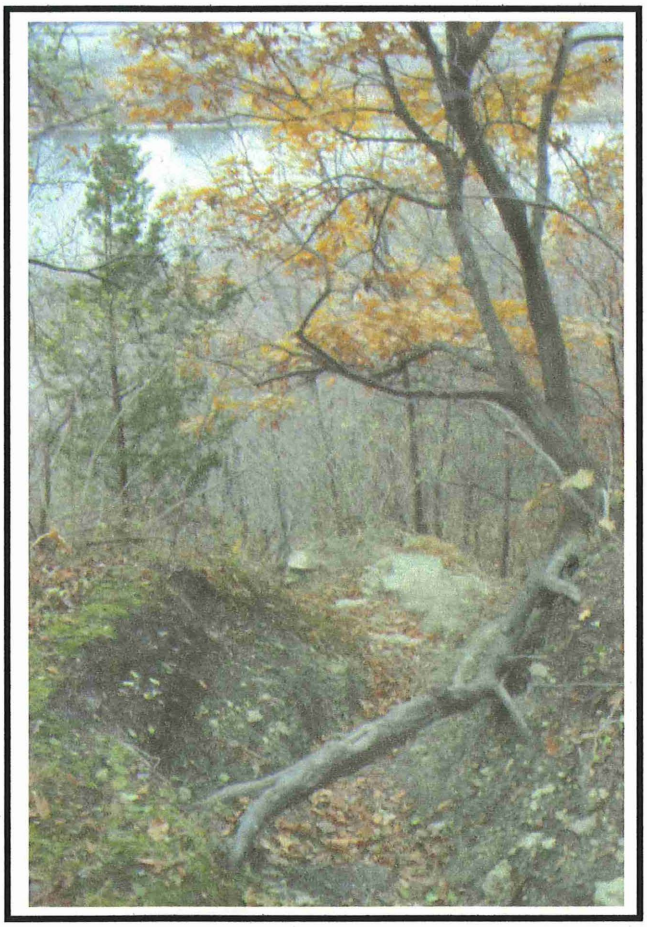
Cherokee Park Management Plan



One of several eroded paths cutting down the bluff that rises above the Mississippi River in St. Paul

July 31, 2003
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Cherokee Park
Restoration Management Plan

Compiled by
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Great River Greening

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Great River Greening (GRG), a nonprofit organization, helps communities coordinate cost-effective and sustained efforts to manage ecosystems of the Mississippi, Minnesota and St. Croix River valleys in the Twin Cities metropolitan area. 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 weeds, native seed collection and stewardship—work that results in an informed and involved citizenry. GRG also acts 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. (See page 28 for more information about Great River Greening.)

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Summary

The Cherokee Park Restoration Management Plan is an attachment to the West Side Bluff Ecological Inventory and Vegetation Management Plan ("West Side Bluff Management Plan", 2001, GRG). The latter plan focuses on the inventory and management of Sectors 2, 3, and 4 (see Map 1) as designated by the West Side Bluff Task Force (West Side Bluff Management Plan, p. 22). The Cherokee Park Restoration Management Plan specifically addresses management of Cherokee Park (West Side Bluff – Sector 1) and presents recommendations for the ongoing management of the vegetation in Cherokee Park to meet ecological goals and social needs. The Cherokee Park Inventory Results (2002, GRG) is included in this plan as Appendix C.

The goals of the management recommendations are to identify ways to improve the ecological health of the bluff vegetation while also allowing for viewing areas and other uses. Recommendations include plantings of native plant species, actions to reduce bluff erosion, and removal and control of invasive plant species that are degrading the ecological health of the bluff. The management plan also identifies those tasks that can be conducted by volunteers and those that are more appropriate for trained professionals.

Appendices to the management plan provide technical information to supplement the recommendations, including detailed plant species lists of current and target native plant communities, information about controlling exotic species, and techniques and methods for many types of vegetation management.

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Acknowledgements

The Cherokee Park Restoration Management Plan is the product of a collaborative project between Great River Greening, the West Side Bluff Task Force of the West Side Citizens Organization, and the City of Saint Paul Division of Parks and Recreation. This project is one of several funded by the Big Rivers Partnership, a large partnership led by Great River Greening. Funding for the Big Rivers Partnership is provided by the Minnesota Environment and Natural Resources Trust Fund, as recommended by the Legislative Commission on Minnesota Resources.

Introduction

Purpose of This Plan

This plan provides recommendations for managing the City of St. Paul's Cherokee Park vegetation in a way that meets the various needs of bluff residents and visitors while also being cost-effective and ecologically sustainable. Specifically, the plan recommends ways to maintain viewing areas from the bluff, while also increasing biological diversity, reducing bluff erosion, increasing landscape aesthetics, improving wildlife habitat and reducing ongoing maintenance costs.

Community interest in Cherokee Park is high. Active community members in the West Side neighborhood and city agency staff have agreed that a sustainable natural resource management approach is crucial to ensuring successful management of the bluff. Vegetation management is best done with an adaptive approach, which recognizes that as management recommendations are implemented, monitoring will be needed to evaluate the results and continue to refine and develop the management plan.

Principles Guiding the Plan

The fundamental principle of the Cherokee Park Restoration Management Plan is that management must be based on ecological and social goals. The Cherokee Park ecosystem is the interacting group of plants, animals (including humans), and physical elements (slope, soil, climate, water) at the site. These interactions need to be considered in developing goals for managing the vegetation in the park. An ecosystem approach to management acknowledges that people are included in the natural system and that maintaining a healthy and diverse ecosystem is the best way to meet the needs of park users, bluff residents and all the other organisms living on the site. Ecosystem management integrates current scientific knowledge and human values with the underlying goal of protecting the health of the ecosystem for the long term. Following are principles used to guide the development of this management plan.

1. Our management efforts should protect or enhance the health of the bluffland ecosystem and the native biological diversity of its habitats. Protecting and restoring high-quality natural areas and the ecological processes that sustain them are high priorities, because these sites are much more biologically diverse than other areas. The native plants and animals of Cherokee Park have evolved together for thousands of years and are particularly suited to surviving and thriving in the natural communities present at this site. Over the long term, native communities will maintain a level of health that can adapt to disease, drought, flood, fire, wind and other natural disturbances, and therefore should require less effort to maintain and manage than degraded or exotic communities. These native communities offer a varied and interesting environment, providing people with many opportunities for recreation and chances to learn about our natural heritage. Finally, high-quality natural areas are increasingly rare worldwide. They are worth protecting because they are rare and difficult and, in some cases, impossible to restore. The longer they are protected, the more valuable they will become. Once high-

quality areas are secure, attention should be given to buffering and/or connecting these areas and restoring lower-quality areas.

2. Planning should recognize that species are interdependent. Individual plant and animal species in a community depend on one another for survival. Relationships and interactions among species are complex and still poorly understood. Saving plant communities where these species and their interactions occur should be a management priority.

3. Planning should acknowledge that people are part of nature. Human actions have been influencing Cherokee Park for hundreds of years. Plans for managing the park's vegetation should recognize that people are a part of this landscape. Appropriate recreational and viewing opportunities as well as cultural and historical resources should be a part of plans for ecological management.

