvestris*	Woodland bluegrass		60
Leersia	*virginica*	White grass		60
Festuca	*subverticillata*	Nodding fescue		60
Leersia	*oryzoides*	Rice cut grass		60
Carex	*pedunculata*	Long-stalked sedge		60
Carex	*rosea*	Rolled-up sedge		60
Carex	*tenera*	Marsh-straw sedge		60
Carex	*disperma*	Soft-leaved sedge		60
Carex	*bromoides*	Brome-like sedge		20
Ferns and Fern Allies				
Matteuccia	*struthiopteris*	Ostrich-fern		1140
Onoclea	*sensibilis*	Sensitive fern		480
Equisetum	*hyemale*	Tall scouring-rush		400
Equisetum	*arvense*	Field horsetail		240
Athyrium	*filix-femina*	Lady-fern		120
Equisetum	*pratense*	Meadow horsetail		100
Adiantum	*pedatum*	Maidenhair fern		60
Osmunda	*claytoniana*	Interrupted fern		60
Cystopteris	*bulbifera*	Bulblet bladder-fern		60
Cystopteris	*protrusa*	Protruding fragile fern		60
Thelypteris	*palustris*	Northern marsh-fern		60
Exotic Invasive Species - Do Not Plant				
Phalaris	*arundinacea*	Reed canary-grass	*	560
Rhamnus	*cathartica*	Common buckthorn	*	400
Lysimachia	*nummularia*	Moneywort	*	300
Myosotis	*scorpioides*	True forget-me-not	*	240
Poa	*pratensis*	Kentucky bluegrass	*	60
Acer	*ginnala*	Amur maple		20
State Listed Rare Species - Do Not Plant Without a Permit				
Hydrocotyle	*americana*	American water pennywort		100
Poa	*paludigena*	Bog bluegrass		60
Juglans	*cinerea*	Butternut		20

Appendix B:
Species Lists for Restoration

SOUTHERN FLOODPLAIN FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	**dnp = do not plant**
Canopy Trees (>10 m)			
Acer	*saccharinum*	Silver maple	
Acer	*negundo*	Box elder	dnp
Celtis	*occidentalis*	Hackberry	
Fraxinus	*pennsylvanica*	Green ash	
Populus	*deltoides*	Cottonwood	
Salix	*nigra*	Black willow	
Ulmus	*americana*	American elm	
Understory Trees			
Acer	*saccharinum*	Silver maple	
Acer	*negundo*	Box elder	dnp
Carya	*cordiformis*	Bitternut hickory	
Celtis	*occidentalis*	Hackberry	
Fraxinus	*pennsylvanica*	Green ash	
Tilia	*americana*	Basswood	
Ulmus	*americana*	American elm	
Shrubs			
Salix	*exigua*	Sandbar willow	
Zanthoxylum	*americanum*	Prickly ash	dnp
Vines			
Menispermum	*canadense*	Canada moonseed	
Parthenocissus	*sp.*	Virginia creeper	
Polygonum	*scandens*	False buckwheat	
Smilax	*hispida*	Green-briar	dnp
Vitis	*riparia*	Wild grape	dnp
Forbs			
Acalypha	*rhomboidea*	Three-seeded mercury	
Asarum	*canadense*	Wild ginger	
Aster	*ontarionis*	Ontario aster	
Bidens	*spp.*	Beggar-ticks	
Boehmeria	*cylindrica*	False nettle	
Campanula	*americana*	Tall bellflower	
Cryptotaenia	*canadensis*	Honewort	
Cuscuta	*spp.*	Dodder	
Eupatorium	*rugosum*	Common snakeroot	
Hackelia	cmx.	Stickseed	
Helenium	*autumnale*	Autumn sneezeweed	
Impatiens	cmx.	Touch-me-not	
Laportea	*canadensis*	Wood-nettle	dnp
Lycopus	*uniflorus*	Northern bugleweed	
Mimulus	*ringens*	Purple monkey-flower	
Physalis	*virginiana*	Ground-cherry	
Physostegia	*virginiana*	Obedient plant	
Pilea	cmx.	Clearweed	
Polygonum	*punctatum*	Dotted smartweed	
Polygonum	*virginianum*	Virginia knotweed	
Ranunculus	*abortivus*	Kidney-leaf buttercup	

Appendix B:
Species Lists for Restoration

SOUTHERN FLOODPLAIN FOREST (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	**dnp = do not plant**
Ranunculus	*hispidus*	Hispid buttercup	
Rudbeckia	*laciniata*	Goldenglow	
Scutellaria	*lateriflora*	Mad-dog skullcap	
Sicyos	*angulatus*	Bur-cucumber	
Solanum	*nigrum*	Black nightshade	dnp
Stachys	*hispida*	Smooth hedge-nettle	
Urtica	*dioica*	Stinging nettle	dnp
Viola	cm1	Violet	
Grasses, Rushes and Sedges			
Leersia	*virginica*	White grass	
Elymus	*virginicus*	Virginia wild rye	
Carex	*lupulina*	Hop-sedge	
Leersia	*oryzoides*	Rice cut grass	
Carex	*intumescens*	Bladder sedge	
Carex	*crawfordii*	Crawford's sedge	
Carex	*tribuloides*	Blunt-broom sedge	
Carex	*blanda*	Charming sedge	
Ferns and Fern Allies			
Onoclea	*sensibilis*	Sensitive fern	
Exotic Invasive Species - Do Not Plant			
Glechoma	*hederacea*	Creeping Charlie	
Phalaris	*arundinacea*	Reed canary-grass	
Arctium	*minus*	Common burdock	
Leonurus	*cardiaca*	Lion's ear	
Stellaria	*aquatica*	Giant chickweed	
Rhamnus	*cathartica*	Common buckthorn	
Melilotus	*spp.*	Sweet clover	
Oxalis	cmx.	Wood-sorrel	
Taraxacum	*spp.*	Common dandelion	
Lysimachia	*nummularia*	Moneywort	
Abutilon	*theophrasti*	Velvet-leaf	
Potentilla	*norvegica*	Rough cinquefoil	
Verbascum	*thapsus*	Common mullein	
State Listed Rare Species - Do Not Plant Without a Permit			
Carex	*typhina*	Cattail-sedge	

Appendix B:
Species Lists for Restoration

SOUTHERN MIXED CATTAIL MARSH (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = invasive species**
Understory Trees			
Acer	*negundo*	Box elder	*
Shrubs			
Amorpha	*fruticosa*	False indigo	
Betula	*pumila*	Bog-birch	
Cornus	*sericea*	Red-osier dogwood	
Salix	*petiolaris*	Slender willow	
Spiraea	*tomentosa*	Steeple-bush	
Forbs			
Acorus	*calamus*	Sweet flag	
Asclepias	*incarnata*	Swamp milkweed	
Aster	*borealis*	Bog aster	
Aster	*firmus*	Red-stemmed aster	
Aster	*pubentior*	Flat-topped aster	
Bidens	*spp.*	Beggar-ticks	
Boehmeria	*cylindrica*	False nettle	
Caltha	*palustris*	Swamp marsh-marigold	
Calystegia	*sepium*	Hedge bindweed	
Campanula	*aparinoides*	Marsh bellflower	
Cicuta	*bulbifera*	Bulb-bearing water-hemlock	
Cicuta	*maculata*	Spotted water-hemlock	
Cuscuta	*spp.*	Dodder	
Epilobium	cm2	Willow-herb	
Epilobium	cm1	Willow-herb	
Eupatorium	*maculatum*	Spotted Joe-pye weed	
Eupatorium	*perfoliatum*	Common boneset	
Galium	*trifidum*	Three-cleft bedstraw	
Galium	*tinctorium*	Small bedstraw	
Helianthus	*grosseserratus*	Sawtooth sunflower	
Impatiens	cmx.	Touch-me-not	
Lathyrus	*palustris*	Marsh vetchling	
Lemna	*spp.*	Lesser duckweed	
Liatris	*ligulistylis*	Northern plains blazing star	
Lobelia	*siphilitica*	Great lobelia	
Lycopus	*americanus*	Cut-leaved bugleweed	
Lycopus	*uniflorus*	Northern bugleweed	
Lysimachia	*thyrsiflora*	Tufted loosestrife	
Lysimachia	*ciliata*	Fringed loosestrife	
Lysimachia	*quadriflora*	Prairie loosestrife	
Lythrum	*alatum*	Wing-angled loosestrife	
Mentha	*arvensis*	Common mint	
Nymphaea	cmx.	Waterlily	
Pedicularis	*lanceolata*	Swamp lousewort	
Pilea	cmx.	Clearweed	
Polygonum	*sagittatum*	Arrow-leaved tearthumb	
Polygonum	*amphibium*	Water smartweed	
Polygonum	*punctatum*	Dotted smartweed	
Polygonum	*pensylvanicum*	Pennsylvania smartweed	
Polygonum	*lapathifolium*	Nodding smartweed	
Polygonum	*amphibium*	Swamp smartweed	