4. Planning should be based on ecological boundaries, not simply political boundaries, and should be based on extended time frames. The natural communities and systems that make up Cherokee Park have existed for thousands of years and extend across the property ownership boundaries. Developing common management goals with surrounding landowners will ensure the long-term health of the park's important natural resources.

5. Management planning should be based on an adaptive approach. Adaptive management refers to an ongoing approach to effectively manage projects. Adaptive management starts with project planning, a thorough site inventory and development of the adaptive management plan. The plan involves discussion of how vegetation establishment should be conducted at a site as well as clear and measurable goals for how monitoring should be conducted to detect changes/responses at the site. Every site is unique and constantly changing and, as a result, monitoring is a key component of any project. Monitoring provides information about the changes that are occurring at a project and about the success of management efforts. Monitoring involves evaluating the development of a project and provides information about how the adaptive management plan should be changed to modifying future practices to increase the effectiveness of management efforts. Ultimately, the adaptive management approach allows for unique responses of a site to management efforts and provides an effective method to adjust management strategies

6. Exotic species should be excluded or carefully controlled. Introduction of exotic species (see examples in Appendix A) can reduce native diversity, the quality of habitat and the general health of the bluff's natural resources. Therefore, exotics should be excluded or carefully controlled.

7. Management should be based on cooperative efforts. In addition to the City of Saint Paul Division of Parks and Recreation and the West Side Bluff Organization, many other individuals, organizations and agencies affect Cherokee Park's resources. Decisions made by surrounding landowners and agencies can alter the

blufflands. For example, undesirable invasive, exotic species planted by neighbors could invade and degrade adjacent city-owned natural areas. Because so many groups and individuals influence the ecology of the park, the Management Plan should not be developed in isolation.

Description of the Project Area

The surrounding landscape, soils, geology and current land cover and of a site all provide clues about an area's ecological condition and how the site should be managed. This section of the management plan looks at the climate of the area in addition to the geological, soil and land cover conditions of Cherokee Park. The larger landscape around Cherokee Park is discussed in the West Side Bluff Management Plan.

Bedrock, Soils and Erosion

Soil type is a major factor controlling a site's hydrologic characteristics, the likelihood of erosion, and the vegetation of the site. Three major soil types are present on three different portions of the bluff: Dorerton soils are present on the slope, Udorthents on the bluff base and Kingsley or Copaston soils on blufftop. Map 4 (page 90) describes the locations of these soil types in Cherokee Park.

The bedrock of Cherokee Park is primarily composed of sandstone, shale and limestone. The bedrock on the site affects root growth and influences the park's hydrology.

Factors contributing to erosion

Soil type: Dorerton-rock outcrop soils are prone to erosion because of their steep slopes, small particle sizes and low organic content. Walking trails and areas where water is directed down the bluff are located on these soils and are currently sources of erosion on the entire West Side Bluff. At Cherokee Park, heavy rains in June 2003 washed out a large hole at the head of a deeply eroded ravine in the middle of the park (see Map 2). This damage extends the erosion another 20 feet up-slope toward the top of the bluff.

In addition to changing runoff patterns from streets, parking lots and lawns, replacing mowed lawn with a band of taller native woodland edge species would help to slow the flow of water to the bluff edge and alleviate this kind of damage.

Significance of organic matter and soil organisms: Erosion is common on bare slopes that lack vegetation or organic matter. Organic matter plays an important role in controlling erosion by slowing water as it moves over a slope, absorbing moisture and providing nutrients for ground-layer woodland plant species. The organic layer of a healthy forest floor is generally composed of accumulated leaves and twigs as well as roots, bulbs, seed and fungi. Soil organisms including bacteria and fungi slowly decompose accumulated organic material, but new leaves and twigs continually regenerate the forest floor. The high productivity and slow decomposition of the forest results in the development of a thick organic layer. The accumulated plant material is generally loose and spongy providing ideal conditions for root growth of woodland plants and cool, moist conditions for seed germination. The organic layer also provides a good insulating layer during the winter.

Mycorrhizae are particularly important to the health of woodland plants. These specialized structures are formed through a symbiotic (mutually beneficial) relationship between a plant's roots and specialized mycorrhizal fungi. The fungal symbiont adds an

extensive network of root-like filaments to the plants roots. The expanded root system provides more nutrients and water for plants and, in turn, plants supply carbohydrates to the fungi.

Because of the crucial roles of both organic matter and mycorrhizal fungi, increasing the organic matter on the bluff is important and should be conducted in combination with tree and shrub plantings by applying thick layers of wood chips or, preferably, shredded bark. Highly degraded areas will benefit from the reintroduction of mycorrhizal fungi. One method for reintroducing mycorrhizae is to broadcast a site with wood chips collected from trails or plantings within healthy forests (Sauer 1998).

One of the greatest threats to the structure of hardwood forests is the presence of earthworms (see a more detailed discussion in Appendix D). All earthworms found in this area are non-native and damage forests by quickly consuming the organic layer. Earthworms consume leaves and other organic material on the forest floor, exposing the roots of woodland plants and preventing their growth. Soil exposed after native plants disappear is often colonized by weedy or invasive species that thrive on disturbed sites. Earthworms also consume bacteria and fungi that are essential to the normal functions of the forest floor.

Soil type on the slope – Dorerton-Rock Outcrop Complex

The most common and ecologically significant soil on the project site is the Dorerton-rock outcrop complex soil found on the slope of the bluff. Dorerton-rock outcrop complex soils are generally found on 25 to 65 percent slopes and are common in stream valleys. The soil complex is composed of 50 to 75 percent Dorerton soils and 15 to 20 percent outcrop. The Dorerton soil generally has a surface layer of dark gray sandy loam about 4 inches thick over about a 6 inch-thick subsurface layer. The subsoil is about 12 inches thick and is dark brown gravelly clay loam in the upper part and dark brown flaggy clay loam in the lower part. Underlying material is pale brown flaggy loamy sand.

Permeability of the Dorerton soil is moderate to moderately rapid, indicating that the bluff slopes are generally dry. This soil type favors plant communities that can survive low soil moisture, such as oak forest, oak savanna, and brushland. However, in ravines and the base of cliffs, where soil moisture is higher, plant communities requiring higher moisture, such as maple-basswood forest, are favored.

Soil type at the base of the bluff

Sediment and rock eroded from the steep bluffs collect at the base of the bluff. Beneath these eroded sediments are wet substratum soils called udorthents. Udorthents consist of fill material and industrial waste that has been placed on poorly drained and very poorly drained mineral or organic soils. This fill material provides sites for buildings, roads, recreation areas and other uses. Permeability and available water capacity of urban fill soils varies. Many areas are highly compacted, and in these locations, water collects on the surface after heavy rainfall. Runoff and internal drainage are also variable, and the depth to the seasonal high-water table varies from 1 foot to more than 6 feet. In most

parts of the project area where udorthents are present, they are covered by the accumulated soil and rock that have eroded from the bluff above.

Soil type on the blufftop

Soils on the blufftop consist of a variety of urban land complexes. Urban land-Kingsley-complex and urban land-Copaston complex are the most common. The urban land portions of these map units are covered by roads, parking lots, buildings and other structures. Changes to the soils have obscured or altered the original appearance so significantly that identification is not feasible. However, original soils may still be found in yards that have been established for many years. Savanna vegetation helped form the dark soils of the Kingsley and Copaston soils. Decomposition of the deep root systems of the prairie grasses and forbs of the savanna added organic material to the soil, contributing to the soil's dark color.

Kingsley or Copaston soils that remain both consist of dark surface layers from 6 to 8 inches deep. The surface layer of Kingsley soils consists of sandy loams, while Copaston soils consist of loam. The Kingsley subsoil is sandy loam and about 26 inches deep, and the Copaston subsoil is about 9 inches deep. Kingsley and Copaston soils differ in their permeability. Kingsley soils area moderate in the surface layer and moderately slow in the subsurface. Available water capacity is moderate and runoff is rapid. Copaston soils have moderate permeability, water capacity is high because of underlying bedrock, and runoff is moderate.

Bedrock of the site

Limestone bedrock underlies the soil at a depth of 45 to 70 inches. In Cherokee Park, bedrock is primarily a combination of sandstone, shale and limestone. The sandstone layer, known as St. Peter sandstone, was formed as large inland seas slowly filled with sand that eroded from surrounding uplands. The sand compressed over time, binding the sand grains into stone. St. Peter sandstone is found at the base of the bluff where caves have formed from natural processes and human excavation. Above the sandstone is a layer of shale that formed from mud deposition on top of the sandstone. Fossils such as brachiopods, gastropods and trilobites are common in the shale. Water levels rose after the mud layer developed. The higher water level allowed many organisms with calcium shells to thrive. A layer of limestone was formed from the chemical precipitation of calcite and the remains of animal life. The limestone at Cherokee Park, known as Platteville limestone, is about 30 feet thick. Above the limestone, another layer of mud formed as the sea receded. This mud layer formed into what is known as Decorah shale. A layer of glacial deposits or drift, consisting primarily of rock, gravel and sand deposited by glacial action, overlays the bedrock.

Bedrock and glacial deposits on the site can influence plant growth in a number of ways. Both bedrock and drift can influence the pH and the hydrology of soils depending on the composition and structure of the materials. Exposed bedrock lacking soil supports scant vegetation. Trees that do grow on bedrock may have a higher chance of being blown over during storms, especially if erosion is exposing their roots. Where bedrock is cracked or composed of soft sandstone, water can travel and seep out of the bluff. Seeps will

generally have species that require high amounts of moisture and are often prone to erosion. Eroding bedrock affects vegetation by smothering some species and creating new areas of growth that favor rapidly establishing species.

Climate

The climate of a site is an extremely important component of the resources and determines what species can grow and sustain themselves. Temperature and moisture are particularly important. This site is located in a typical continental climate with moderate precipitation and wide ranges in temperature from summer to winter. The west-facing aspect of the bluff

The climatological information relevant to Cherokee Park is based on the data from the weather data collecting station at St. Paul, Minnesota. The monthly normals for temperature range from a minimum of 6.2 °F in January to a high of 83.2 °F in July. Precipitation ranged from .76 inches in February to 4.98 inches in August with an annual average precipitation of 32.59 inches.

Table 1. Monthly Station Normals of Temperature and Precipitation 1971 – 2000

Temperature Normals (degrees Fahrenheit)														
Station Name	Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
St Paul	Max	22.8	29.7	41.7	58.2	71.2	79.1	83.2	80.8	71.8	59.4	40.5	26.7	55.4
	Mean	14.5	21.4	32.8	47.2	59.9	68.4	73.0	70.8	61.8	49.8	33.3	19.5	46.0
	Min	6.2	13.0	23.9	36.2	48.5	57.6	62.7	60.7	51.7	40.1	26.1	12.3	36.6

Precipitation Normals (Total in inches)													
Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
St. Paul	1.02	.78	1.92	2.54	3.73	4.98	4.41	4.37	3.20	2.51	2.09	1.04	32.59

From: Climatography of the United States No. 81. National Oceanic and Atmospheric Administration. United States Dept. of Commerce. National Climatic Data Center, Ashville, NC. December 1, 2001.

The average date of the last freezing temperature (32 °F) in spring occurs on May 2 and on an average, the first freezing temperature in fall occurs on September 19 resulting in an average of 159 days free of frost in between.

Table 2. Median Frost Dates Derived from 1971-2000 Averages

	Median Date of Last Min. Temp. in Spring			Median Date of First Min. Temp. in Fall			Days in Between Median Dates		
Station Name	24°F	28°F	32°F	32°F	28°F	24°F	32°F	28°F	24°F
St. Paul	04/08	04/19	05/02	10/04	10/18	10/31	159	186	210

From: The Midwest Regional Climate Center, Champaign, IL. Available: http://mcc.sws.uiuc.edu/html/Mwclimate_data_summaries.htm (Accessed: June 26, 2003)

The average date of the first 1-inch snowfall in the fall is November 22 and the average date of the last 1-inch snow cover in the spring is April 2. The average number of days when there is a snow cover greater than 1 inch is 16.3. The annual average snowfall is 52.4 inches.

Table 3. Mean Number of Snow Cover Days for Indicated Depths and the First and Last Dates of 1-inch Snow Cover, October 1959 – May 1979.

Station	Average seasonal snow cover days					Average date of last 1" snow cover in the spring	Average date of first 1" snow cover in the fall
	1"	3"	6"	12"	24"		
St. Paul	100	79	54	24	1	November 22	April 2

From: Climate of Minnesota, Part XIII – Duration and Depth of Snow Cover. Kuenhast, E. L., D. G. Baker and J. A. Zandlo. Tech. Bull. 333-1982. Agricultural Experiment Station, University of Minnesota.

Current Land Cover and Management Recommendations

Land Cover

Land cover is defined as the physical cover, including vegetation (natural or planted) and human constructions (buildings, roads, etc.) present on the landscape. Information about existing land cover can help guide decisions about what human uses are appropriate at a site, where restoration efforts should be focused and what plant communities should be connected. Map 3 presents the land cover for the Cherokee Park project area.

The land cover map for the Cherokee Park project is based on work completed under a cooperative agreement between the National Park Service, the Minnesota Department of Natural Resources and Great River Greening. The principal objective of this agreement was to complete a land-cover inventory using the Minnesota Land-Cover Classification System (MLCCS) (Leete et al. 2000, Map 2) for the entire Mississippi National River and Recreation Area and additional areas.

The land cover data collected for Cherokee Park served as a framework for more detailed surveys conducted at the site. Additional background information was gleaned from the Minnesota Natural Heritage Database, Minnesota County Biological Survey data and the Ramsey County Soil Survey.

Land cover types in the Cherokee Park project area include:

- Dry oak savanna sand-gravel subtype
- Oak forest
- Maple-Basswood forest
- Lowland hardwood forest
- Floodplain forest
- Willow swamp
- Mixed-emergent marsh
- Disturbed deciduous woodland
- Boxelder - green ash disturbed native forest
- Short grasses with sparse tree cover on upland soils
- Short grasses and mixed trees with 26-50% impervious cover
- 51 to 75% impervious cover with deciduous trees
- Buildings and pavement with 76-90% impervious cover

Target Plant Communities

The determination of target plant communities was made by considering the historic vegetation of the area and the current land cover. According to the land surveyors of the 1850's, most of the uplands were covered with oak openings or savanna. The slopes of the bluff supported oak forest and maple-basswood forest and the bottomlands were floodplain forest and wetlands. Today, remnants of the original vegetation are still apparent although highly disturbed. Oak savanna, oak forest and maple-basswood forest

Management Units and Recommendations

The Cherokee Park site is divided into management units based on variations in the land use, terrain, and vegetation (Map 4). On this basis, three general management units are identified: Lawn, Side Slopes, and Bottom Lands. The following sections present management recommendations for each management unit. Priority status is based on current ecological condition, management history, future management and social considerations.