Appendix B:
Species Lists for Restoration

SOUTHERN MIXED CATTAIL MARSH (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = invasive species**
Rorippa	*palustris*	Icelandic yellow cress	
Rumex	*orbiculatus*	Great water dock	
Rumex	*maritimus*	Golden dock	
Sagittaria	*latifolia*	Broad-leaved arrowhead	
Scutellaria	*galericulata*	Marsh skullcap	
Sium	*suave*	Water-parsnip	
Solidago	*gigantea*	Giant goldenrod	
Sparganium	*eurycarpum*	Giant bur-reed	
Stachys	*palustris*	Woundwort	
Stellaria	*longifolia*	Long-leaved chickweed	
Teucrium	*canadense*	Germander	
Thalictrum	*dasycarpum*	Tall meadow-rue	
Typha	*angustifolia*	Narrow leaf cattail	*
Typha	*latifolia*	Broad leaf cattail	
Viola	cm1	Violet	
Grasses, Rushes and Sedges			
Calamagrostis	*canadensis*	Bluejoint	
Carex	*lacustris*	Lake-sedge	
Carex	*comosa*	Bristly sedge	
Carex	*stricta*	Tusssock-sedge	
Carex	*hystericina*	Porcupine sedge	
Carex	*haydenii*	Hayden's sedge	
Carex	*interior*	Inland sedge	
Carex	*stipata*	Awl-fruited sedge	
Carex	*pellita*	Woolly sedge	
Cyperus	*odoratus*	Fragrant cyperus	
Cyperus	*bipartitus*	Brook nut sedge	
Dulichium	*arundinaceum*	Three-way sedge	
Eleocharis	*palustris*	Marsh spikerush	
Leersia	*oryzoides*	Rice cut grass	
Muhlenbergia	*glomerata*	Clustered muhly grass	
Phragmites	*australis*	Common reed	*
Scirpus	*acutus*	Hard-stemmed bulrush	
Scirpus	*validus*	Softstem bulrush	
Scirpus	*fluviatilis*	River bulrush	
Zizania	*palustris*	Wild rice	
Ferns and Fern Allies			
Equisetum	*fluviatile*	Water horsetail	
Thelypteris	*palustris*	Northern marsh-fern	
Exotic Invasive Species - Do Not Plant			
Agrostis	*gigantea*	Redtop	*
Echinochloa	*crusgalli*	Cockspur barnyard grass	*
Phalaris	*arundinacea*	Reed canary-grass	*
Polygonum	*convolvulus*	Black bindweed	*
Rumex	*crispus*	curly dock	*
State Listed Rare Species - Do Not Plant Without a Permit			
Decodon	*verticillatus*	waterwillow	

Appendix B:
Species Lists for Restoration

NORTHERN WET MEADOW/CARR - SEDGE MEADOW TYPE (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = invasive species**
Understory Trees			
Acer	*negundo*	Box elder	*
Betula	*papyrifera*	Paper-birch	
Fraxinus	*pennsylvanica*	Green ash	
Larix	*laricina*	Tamarack	
Populus	*tremuloides*	Quaking aspen	*
Ulmus	*americana*	American elm	
Ulmus	*rubra*	Slippery elm	
Shrubs			
Alnus	*incana*	Speckled alder	
Betula	*pumila*	Bog-birch	
Cornus	*amomum*	Silky dogwood	
Cornus	*sericea*	Red-osier dogwood	
Ilex	*verticillata*	Winterberry	
Salix	*bebbiana*	Bebb's willow	
Salix	*candida*	Sage-leaved willow	
Salix	*discolor*	Pussy willow	
Salix	*eriocephala*	Heart-leaved willow	
Salix	*exigua*	Sandbar willow	
Salix	*pedicellaris*	Bog willow	
Salix	*petiolaris*	Slender willow	
Spiraea	*alba*	Meadowsweet	
Spiraea	*tomentosa*	Steeple-bush	
Forbs			
Acorus	*calamus*	Sweet flag	
Alisma	*triviale*	Ordinary water-plantain	
Anemone	*canadensis*	Canada anemone	
Apios	*americana*	Groundnut	
Apocynum	*sibiricum*	Clasping dogbane	
Asclepias	*incarnata*	Swamp milkweed	
Aster	*lanceolatus*	Panicled aster	
Aster	*borealis*	Bog aster	
Aster	*firmus*	Red-stemmed aster	
Aster	*umbellatus*	Flat-topped aster	
Bidens	*spp.*	Beggar-ticks	
Boehmeria	*cylindrica*	False nettle	
Calla	*palustris*	Wild calla	
Caltha	*palustris*	Swamp marsh-marigold	
Campanula	*aparinoides*	Marsh bellflower	
Chelone	*glabra*	White turtlehead	
Cicuta	*bulbifera*	Bulb-bearing water-hemlock	
Cicuta	*maculata*	Spotted water-hemlock	
Cirsium	*muticum*	Swamp thistle	
Conyza	*canadensis*	Horseweed	*
Echinocystis	*lobata*	Wild cucumber	
Epilobium	cm2	Willow-herb	
Epilobium	cm1	Willow-herb	
Erechtites	*hieracifolia*	Pilewort	
Erigeron	*philadelphicus*	Philadelphia fleabane	
Eriocaulon	*aquaticum*	Pipewort	
Eupatorium	*maculatum*	Spotted Joe-pye weed	
Eupatorium	*perfoliatum*	Common boneset	
Fragaria	*virginiana*	Common strawberry	
Galium	*trifidum*	Three-cleft bedstraw	
Galium	*tinctorium*	Small bedstraw	
Galium	*labradoricum*	Marsh bedstraw	

Appendix B:
Species Lists for Restoration

NORTHERN WET MEADOW/CARR - SEDGE MEADOW TYPE (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = invasive species**
Gentiana	*billingtonii*	Closed gentian	
Geum	*aleppicum*	Yellow avens	
Habenaria	*psycodes*	Small purple fringed-orchid	
Helenium	*autumnale*	Autumn sneezeweed	
Helianthus	*giganteus*	Giant sunflower	
Hypericum	*majus*	Large St. John's-wort	
Impatiens	*spp.*	Touch-me-not	
Iris	*versicolor*	Northern blue Flag	
Lathyrus	*palustris*	Marsh vetchling	
Lemna	*spp.*	Lesser duckweed	
Lycopus	*uniflorus*	Northern bugleweed	
Lycopus	*americanus*	Cut-leaved bugleweed	
Lycopus	*asper*	Rough bugle-weed	
Lysimachia	*thyrsiflora*	Tufted loosestrife	
Lysimachia	*terrestris*	Yellow loosestrife	
Mentha	*arvensis*	Common mint	
Nuphar	*luteum*	Yellow pond-lily	
Pedicularis	*lanceolata*	Swamp lousewort	
Pilea	*spp.*	Clearweed	
Polygonum	*amphibium*	Water smartweed	
Polygonum	*sagittatum*	Arrow-leaved tearthumb	
Polygonum	*punctatum*	Dotted smartweed	
Polygonum	*lapathifolium*	Nodding smartweed	
Polygonum	*hydropiperoides*	Mild water-pepper	
Potentilla	*palustris*	Marsh cinquefoil	
Potentilla	*norvegica*	Rough cinquefoil	*
Pycnanthemum	*virginianum*	Virginia mountain-mint	
Ranunculus	*pensylvanicus*	Bristly buttercup	
Rubus	*pubescens*	Dwarf raspberry	
Rumex	*orbiculatus*	Great water dock	
Sagittaria	*latifolia*	Broad-leaved arrowhead	
Saxifraga	*pensylvanica*	Swamp saxifrage	
Scutellaria	*galericulata*	Marsh skullcap	
Scutellaria	*lateriflora*	Mad-dog skullcap	
Sium	*suave*	Water-parsnip	
Smilacina	*stellata*	Starry false Solomon's-seal	
Solidago	*canadensis*	Canada goldenrod	
Solidago	*gigantea*	Giant goldenrod	
Sparganium	*eurycarpum*	Giant bur-reed	
Stachys	*palustris*	Woundwort	
Stellaria	*longifolia*	Long-leaved chickweed	
Teucrium	*canadense*	Germander	
Thalictrum	*dasycarpum*	Tall meadow-rue	
Triadenum	*fraseri*	Marsh St. John's-wort	
Typha	*angstifolia*	Narrow leaf cattail	*
Typha	*latifolia*	Broad leaf cattail	
Urtica	*dioica*	Stinging nettle	*
Verbena	*hastata*	Blue vervain	
Veronica	*scutellata*	Marsh speedwell	
Viola	cm2	Violet	
Viola	*renifolia*	Kidney-leaf violet	
Grasses, Rushes and Sedges			
Agrostis	*hyemalis*	Rough bent-grass	
Bromus	*ciliatus*	Fringed brome	
Calamagrostis	*canadensis*	Bluejoint	
Carex	*aquatilis*	Water sedge	