The following table describes the current conditions of each management unit, the land cover types it encompasses, and the recommended target plant communities.

Table 4: Cherokee Park Management Unit Summary

Management Unit	Description	Land-cover types	Target Plant Communities
Lawn	*Activity areas including picnic areas, playgrounds, parking lots, and sidewalks are prominent features in this unit which occupies the generally level, top part of the bluff. The large oaks scattered throughout this unit are reminiscent of the native oak savannas found here in presettlement times. The principal vegetation management is mowing.*	• *Short grasses and mixed trees with 26-50% impervious cover* • *Short grasses and sparse tree cover on upland soils* • *Buildings and Pavement with 76-90% Impervious Cover*	• *Oak savanna*
Side Slopes	*The steep slopes of the bluff face are criss-crossed with paths used by people and animals, especially deer. This activity, water runoff from the lawns and pavements above, and invasive earthworms have removed much of the ground cover throughout the unit. Never the less, some of the most intact native plant communities are found in this unit.*	• *Maple-Basswood Forest* • *Oak Forest* • *Dry Oak Savanna Sand-gravel Subtype* • *Disturbed Deciduous Forest* • *Boxelder-Green Ash Disturbed Native Forest*	• *Oak Forest* • *Maple-basswood Forest*
Bottom Lands	*In addition to trails, roads and past use of adjacent areas as "brick yards", frequent floods periodically disturb a large part of the Bottom Lands unit. These activities and exotic invasive plants, such as reed canary grass and buckthorn have extensively disturbed the plant communities of this unit. Debris is common throughout the floodplain forest floor.*	• *Floodplain Forest* • *Willow Swamp* • *Mixed Emergent Marsh* • *Lowland Hardwood Forest* • *51-75% Impervious Cover with Deciduous Trees*	• *Lowland Hardwood Forest* • *Floodplain Forest*

As in Sectors 2, 3 and 4 (refer to West Side Bluff Management Plan, pp. 22-27), mowed lawn areas are maintained on the top of the bluff in Cherokee Park along the streets and in activity areas around parking lots and picnic grounds. The early vegetation of this level upland was typically oak savanna, which was developed for housing and city streets early in the history of the city.

Some patches of oak forest, maple basswood forest and dry-prairie along the side slopes or bluff face contain moderate native plant diversity with lower degrees of disturbance

and invasive exotic plants. These areas are among the most intact native plant communities of the West Side Bluff and are collectively cited by the Minnesota County Biological Survey as "a site with high biodiversity significance". The bluffs of Cherokee Park are predominantly west facing and receive more sun exposure than the rest of the West Side Bluff, which generally faces north. Increased sun exposure creates hotter and drier conditions favoring prairie, savanna and oak forest. Remnants of maple-basswood forest are found in areas that are cooler, shadier and moister, such as on north-facing slopes, in ravines and at the base of slopes.

The bottom lands are heavily disturbed with only very tolerant native species remaining in the Floodplain Forest, Lowland Hardwood Forest, Willow Swamp and Mixed Emergent Marsh native plant communities found there.

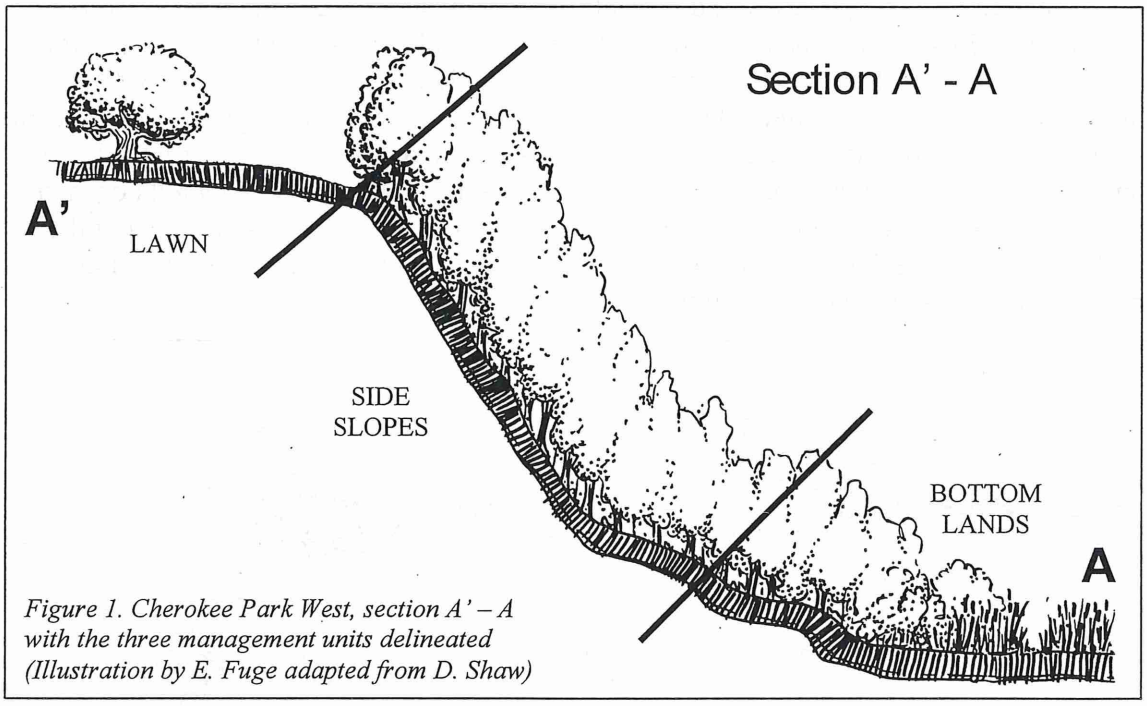

Figure 1. Cherokee Park West, section A' – A with the three management units delineated (Illustration by E. Fuge adapted from D. Shaw)

The Cherokee Park Inventory Results, completed in 2002, can be found in Appendix C.

Management recommendations for the Dry Oak Savanna Sand-gravel Subtype remnant in the Side Slopes Management Unit are not included within this document. In December 2002, the Cherokee Park Prairie - Ecological Inventory and Restoration Management Plan was completed by Daniel B. Shaw to guide the protection, restoration, and management of this unique area.

Lawn

Target Plant Community: Oak Savanna, Oak Woodland Brushland
Priority Status: 1

Description: This management unit has two parts: the first following Cherokee Heights Boulevard and Cherokee Avenue, and the second being the southern-most recreational portion of Cherokee Park (with picnic tables, a playground, and restrooms) (Map 5). A vegetation inventory of the lawn management unit can be found in Appendix C, pp. C-5 – C-7, in the sections titled "Short grasses and mixed trees with 26-50% impervious cover" and "Short grasses and sparse tree cover on upland soils."