Appendix B:
Species Lists for Restoration

NORTHERN WET MEADOW/CARR - SEDGE MEADOW TYPE (modified from Dunevitz and Lane 2004)			
Genus	**Species**	**Common Name**	*** = invasive species**
Carex	*bebbii*	Bebb's sedge	
Carex	*buxbaumii*	Buxbaum's sedge	
Carex	*cephalantha*	Bunched sedge	
Carex	*diandra*	Lesser-panicled sedge	
Carex	*haydenii*	Hayden's sedge	
Carex	*interior*	Inland sedge	
Carex	*lacustris*	Lake-sedge	
Carex	*lasiocarpa*	Wire-sedge	
Carex	*prairea*	Prairie sedge	
Carex	*sartwellii*	Sartwell's sedge	
Carex	*scoparia*	Pointed-broom sedge	
Carex	*stipata*	Awl-fruited sedge	
Carex	*stricta*	Tusssock-sedge	
Carex	*tribuloides*	Blunt-broom sedge	
Carex	*vesicaria*	Inflated sedge	
Carex	*pellita*	Woolly sedge	
Carex	*utriculata*	Beaked sedge	
Dulichium	*arundinaceum*	Three-way sedge	
Eleocharis	*compressa*	Flattened spike-rush	
Eleocharis	*palustris*	Marsh spike rush	
Eriophorum	*angustifolium*	Narrow-leaved cotton-grass	
Glyceria	*canadensis*	Rattlesnake grass	
Glyceria	*grandis*	Tall manna-grass	
Glyceria	*striata*	Fowl manna-grass	
Juncus	*canadensis*	Canada rush	
Leersia	*oryzoides*	Rice cut grass	
Leersia	*virginica*	White grass	
Muhlenbergia	*racemosa*	Marsh muhly grass	
Phragmites	*australis*	Common reed	*
Poa	*palustris*	Fowl meadow-grass	
Scirpus	*acutus*	Hard-stemmed bulrush	
Scirpus	*atrovirens*	Dark green bulrush	
Scirpus	*cyperinus*	Wool-grass	
Scirpus	*pungens*	Three-square	
Scirpus	*validus*	Softstem bulsush	
Spartina	*pectinata*	Prairie cord-grass	
Ferns and Fern Allies			
Equisetum	*fluviatile*	Water horsetail	
Equisetum	*arvense*	Field horsetail	*
Onoclea	*sensibilis*	Sensitive fern	
Thelypteris	*palustris*	Northern marsh-fern	
Exotic Invasive Species - Do Not Plant			
Cirsium	*arvense*	Canada thistle	*
Cirsium	*vulgare*	Bull thistle	*
Crepis	*tectorum*	Yellow hawk's-beard	*
Leonurus	*cardiaca*	Lion's ear	*
Lythrum	*salicaria*	Purple loosestrife	*
Phalaris	*arundinacea*	Reed canary-grass	*
Poa	*pratensis*	Kentucky bluegrass	*
Polygonum	*convolvulus*	Black bindweed	*
Rumex	*crispus*	Curly dock	*
Ulmus	*pumila*	Siberian elm	*
State Listed Rare Species - Do Not Plant Without a Permit			
(none)			

Appendix C: Fact Sheets for Selected Exotic and Invasive Species

The following pages contain information on the habitat, phenology and niche of exotic and invasive plants found in Crosby Farm Park. These species are troublesome plants, both native and exotic, which compete with the native plants typical of undisturbed native communities. They threaten the integrity, structure and function of those communities. Active management to control invasive plant species is essential to restoring the health of plant communities and the habitats they provide for a diverse group of native animals.

Invasive trees and shrubs:

Black locust	*Robinia pseudoacacia*
Box elder	*Acer negundo*
Common buckthorn *	*Rhamnus cathartica*
Tartarian Honeysuckle*	*Lonicera tartarica*
Siberian elm*	*Ulmus pumila*
Smooth sumac	*Rhus glabra*

Invasive Forbs:

Canada thistle*	*Cirsium arvense*
Garlic mustard *	*Alliaria petiolata*
Leafy spurge*	*Euphorbia esula*
Purple loosestrife*	*Lythrum salicaria*
Spotted knapweed*	*Centaurea bieberstonii*

Invasive Grasses:

Bluegrass *	*Poa pratensis, P. compressa*
Reed canary grass *	*Phalaris arundinacea*
Smooth brome grass*	*Bromus inermis*

* exotic species

Black Locust (*Robinia pseudoacacia*)

DESCRIPTION: Black locust is a leguminous deciduous tree that grows from 30 to 80 feet tall. It is often attacked by stem borers and other insects, causing deformed growth and dieback. It has a shallow, fibrous root system and spreads by underground rhizomes. Young saplings have smooth, green bark; older trees have deep, furrowed, shaggy, dark bark with flat-topped ridges. Leaves are alternate and pinnately compound with 7 to 21 leaflets. Leaflets are thin, elliptical, dark green above, and pale beneath. Smaller branches are armed with heavy, paired thorns. Flowers are pea-like, fragrant, white and yellow, and born in large drooping racemes. Seed pods are shiny, smooth, narrow, flat, 2 to 4 inches long, and contain 4 to 8 seeds. Black locust stands are easy to identify in spring because they typically form multiple-stemmed clones and are slow to leaf out. They produce showy flower clusters in May or June.

DISTRIBUTION AND HABITAT: Black locust is a translocated deciduous tree that is frequently found in upland prairies, savannas, roadsides, old fields, and woodlots. Black locust prefers humid climates with sandy, loamy, well-drained soils in open, sunny locations.

The tree is native to the slopes and forest margins of Southern Appalachia and the Ozarks. It was introduced throughout Wisconsin in the early 1900's because its aggressive growth pattern and extensive root system discourage soil erosion. Black locust wood is also valued for its durability and high fuel value, and provides good forage for bees.

LIFE HISTORY AND EFFECTS OF INVASION: Black locust produces abundant seeds, but a thick seed coat hinders consistently successful seed germination. The plant typically reproduces vegetatively 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 (e.g. from fire, wind, cutting, disease, etc.) stimulates vigorous sprouting, root suckering, and lateral spread. Black locust is susceptible to severe insect damage from locust borers, locust leaf miners, and locust twig borers.

Black locust commonly occurs in disturbed habitats like pastures, degraded woods, thickets, old fields, and roadsides. Successful reproduction via vegetative runners has contributed to the naturalization of black locust in upland forests, prairies, and savannas. Because dense clonal stands shade out most understory vegetation, such tree groves can be detrimental to native vegetation.

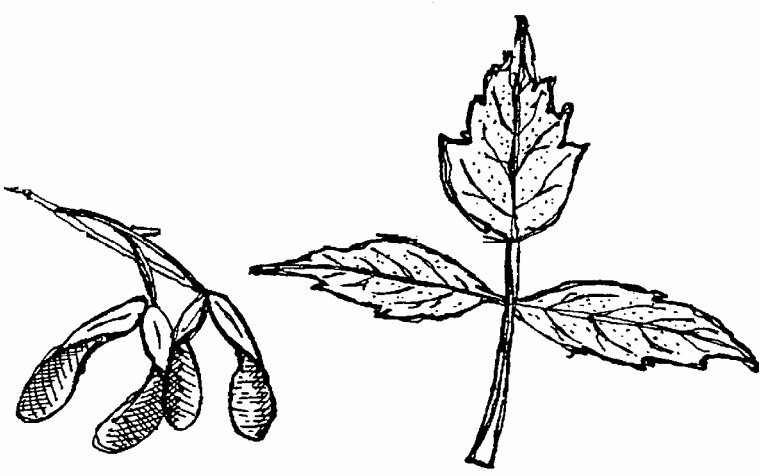
CONTROLLING BLACK LOCUST

Mechanical Control: Cutting black locust stimulates sprouting and clonal spread. For this reason, some suggest to avoid simply cutting the stems. Mowing and burning temporarily control spreading, but mowing seems to promote seed germination, and burning stimulates sprouting. Girdling is ineffective because it kills the stem but does not prevent sucker formation. Annual haying may be adequate to control first year seedlings and prevent spreading in prairie communities. Bulldozing may be an option on disturbed lands.

Chemical Control: Treat cut stumps of black locust with Transline (clopyralid) herbicide.

Source: modified from the Wisconsin Department of Natural Resources, 1997,

Box elder *(Acer negundo)*



Effects of Invasion
Box elder is an opportunistic species native to the United States. Extremely prolific, it will inhabit many environments disturbed by humans. Box elders produce seeds during summer and fall and the wind disperses the fruits to suitable habitats for germination. Reproduction can also take place through suckers, sprouts, and root shoots. Box elders are aggressively opportunistic and tend to shade out smaller, herbaceous flora.

Size: 30–50 feet in height, can reach 70 feet with spread equal to or greater than the height.
Habit: Usually rounded to broad-rounded in outline, branches develop irregularly to support the uneven crown.
Leaves: Pinnately compound with 3–5 leaflets arranged oppositely on the stem. Leaflets can be lanceolate to oblong, with margins that may be separated into several shallow lobes.
Stem: Green to reddish brown, often covered with a waxy whitish bloom that can be rubbed off.
Bark: Gray-brown, slightly ridged, and furrowed.
Fruit: Double-winged produced by females.
Flower: Male plants bear stamens in umbel-like arrangements, while the female plants produce apetalous racemes.
Origin: United States and southern Canada.

Mechanical Control

- Large-diameter trees can be cut with a chainsaw. Re-sprouts must be recut or herbicides may be applied to the cut stump.

Chemical Control

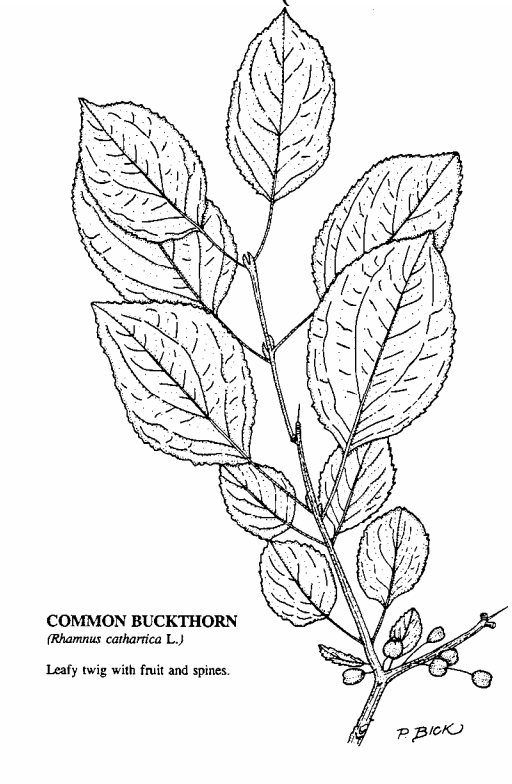
Cut and spray

- 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 efffective 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.

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, and 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 an 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.

Controlled burning

In oak woods with accumulations of oak leaf litter, controlled burning carried by oak leaves can be a successful strategy for controlling small buckthorn plants of an inch or less in diameter that remain after removal of larger buckthorn plants. In stands dominated by red oak and northern pin oak, fire to control small buckthorn works best in the spring when the trees drop their leaves. In stands dominated by white oak and bur oak, late fall after leaves drop is a better time to burn. Once buckthorn has been set back in this way after a couple of years, oak seedlings can be encouraged to grow. If desirable seedlings already exist in an area to be burned for buckthorn control, leaves can be raked or blown away from the seedling to prevent it from burning. Such seedlings can also be wet down prior to the burn.

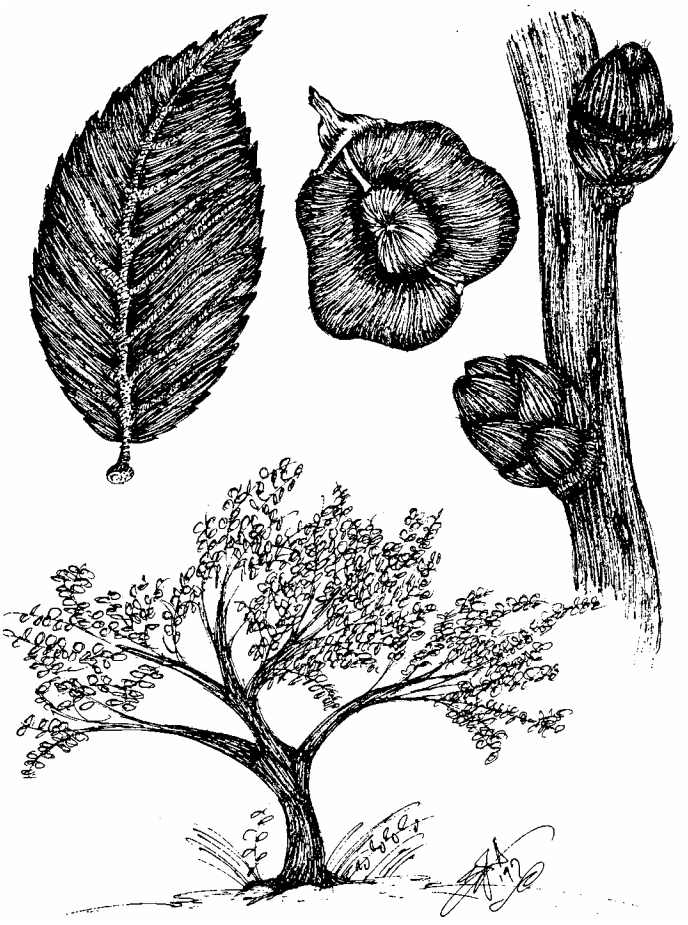
In areas that cannot be burned, buckthorn control may be accomplished by applying Krenite as a bud inhibitor or Garlon 3a as a foliar application. This can be sprayed on seedlings after an explosion of germinating seeds in a recently cleared area.

Long term considerations

Buckthorn is a plant that prefers wooded areas with thin canopies and a moderately high amount of light penetration, such as under the thin canopy of open grown oaks. Areas that are restored to forest structure with heavier tree canopies should have less buckthorn invasion due under the heavier shade. Once removed, buckthorn can be replaced with native shrubs and understory trees, though this may inhibit recruitment of desirable tree seedlings into the canopy. If there is enough light present, a good strategy would be to replace buckthorn thickets with trees such as oaks that need the light to reach the canopy.

Source: Wisconsin Department of Natural Resources, 1997, with additions by the author.

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.
Habit: Open, round crown of slender, spreading branches.
Leaves: Small, elliptical, smooth singly toothed leaves that reach lengths of approximately 0.8–2.6 inches, tapering or rounded at their asymmetrical base.
Stem: Slender, brittle, very light gray or gray-green, usually smooth, can be 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

- Girdle in late spring to mid-summer by removing a band of bark around the tree trunk, just within the bark layer (cambium). Girdling too deeply may lead to re-sprouting. Girdled trees die slowly over 1–2 years.
- Hand pull or weed-wrench seedlings.
- Conduct regular prescribed burns in fire-adapted communities. Saplings older than a few years may not be killed by fire and instead will require another control method.

Chemical Control

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.

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

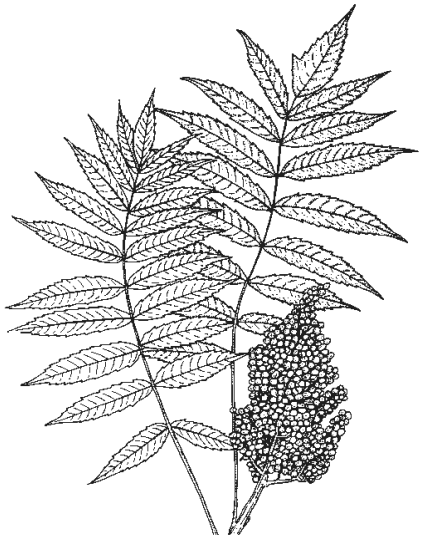
- Cut and apply herbicide to any honeysuckle regardless of size if soil conditions are not appropriate for mechanical control.
- In high-quality natural areas and in aquatic environments where surface water is present, apply an herbicide formulated for use over water.
- Repeat control methods for at 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.
- This is a particularly tough shrub to control. Thorough application of at least 25% Triclopyr (Garlon) is recommended to cut stumps. Applications should not be done in the spring. Crossbow is a new herbicide with potential for foliar application on resprouts.

Source: Wisconsin Department of Natural Resources, 1997, with additions from the author.

Staghorn Sumac *(Rhus typhina)*
Smooth Sumac *(Rhus glabra)*



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 1 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). Cutting 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 prairies 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 3–4 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 people.