Management Approach: Currently, mowed lawn with various scattered landscape trees are maintained up to the edge of the bluff, contributing to increased erosion from water runoff and inviting foot traffic along sensitive areas of the bluff's edge. To improve water infiltration and slow erosion on the bluff, convert a minimum of 5 to 10 feet of existing lawn to native plants typical of a woodland edge or oak savanna. Erosion would be abated and weedy species would be replaced by prairie and savanna trees, shrubs, grasses and flowers. A broader band of tall vegetation along the edge of the bluff would serve to protect this highly erodable edge from excessive pedestrian traffic as well. The large grove of mature oak trees shown on Map 4 and referenced on page C-5 of Appendix C, is an example of a larger area for potential oak savanna restoration by re-introducing native ground layer grasses and forbs (flowering plants). Some of the planted non-native trees, especially Norway maple, are spreading to near-by natural areas. Replacing these with native tree species (e.g. bur oak) and converting other potentially invasive non-native plantings to natives in the future should be considered.

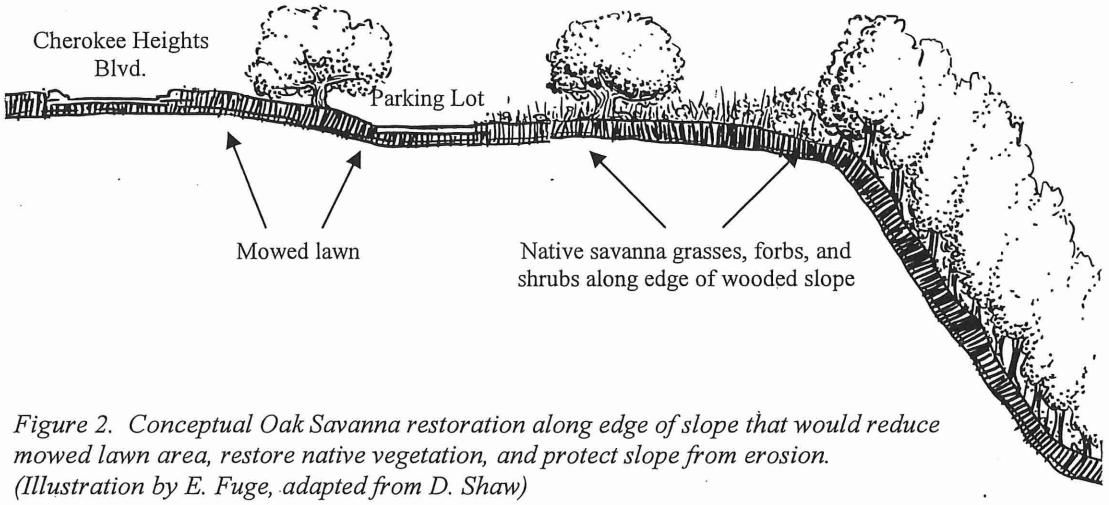

Figure 2. Conceptual Oak Savanna restoration along edge of slope that would reduce mowed lawn area, restore native vegetation, and protect slope from erosion. (Illustration by E. Fuge, adapted from D. Shaw)

The first phase of restoration involves the application of herbicide to the areas of lawn to be converted to woodland edge or savanna. A herbicide with a combination of a broad-spectrum herbicide (such as Rodeo) and a broad-leaf weed killer (such as Garlon) is used to ensure that all current vegetation is eliminated. Two applications are recommended to ensure that hard-to-eliminate species such as quack grass, smooth brome, burdock and Canada thistle are removed from the site. If a large enough area is to be planted, a seed drill can be used to plant native grass seed directly through the dead turf. If a small strip

were planted, removing the dead grass by burning would be advisable. Then the seed could be hand broadcast and raked into the exposed soil.

The final step in the process is conducted after prairie grasses are established and involves the planting of forb species, either as potted plants or plugs. After forbs are added to the planting, fire will be the most useful management technique for eliminating weeds from the planting. However, if perennial weeds persist or if burning is not possible, targeted mowing or herbicide application may still be necessary.

Long-term management of the site would involve a combination of mowing and burning. If weeds become common, they must be cut with a weed cutter before they reach one foot in height, and definitely before they flower and go to seed. The planting should be monitored for invasion of problem weed species such as Canada thistle, quack grass, smooth brome or burdock. After 3 or 4 years, the savanna planting can be managed through burning.

Many of the invasive and weedy species at the site will persist into the future. Long-term management involves monitoring of the site by a trained ecologist and adjustment of the management plan as the site changes.

Side Slopes

Target Plant Communities: Maple-Basswood Forest, Oak Forest
Priority Status: 1

Maple-Basswood Forest

Inventory Results: A detailed inventory of the Maple-Basswood Forest land cover type and the areas targeted for Maple-Basswood Forest restoration can be found in Appendix C in the sections titled: "Maple-basswood forest," "51-75% Impervious cover with deciduous trees (Northern portion)," "Disturbed deciduous woodland (Northern portion)," "Disturbed deciduous woodland (Southern portion)," "Oak forest," and "Boxelder-green ash disturbed native forest (Southeast portion)."

Management Approach: Vegetative diversity is relatively good in the Maple-basswood forest unit despite on-going disturbance due to human activity, deer, and non-native earthworms.

In many areas, the forest is devoid of groundcover and root crowns are exposed, indications of earthworm infestations. A review of storm water drainage should be conducted to mitigate erosion in the major ravines. Soil-rooted species of shrubs, forbs, grasses and sedges could help revegetate and stabilize the slopes. Ferns, such as interrupted, ostrich, or lady fern, should be planted in the ravine area. Although this is a typical species present in healthy ravine habitats, very few were spotted and most were isolated plants.

Human activity in the area needs to be curtailed. A trail plan is recommended to formalize the trail system by determining which trails to eliminate, re-route, or stabilize. Reducing and re-routing the trails will reduce continued damage and erosion of the bluff.

As with the other management units, management in this area should include common buckthorn and Tartarian honeysuckle removal.

The area of disturbed deciduous woodland in the northernmost portion of the project area is targeted for Maple-basswood forest restoration. Young sugar-maple and ironwood trees are common, indicating it may be developing into maple-basswood forest. It appears that a combination of factors, including bridge construction, erosion, the presence of invasive species and tree cutting have contributed to the disturbed nature of the woodland. To control erosion, water bars should be placed in some of the deeper ravines. Both common buckthorn and Tartarian honeysuckle are common on the slope. Buckthorn is locally abundant in areas of more intense disturbance. The exotic species should be removed and replaced with native trees and shrubs. The buckthorn should be cut and treated and tree species such as sugar maple, hackberry and ironwood, shrubs like alternate-leaved dog wood, arrow wood, and red-berried sumac should be planted in its place.

Human activity is quite evident in this area. A large amount of garbage has been dumped into the woodland from the top of the slope. Removing this trash at some point in the future would benefit the area's vegetation.

From the map of target plant communities (Map 4), it can be illustrated that some areas within the current oak forest land cover type are targeted for maple-basswood forest. The two principal locations where this occurs are on the cooler, north facing slopes of large ravines. While the north-facing slope is targeted for maple-basswood forest, the hotter and drier south-facing slope is best suited for oak forest.