Source: Wisconsin Department of Natural Resources, 1997

Canada Thistle *(Cirsium arvense)*

Photo by Merel R. Black

Effects of Invasion:
Canada thistle is an alien species capable of crowding out and replacing native grasses and forbs. It is detrimental to natural areas where it occurs, particularly non-forested communities, and it can change the natural structure and species composition where it becomes well established. Prairies, barrens, savannas, and glades are susceptible, particularly those sites that have been disturbed as well as those undergoing manipulative restoration management. It is important to control this species prior to restoration work.

The plant grows in clonal patches of all female or male plants. As a result, some patches produce seeds and others do not. Seeds mature quickly and are capable of germinating within 8 to 10 days after the flowers open, even if the plants are cut when flowering. Most seeds germinate within one year, but may remain viable in the soil for up to 20 years. Seeds are mostly dispersed by wind and sometimes by water runoff. Small sections of broken roots are capable of producing new plants.

Canada thistle is considered a noxious weed under Minnesota law and should not be allowed to go to seed.

Size: Canada thistle is a 2 to 5 foot (0.6 to 1.5 meters) tall herbaceous plant with deep, wide spreading, horizontal roots. The root system is usually within a foot of the surface, but may extend 6 feet deep or more in loose soil. The horizontal roots stemming from the fibrous taproot

of a single plant can spread 10 to 12 feet in one season, resulting in a circular infestation 20 feet across. Aerial shoots are sent up in 2 to 6 inch intervals, and generally produce basal leaves the first year and flowering stems the next year.
Habit: Canada thistle is a clone-forming perennial. The grooved, slender stems branch only at the top and are slightly hairy when young; becoming covered with hair as the plant grows.
Leaves: The oblong, tapering, sessile leaves are deeply divided, with prickly margins. Leaves are green on both sides with a smooth or slightly downy lower surface.
Fruit: Seeds are small (3/16 inch or 0.5 cm long), light brown, smooth and slightly tapered, with a tuft of tan hair loosely attached to the tip.
Flowers: Numerous small, compact (3/4 inch or 1.9 cm. diameter), rose-purple or white flowers appear on upper stems from June to September.
Origin: Canada thistle is native to Europe, not Canada, as its name suggests. Its current range encompasses the northern portion of the United States east of the Rocky Mountains.

Mechanical Control:
Repeated pulling, routine mowing or selective cutting will eventually starve underground stems and effectively reduce an infestation within 3 or 4 years. The ideal time to cut is in the very early bud stage when food reserves are at their lowest point. Plants cut 8 days or more after flowers have opened should be removed from the site because seeds mature quickly. Cutting should be completed prior to flowering and seed set. If seeds are ripe, cut flower heads must be removed from the site immediately to avoid further seed dispersal. Plants should be pulled or cut at least three times during the growing season -- for example, in June, August, and September. Some persons have had success killing individual plants by cutting the top and putting table salt down the hollow stem.

Prescribed fire can be effective in controlling this species and is a preferred treatment. Late spring burns between May and June, effectively discourage this species, whereas early spring burns can increase sprouting and reproduction. During the first 3 years of control efforts, burns should be conducted annually. Healthy, dense prairie vegetation can produce enough competition to reduce the abundance of Canada thistle.

On severely disturbed sites with heavy infestations, such as cropland or abandoned cropland, the site could be plowed and sowed to a cover crop (wheat, alfalfa, and rye), if practical and desirable. The following May, the cover crop should be plowed under and desired native species should be seeded. Tillage disturbance of soil may provide ideal conditions for reinvasion and for introduction of other exotics.
Grazing is not an effective control measure as the prickles prevent livestock from grazing near Canada thistle.

Chemical Control:
Control of this species with herbicides in natural areas is not recommended, as the herbicide can damage native vegetation more than the damage caused by the thistle. However, spot application of the amine formulation of 2,4-D using a wick applicator or hand sprayer can control individual stems if necessary.

Infested lands that are not considered high quality natural areas may be controlled using a foliar application of a 1-2% active ingredient solution of glyphosate in spring when plants are 6-10 inches tall.

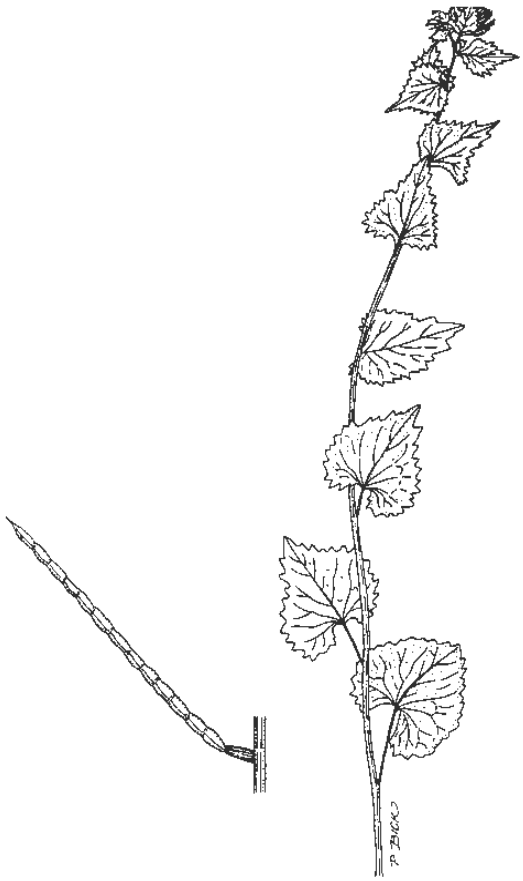
Spot application of Transline (a formulation of clopyralid), according to label instructions can control this plant. Individual plants of Canada thistle should be treated with a wick applicator or hand sprayer. The herbicide Transline is selective for broadleaf plants. To reduce vapor drift and improve plant up-take of the chemical, a surfactant may be added to the spray solution. Precautions should be taken to avoid contacting nontarget plants with the solution.

A foliar application of a 1-2% solution of Roundup (a formulation of glyphosate) applied in spring when plants are 6-10 inches (15.2 -25.4 cm) tall is an effective herbicide treatment. Individual plants should be spot-treated with a wick applicator. Roundup normally kills the entire plant, including the roots, when applied in this manner. Roundup is a nonselective herbicide and precautions should be taken to avoid contacting nontarget plants with the solution.

Sources:

Wisconsin Department of Natural Resources, 2002
Vegetation Management Manual, Vol. 1, No. 2. Illinois Nature Preserves Commission, approved 02/06/90

Garlic Mustard *(Alliaria petiolata)*



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. This is not recommended for slopes, as it promotes erosion.
- Cut the flower stalk with a weed whip as close to the soil surface as possible just as flowering begins. Cutting before the plant flowers may promote re-sprouting.
- Burn in fall or early spring (before wild flower growth). Burn annually for 3–5 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.

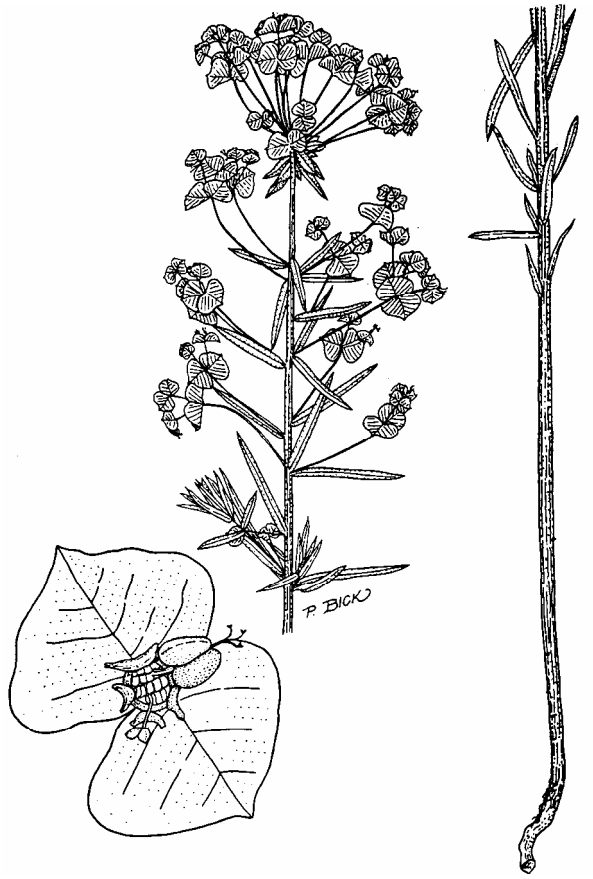
Source: Wisconsin Department of Natural Resources, 1997, with additions from the author.

Additional Comments:

Biological Control

There are efforts underway in the Minnesota DNR to identify insects for biological control of this exotic plant. It will take several years to test potential control species before they will be released, if they find a good control agent. As with purple loosestrife, biological controls will not eradicate this plant but hopefully will keep the population down enough to allow the establishment of a continuous and diverse herbaceous plant community.

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 yellow-green petal like bracts around tiny flowers.
Origin: Europe and Asia.

Mechanical Control

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

Biological Control

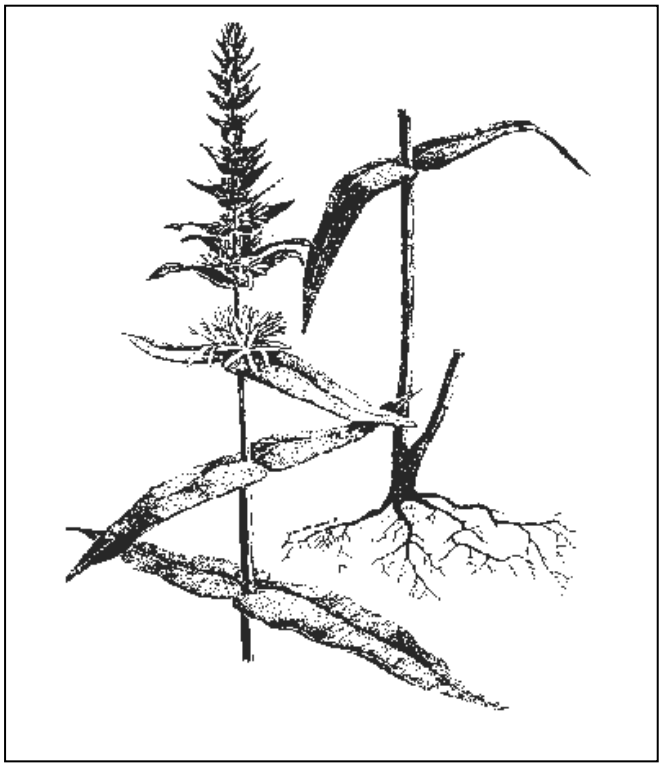
- Pasturing goats in areas infested with leafy spurge.
- Experimental insect control with beetles and a midge species is reducing populations.
- The allelopathic effects of black walnut inhibit plant growth.

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.

Purple Loosestrife *(Lythrum salicaria)*



Effects of Invasion
Purple loosestrife spreads mainly by seed, but it can also spread from roots or stems. A single stalk can produce 100,000–300,000 seeds per year. Sunny and partly shaded wetland is susceptible to invasion. Purple loosestrife generally builds up a large seed bank in the soil for several years before becoming dominant. After disturbance, loosestrife can spread rapidly, eventually taking over entire wetlands. Purple loosestrife degrades wetlands by displacing native wetland vegetation and decreasing habitat for wildlife species.

Habit: Purple loosestrife is a perennial herb 3–7 feet tall with a dense bushy growth of 1–50 stems.
Size: 3–7 feet tall.
Leaves: Leaves are opposite, nearly linear, and attached to 4-sided stems without stalks.
Stem: Stems range from green to purple.
Flower: Flowers vary from purple to magenta, have 5–6 petals and are aggregated into numerous long spikes. Flowering occurs from July to September.
Origin: Europe.

Mechanical Control
Small young plants can be hand pulled while older plants can be removed with a shovel. If possible, entire root systems should be removed to prevent re-sprouting. Soil disturbance should be minimized to prevent seedling establishment. Plants should be controlled before the onset of

seeds around the first week of August or seeds should be cut and bagged. Plant parts should be dried and disposed of accordingly. Follow-up treatments are recommended for at least 3 years after removal. Mowing and burning have not been effective with purple loosestrife. However, water-level manipulation has been successful. Water levels are reduced until loosestrife has sprouted, then levels are increased until stems are drowned.

Biological Control

Biocontrol is currently considered the most viable option for purple loosestrife control. Several natural insect enemies of purple loosestrife from Europe have been introduced. A species of weevil (*Hylobius transversovittatus*) lays eggs in the stem and upper root system of the plant and its larvae eat root tissue. In addition, two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) and a weevil that feeds on flowers (*Nanophyes marmoratus*) are being used. These insects almost exclusively feed on *Lythrum salicaria* and not native plants. The insects generally do not eradicate loosestrife but reduce the population to a state where it does not dominate native habitats.

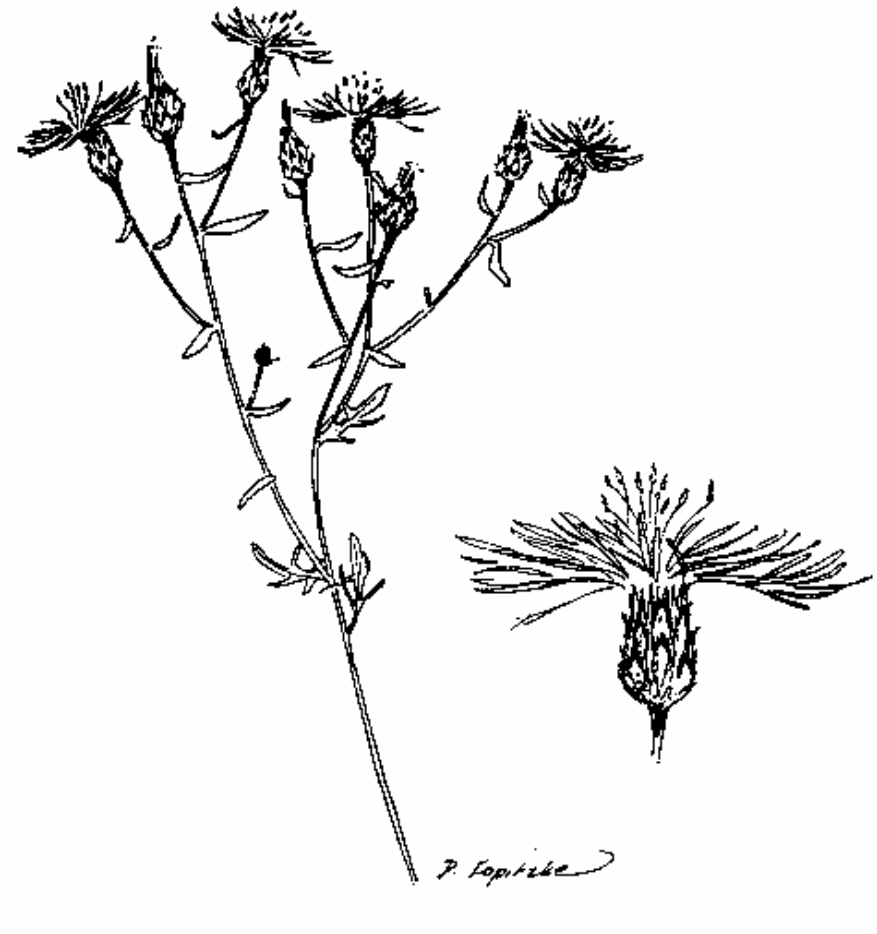
Recent data show that we will never eradicate purple loosestrife from the area by using biocontrol agents alone (Skinner, pers. comm.). Once well established, the insects will have a cyclical, boom and crash population following expansion and contraction of the loosestrife population. Once the insects have eaten down existing loosestrife, the insect population will crash. Purple loosestrife, a prolific seed producer, will eventually recover from the seed bank. After a short lag, the biocontrol insect population will also recover and then knock back the purple loosestrife population again. The insects move around and once established within the nature center, they should also eventually find other purple loosestrife stands. Their dispersal could be aided by collecting and moving insects. In spite of the boom and bust cycle of purple loosestrife under biological control, native wetland plants cover has increased greatly in experimental trials. Hand pulling of purple loosestrife while it is in flower is effective in conjunction with biological control.

Chemical Control

Glyphosate is the most common chemical used for killing purple loosestrife. The formula designed for use on wet or standing water sites should be applied in late July or August. A 1% active ingredient (a.i.) solution should be used, and only 25% of the foliage of each plant needs to be covered. Glyphosate mixed to 3%–10% solution can also be used on freshly cut stems (this is effective on larger plants in areas of low loosestrife densities). Cut stems should be removed from the site and disposed of appropriately. Triclopyr formulated for water dilution is an effective herbicide for loosestrife. This broadleaf herbicide does not harm sedges or monocots. Foliar application should cover nearly all of the foliage.

Source: Wisconsin Department of Natural Resources, 1997, with additions from the author.

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.