Recommendations for management of the northern ravine include working to keep the buckthorn out of the area. Currently, there is not much buckthorn present. Monitoring the area will allow any new buckthorn and other invasives to be eliminated before they become established. More ferns and horsetails can be found in this location than in the ravines farther north, probably because the area is wetter and suffers from less foot traffic.

The north-facing slope of the southern most ravine, which is targeted for maple-basswood forest, has a relatively good ground cover composition. Very little honeysuckle and buckthorn are present. Management of this slope will involve removing these exotics and monitoring their regrowth.

The patch of land cover identified as 51-75% impervious cover with deciduous trees in this management unit can be planted to Maple-basswood Forest species. Any exotic species found here must be controlled before planting to natives takes place.

Oak Forest

Inventory Results: A detailed inventory of the Oak Forest land cover type and the areas targeted for Oak Forest restoration can be found in Appendix C in the sections titled "Oak forest," "Boxelder – green ash disturbed native forest (Northwest portion)," "Disturbed deciduous woodland (Southern portion)," and "Boxelder – green ash disturbed native forest (Southeast portion)."

Management Approach: Erosion is a serious problem in several portions of the oak forest unit. One large ravine is experiencing extensive erosion. Other smaller ravines are eroding to a lesser degree. A large slump is also present. The Ramsey Soil and Water Conservation District is aware of the ravine with severe erosion and has an interest in future stabilization efforts.

Very few sedges or ferns were observed near the ravines; these native species should be reintroduced and planted to help combat erosion and replace native ground layer species.

Human activity and trails contribute to erosion in many areas and also cause soil compaction and habitat fragmentation. This is particularly true with reference to the large ravine present near the Baker St. and Chippewa Ave. intersection. Closing or rerouting the trail leading to the ravine and the one that passes by the head of the ravine may help to curtail the damage in this area. A trail plan should be encouraged for the park to decide which trails can be closed, stabilized or re-routed.

Buckthorn removal has been taking place in the oak forest unit. The cut stump treatment appears to be very effective. However, crews will need to return to remove the occasional plants that were missed and include honeysuckle in the removal. Re-cutting and treating buckthorn and honeysuckle every couple of years will be necessary. This should occur when the buckthorn is either getting dense enough to shade out natives or starting to produce seed.

There are a couple of seeps present. These seeps occur just north of a large ravine. There is buckthorn present in the area around the seeps, but it appears to have been both cut and treated with herbicide. The seeps themselves are relatively free of buckthorn. Management in this area should thus focus on keeping the buckthorn out.

Some locations that are targeted for oak forest have much less buckthorn present than others, such as around the area following a major trail in the disturbed deciduous woodland (southern portion). These areas will need to be monitored to ensure that the invasive shrubs are removed at the early stages of colonization to prevent them from becoming established.

The current boxelder - green ash disturbed native forest in the south-eastern portion of the management area that contains a major ravine and is targeted for oak forest on the south-facing slope has a fair amount of buckthorn that needs to be cut. This especially needs to occur along the rim of the ravine. Some honeysuckle is also present and needs to be

removed. The south-facing slope is in much worse shape than the north-facing slope. It is bare and eroded; engineers should be contacted to figure out how to repair this before any activity can occur to re-vegetate the location.

Bottom Lands

Target Plant Communities: Lowland Hardwood Forest, Floodplain Forest, Willow Swamp, Mixed Emergent Marsh
Priority Status: 2

Floodplain

Inventory Results: A detailed inventory of the floodplain vegetation land cover can be found in Appendix C in the sections titled "Floodplain Forest," "Willow Swamp" and "Mixed Emergent Swamp."

Management Approach: These vegetation communities are regularly flooded. Consequently, vegetation management is difficult since soil and water conditions cannot be readily controlled. However, some management can be carried out including periodic debris removal, exotic brush removal, and planting tree and shrub species to augment and restore plant diversity. Timing plantings for periods after flooding in the spring will give the saplings a growing season to become established. Use as large a sapling as financially possible to increase the survival through floods. Debris will inevitably be deposited after each flood. Monitor the status of the area after flooding to assess the need for any clean up activities and survival of plantings. What little buckthorn is present can be removed by cutting and treating in the spring or fall with an aquatically approved herbicide such as Rodeo.

Lowland Hardwood Forest

Inventory Results: A detailed inventory of the Lowland Hardwood Forest land cover type and the areas targeted for Lowland Hardwood Forest restoration can be found in Appendix C in the sections titled "Lowland hardwood forest," "Boxelder – green ash disturbed native forest (Northwest portion)."and "51-75% Impervious Cover with Deciduous Trees."

Management Approach: The southwest end of the area targeted for lowland hardwood forest, dense stands of buckthorn have become established. A large amount of buckthorn was cut in the fall of the previous year, but the floor is dense with seedlings and resprouting stems. This area will need to be cut within the next two years. In order to remove the dense cover of buckthorn, a foliar spray may need to be used before native plants can be re-introduced into the area. In the spring or fall when desirable native vegetation is dormant, a broad spectrum herbicide (such as Roundup) or one that targets broad leafed plants (such as Garlon) may be used as a foliar spray on the still-green leaves of buckthorn.

Planting of tree, shrub and ground layer species in the spring of the year will augment existing native vegetation and increase plant diversity in the Lowland Hardwood Forest target areas.

Summary of management approaches

The table below summarizes the priorities for managing the units in Cherokee Park and shows where volunteers could be involved.

Table 5: Management Unit Priority Status, Management Actions and Volunteer Involvement

Cherokee Park Management Units	**Priority Status**	**Management Action**	**Possible Volunteer Involvement**
Lawn	1	Reconstruction of Oak Savanna along edge of bluff:	
		• Site Prep	
		• Seeding and planting of plugs	X
Side Slopes	1	Restoration of Oak and Maple-Basswood Forests	
		• Exotic brush removal	X
		• Planting plugs of grasses, forbs, and shrubs	X
		• Collecting seed of selected forest trees and shrubs and planting in specified areas	X
Bottom Lands	2	Restoration of Floodplain and Lowland Hardwood Forests	
		• Exotic brush removal	X
		• Planting plugs and seedlings of grasses, forbs, shrubs and trees	X
		• Collecting seed of selected forest trees and shrubs and planting in specified areas	X