Habit: Biennial or short-lived upright perennial forb.
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: Lavender 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. Repeating this several years in a row is effective. Do a major pulling in June. Check and pull plants 4 to 6 times during the rest of the growing season, as knapweed blooms throughout the year.
- Conduct prescribed burn followed by selective pulling or digging.
- Black plastic put over dense infestations is effective as an alternative to chemical control.

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./acre 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:

- Biological controls include two seed-head attacking flies and root-boring insect species. Consult the Minnesota Department of Agriculture 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.

Kentucky Bluegrass (*Poa pratensis*)
Canada Bluegrass (*Poa compressa*)


(c) John M. Randall/The Nature Conservancy

Effects of invasion: Because bluegrass grows early in the season (when most other species are still dormant), it can spread very quickly. However, its shallow root system makes it susceptible to high soil temperatures and low soil moisture. Bluegrass has successfully invaded both remnant and restored prairies, savannas, and barrens. Establishment can be attributed to intentional introduction, past mowing, grazing, or cessation of fire. If left unattended, bluegrass can out-compete native prairie grasses and forbs, and will dominate shaded areas resulting from woody species invasions.

Description: Most of the cool season grasses that begin growing early are not native to Wisconsin prairies. Bluegrass can be distinguished vegetatively from other early grasses by its narrow blade, which is V-shaped in cross section, and by the leaf tip, which is shaped like the bow of a boat. Kentucky bluegrass is distinguished from Canada bluegrass by the shape of the stem. In Kentucky bluegrass the stem is round; Canada bluegrass has a flat stem. Their effects on the natural systems are equivalent and therefore should be treated as one problem. Many of the other cool-season European grasses (brome, timothy, orchard grass, quack grass, etc.) have similar growth habits and can be controlled using the techniques discussed below.

Distribution and habitat: Kentucky bluegrass was introduced as a cultivar from Europe, and has been bred into multiple cultivars since its introduction. Because of its extensive use for lawns and in pastures, it is common in most grasslands, even those managed for native species. Canada bluegrass is also naturalized from Europe. Kentucky bluegrass is a common lawn and pasture grass. Canada bluegrass is often mistaken for Kentucky bluegrass, but is distinguished by forming extensive sods in dry, sterile soils (especially acidic soils) that cannot sustain the more common Kentucky bluegrass. Kentucky bluegrass is usually found on more mesic and fertile soils, although it will grow on dry neutral or alkaline soils.

Mechanical Control

A controlled fire can dramatically reduce bluegrass in a native or planted prairie, savanna, or barrens. Fire will also set back the woody species whose shade encourages the proliferation of cool-season grasses. In southern Wisconsin, a late April or early May burn will destroy three to eight inches of new growth. Timing of burns may change on a year-to-year basis depending on weather conditions. Observing bluegrass growth is essential for effective control by burning. Fire is most effective when bluegrass is three to eight inches high. Burning at this time kills new growth and removes accumulated leaf litter. Burning off the moisture-retaining blanket of leaf litter increases stress on the shallow-rooted bluegrass by exposing the darkened surface to the sun. This helps reduce the competitive ability of bluegrass by encouraging summer dormancy and decreasing the chance of flowering and seed production. The effect is most pronounced on dry prairies and barrens. Burning can reduce bluegrass by more than 90%, but it is rarely 100% effective. Burning at the right time also improves the competitive advantage of native, warm-season grasses and forbs. Native species emerge later and benefit from the elimination of duff and a darkened soil surface.

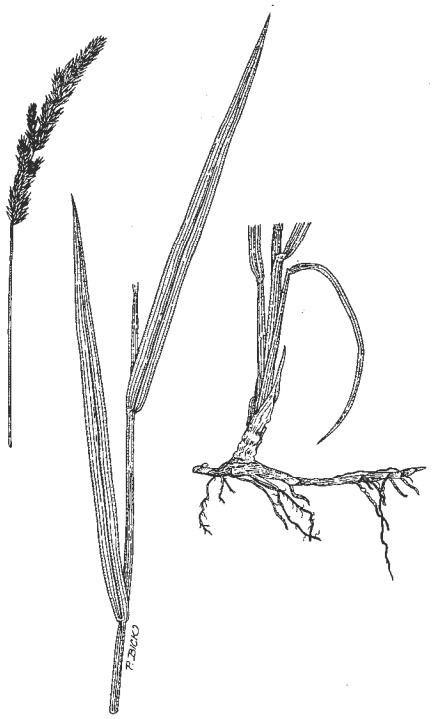
When converting areas dominated by cool-season grasses into prairie, it is helpful to reduce the grass cover and seed bank before planting native seeds. This can be accomplished by any combination of tilling, smothering the grass, or applying herbicide. Till several times a year for at least one season to expose the seed bank and prevent further growth of the grass sod. Herbicide use followed by a season of tilling is also effective. On small sites, grasses can be killed by covering with black plastic or layers of newspapers during the growing season.

Chemical Control

Herbicide use is not recommended to control bluegrass on grasslands or savannas where there are native prairie plants. However, herbicide may be required on severely degraded areas or where prairie restoration is beginning. In such cases, the herbicide glyphosate has proven effective when used according to label applications.

Source: Wisconsin Department of Natural Resources, 2002

Reed Canary Grass *(Phalaris arundinacea)*



Effects of Invasion
Reed canary grass reproduces by seed or creeping rhizomes and spreads aggressively. It prefers disturbed areas but can easily move into native wetlands. In less than 12 years, reed canary grass can form large, monotypic stands that harbor few other plant species and therefore are of little use to wildlife. Reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated areas. Reed canary grass is difficult to eradicate; no single control method is universally applicable.

Size: 2–9 feet in height.
Habit: A large, coarse, cool-season, sod-forming, perennial wetland grass. Sprouts early in spring, forming a thick rhizome system that dominates the subsurface soil.
Blades: Erect, hairless stem with gradually tapering leaf blades 3.5–10 inches long and .25–.75 inches wide. The ligule is highly transparent.
Panicles: Compact, erect or slightly spreading (depending on the plant's reproductive stage), ranging from 3–16 inches long with branches .5–1.5 inches long.
Flowers: Single flowers occur in dense clusters in May to mid-June. They are green to purple, changing to beige over time.
Seeds: Shiny brown.
Origin: Eurasia and North America.

Mechanical Control

- Small, discrete patches may be covered by black plastic for at least one growing season then seeded with native species. This method is not always effective and must be monitored because rhizomes can spread beyond the edge of the plastic.
- Prescribed burns in late spring or late fall may help reduce the population if repeated annually for 5–6 years. The application of 1.5% glyphosate solution will "brown off" reed canary grass enough to conduct burns. A late spring burn followed by mowing or wick application of glyphosate to the emerging flowering shoots will eliminate seed production for that year. Burning is ineffective in eliminating dense stands of reed canary grass that lack competition from native, fire-adapted sepias in the seed bank.
- Mowing twice yearly (early to mid-June and early October) may help control reed canary grass by removing seed heads before the seed matures and by exposing the ground to light, which promotes the growth of native wetland species. Discing the soil in combination with a mowing or burning regimen may help by opening the soil to other species.
- Hand-pulling or digging may work on small stands in the early stages of invasion.
- A bulldozer can be used to remove reed canary grass and rhizomes (12–18 inches deep), after which native species should be seeded. Discing or plowing can also be used in this way.
- Repeated cultivation for one full growing season followed by dormant seeding near the first-frost date. Combine with spot herbicide application in sections too wet for early or late cultivation.

Chemical Control

- Perform foliar application of a 5% glyphosate solution designed for use in wetlands in early spring when most native species are dormant. Remove the dead leaves from the previous year before applying herbicide. Two herbicidal applications may be necessary to ensure complete coverage. Mow in mid-September then apply herbicide in October (after big bluestem is dormant).
- Perform wick application of a 5% glyphosate solution designed for use in wetlands in the first to third weeks of June, followed by a late June to mid-July burn. This technique reduces reed canary grass cover, depletes the seed bank, and stimulates native seed banks.
- In non-aquatic environments, apply Dalpon and trichloracetic in late fall or early winter at a rate of 20lbs.–40 lbs./acre on dried foliage.

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

Smooth (Awnless) Brome (*Bromus inermis)*

Seed head

Field of brome

Photos: Minnesota DNR-Angela Anderson

Effects of Invasion: Smooth brome is a cool season exotic that is especially troublesome in disturbed portions of native plant communities and restorations in the tallgrass and mixed prairie regions. Although less invasive than Kentucky bluegrass, with which it often occurs and is managed, it is also less responsive to management. Smooth brome has been widely planted as a forage and cover crop. Although perhaps not as invasive as *Poa pratensis*, with which it often grows, it is highly persistent. It forms a dense sod that often appears to exclude other species, thus contributing to the reduction of species diversity in natural areas.

Size: *Bromus inermis* is a perennial cool season grass that grows 2 - 3' high with a hairless erect stem. Brome roots have been known to reach a depth of 4.7 feet.
Habit: *Bromus inermis* is a deeply rooting, rhizomatous, sod-forming perennial grass. The drought resistance of smooth brome is probably accounted for in part by its deeply penetrating root system. The heavy concentration of total root mass near the surface is the result of smooth brome's creeping rhizomatous habit. Old brome fields develop a "sod bound" condition in which shoot density is reduced and symptoms of nitrogen deficiency are exhibited. Because of its fairly distinctive foliage and habit of growing in solid patches *Bromus inermis* is easily recognized at all seasons. Its early green-up makes it especially easy to detect during the spring months.
Leaves: The leaf blades are smooth, flat, 4-5 inches long and 1⁄4-3/8 inches wide with a conspicuous “M”- or “W”-shaped constriction in the middle.
Fruit: Lemmas are all unawned or with very short awn.
Flowers: The inflorescence is an erect, open panicle with ascending branches that are sometimes reflexed, blooming May – July.
Origin: *Bromus inermis* is a Eurasian species ranging from France to Siberia, apparently introduced in the United States by the California Experiment Station in 1884. Within the United States smooth brome has been introduced in the northeastern and northern Great Plains states as far south as Tennessee, New Mexico and California. It has become naturalized from the maritime provinces to the Pacific coast north to Alaska to California and through the plains states. Within the United States, "northern" and "southern" agricultural strains have been developed. The southern strain is more tolerant of drought and heat than the northern strain.

Mechanical Control

Both experimental studies and management experience indicate that burning or cutting smooth brome in the boot stage is perhaps the most effective means of control. Smooth brome is in boot stage between mid-April and late May when the plant has reached a height of 18 to 24 inches and the flowering head is still enclosed within the sheath. This is somewhat later than would be recommended for other management purposes such as control of Kentucky bluegrass. Research indicates that a well-timed burn that treats *Bromus inermis* in boot or early flower may be more effective than mowing at the same susceptible period. It appears that late May burns would be optimal in the northern plains for reduction of smooth brome. One close mowing when the plants are 18-24 inches tall (followed ideally by 3 repetitions), may improve chances of selectively controlling this species. The best conditions for damage are hot, moist weather at the time of cutting, followed by a dry period.

Chemical Control

Its habit of occurring frequently in nearly pure swards renders *Bromus inermis* a good target for selective control by timed, close mowing or use of herbicides. An early study of brome control found Tordon (picloram) most effective at rates of 1.1 to 2.2 kg/ha, or treatment with Roundup (glyphosate) at 0.5 to 1.1 kg/ha before flowering. It appears that April or May applications of glyphosate at 2 kg/ha may be an effective management technique for controlling smooth brome in pure patches.

Sources:

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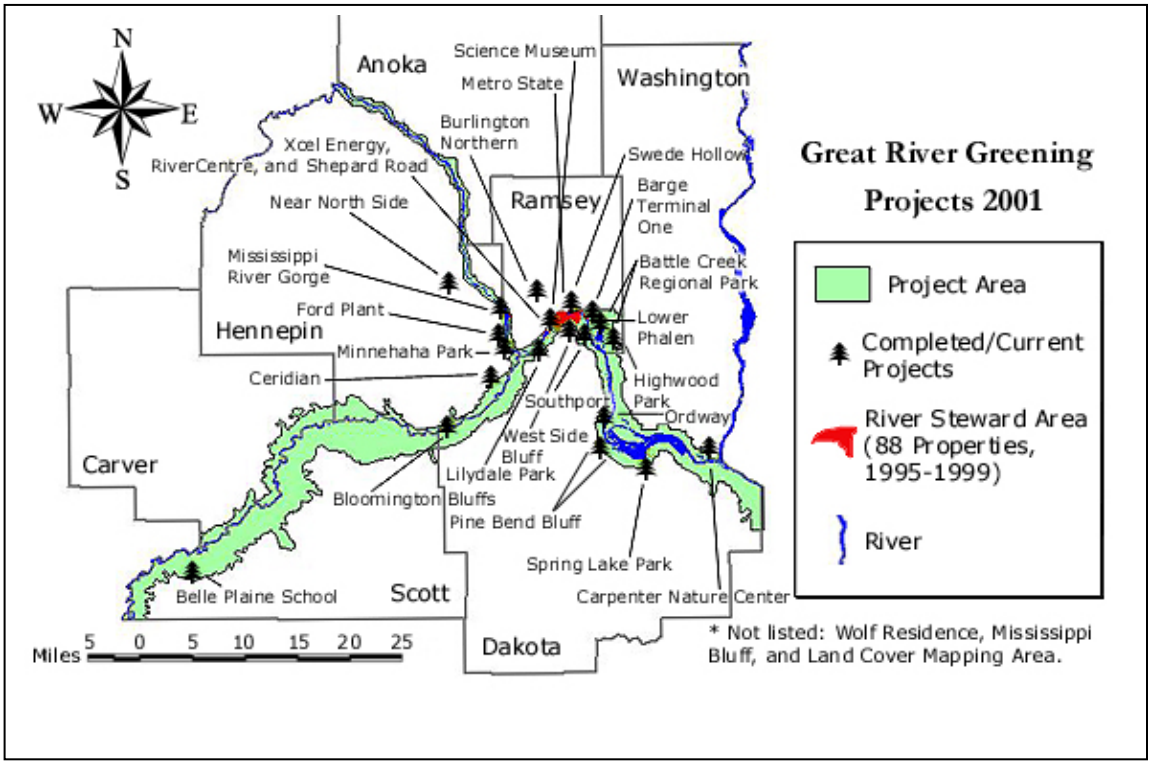
Appendix D: Great River Greening

Helping communities restore, manage and learn about their natural environment through volunteer involvement.



The Challenge

Erosion, trash, and the invasion of exotic and invasive plant species are degrading our urban river valleys, reducing ecological diversity destroying wildlife habitat. Many public and private organizations are working to protect the river valleys, but these programs often lack long-term community involvement and stewardship.

These problems are especially pressing in the Twin Cities metropolitan region, home to more than 2 million people. The river valleys in this area:

- Hold some of the region's last intact native landscapes
- Serve as vital wildlife corridors for hundreds of migratory bird species
- Provide a water source for millions of the region's residents
- Contain some of the region's most scenic sites and vistas

Great River Greening's response

Great River Greening, a nonprofit organization, helps coordinate a cost-effective and sustained effort to manage ecosystems of the three great river valleys of the metropolitan area: the Mississippi, Minnesota and St. Croix. We are primarily an implementing organization, providing on-the-ground ecological restoration and management of both public and private land. We

engage thousands of volunteers in the planting of native vegetation, removal of exotic and invasive weeds, native-seed collection, and stewardship—work that cultivates an informed and involved citizenry. We also act as a catalyst, creating effective partnerships among agencies, municipalities, and private landowners responsible for managing river valleys and their natural resources. Restoration ecologists and other scientists provide technical expertise.

Key values

Great River Greening bases its work on these values:

1. Native trees and other vegetation have ecological and sociological value: They contribute to the health and biodiversity of ecosystems; they beautify surroundings; and they enhance a community's natural heritage and sense of place.
2. People want opportunities for direct involvement in natural resource protection and management, which help them feel connected and committed to their local natural areas.
3. Volunteer involvement in restoration and planning is one of the most effective methods of environmental education. When people work side by side to improve their environment, their communities become stronger and more vital.
4. Environmental restoration and stewardship require collaboration and inclusiveness.

We are committed to:

Citizen-based restoration, stewardship and education

Ecologically sound implementation and evaluation

Collaboration to help advance ecosystem-based management

Long-term stewardship.

Accomplishments—highlights

Since 1995, Great River Greening has involved more than 10,700 volunteers in the planting of 35,000 trees and shrubs and 16,000 wildflowers and grasses, as well as exotic-species removal, prairie-seed collection and broadcasting, plant inventories, training programs, and ongoing stewardship. In 2000 alone, we organized 30 events attended by nearly 1,500 volunteers!

We've also provided design and ecological consulting for numerous groups, including the city of Saint Paul Parks and Recreation Division, the Saint Paul Port Authority, the Science Museum of Minnesota, River Center, and the Greater Minnesota Housing Fund.

Great River Greening's major partners

City of Saint Paul · Friends of the Minnesota Valley · Friends of the Mississippi River · Metropolitan Council · Minneapolis Park and Recreation Board · Minnesota Department of Natural Resources · National Park Service · Ramsey County Parks and Recreation · Saint Paul Audubon Society · Trust for Public Land · U.S. Fish and Wildlife Service · Private landowners

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