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Great River Greening

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

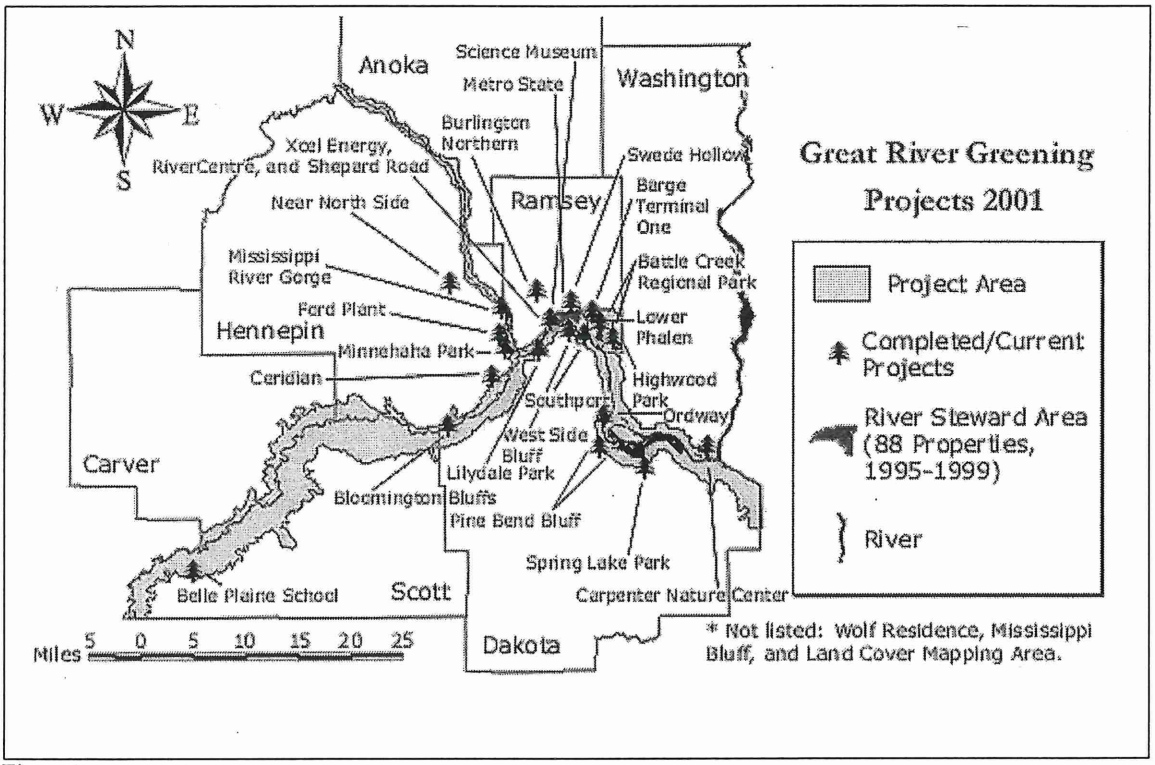

Figure t.

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

To Contact Us

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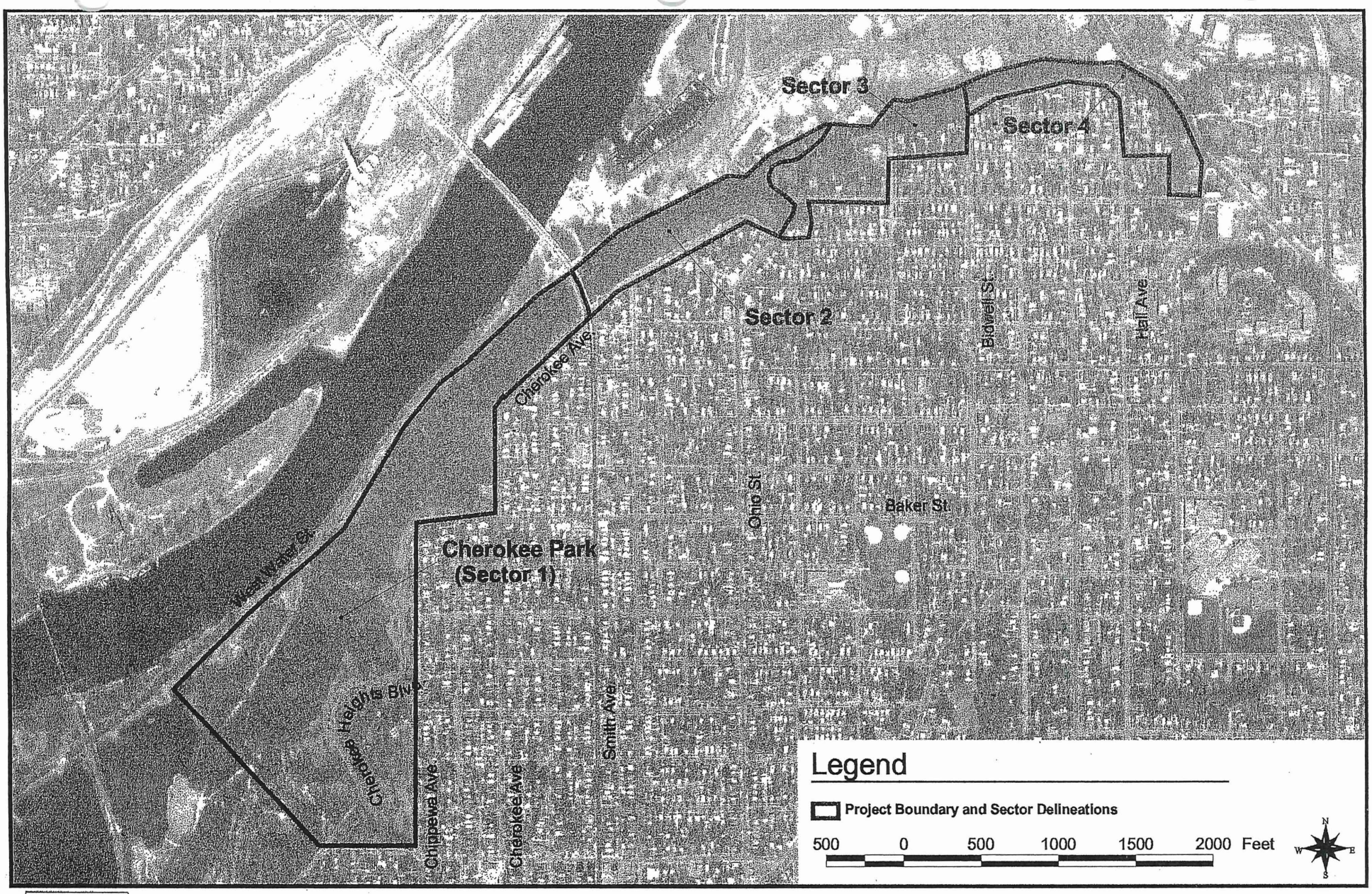
651-665-9500 http://www.greatrivergreening.org



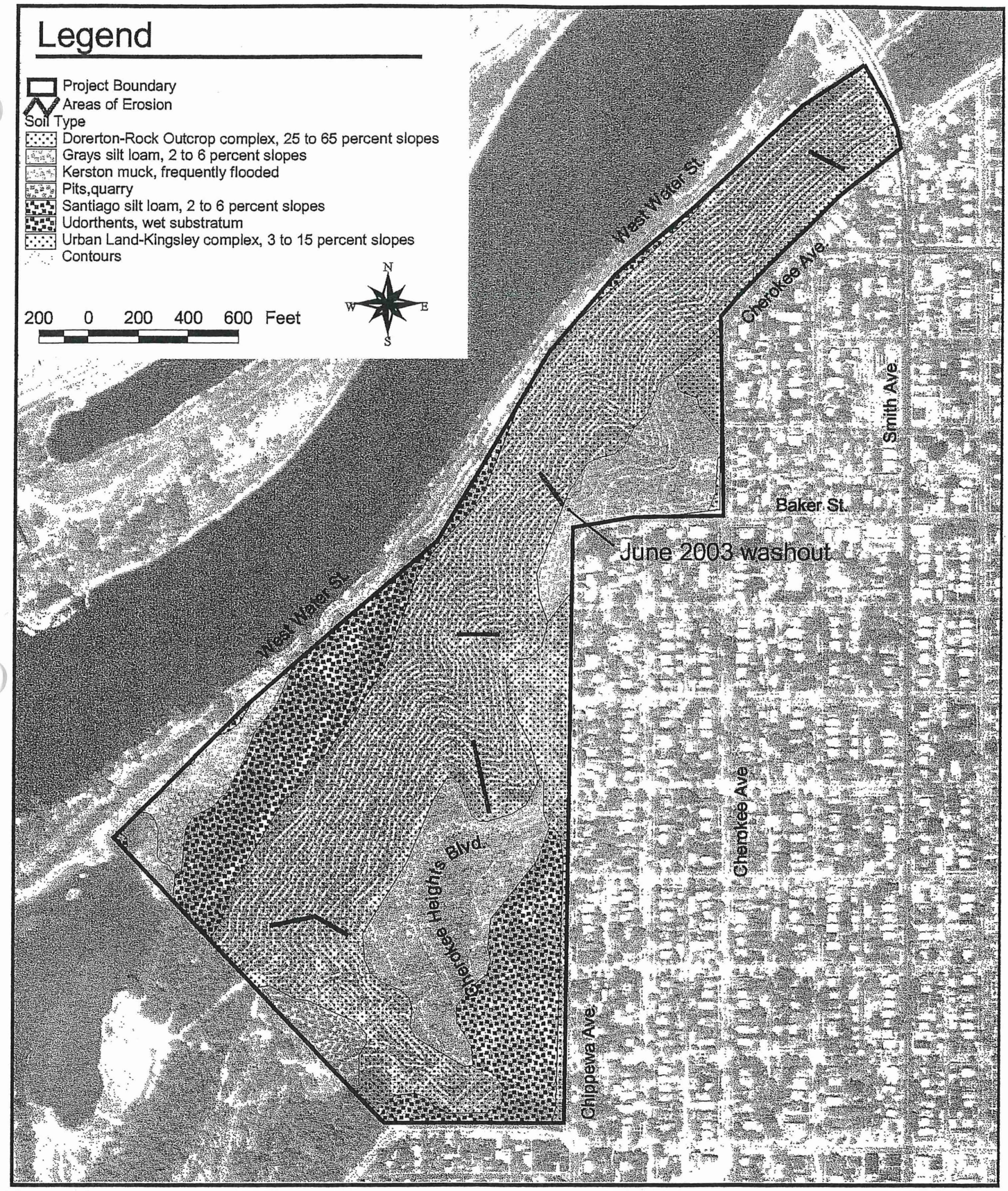
Cherokee Park Location in West Side Bluff Project Area

Partners: West Side Citizen's Organization - Bluff Task Force and the City of St. Paul Division of Parks and Recreation

Map Created June 10, 2003, E. Fuge, Great River Greening

With Funding as Recommended by the Legislative Commission on Minnesota Resources

Map 1, Page 31



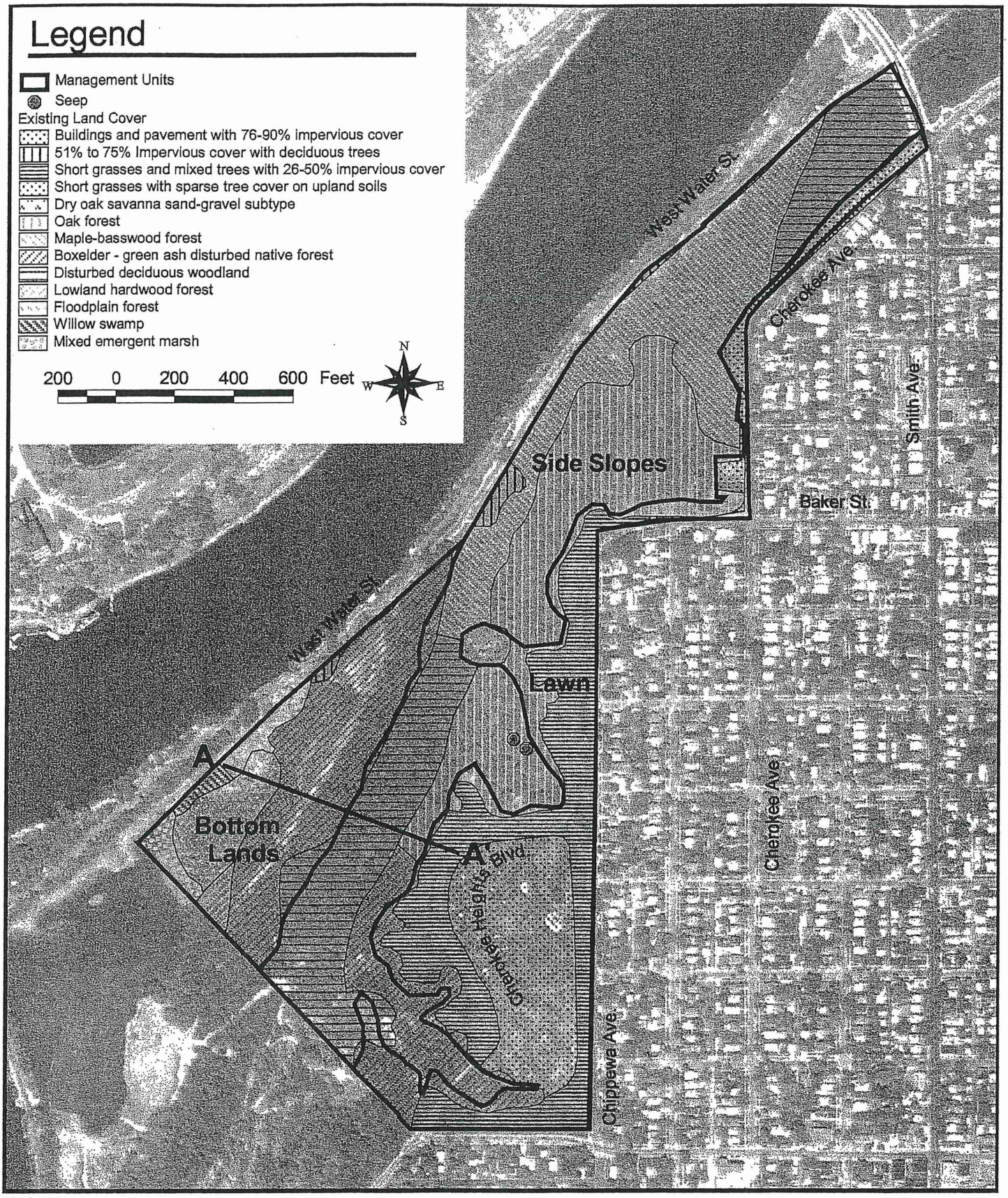
GREAT RIVER GREENING

Cherokee Park Soils, Slope and Erosion

Partners: West Side Citizens' Organization - Bluff Task Force and the City of St. Paul Division of Parks and Recreation

Map created June 10, 2003, E. Fuge, Great River Greening

With Funding as Recommended by the Legislative Commission on Minnesota Resources



Cherokee Park Existing Land Cover

Partners: West Side Citizens' Organization - Bluff Task Force and the City of St. Paul Division of Parks and Recreation

Map created June 10, 2003, E. Fuge, Great River Greening

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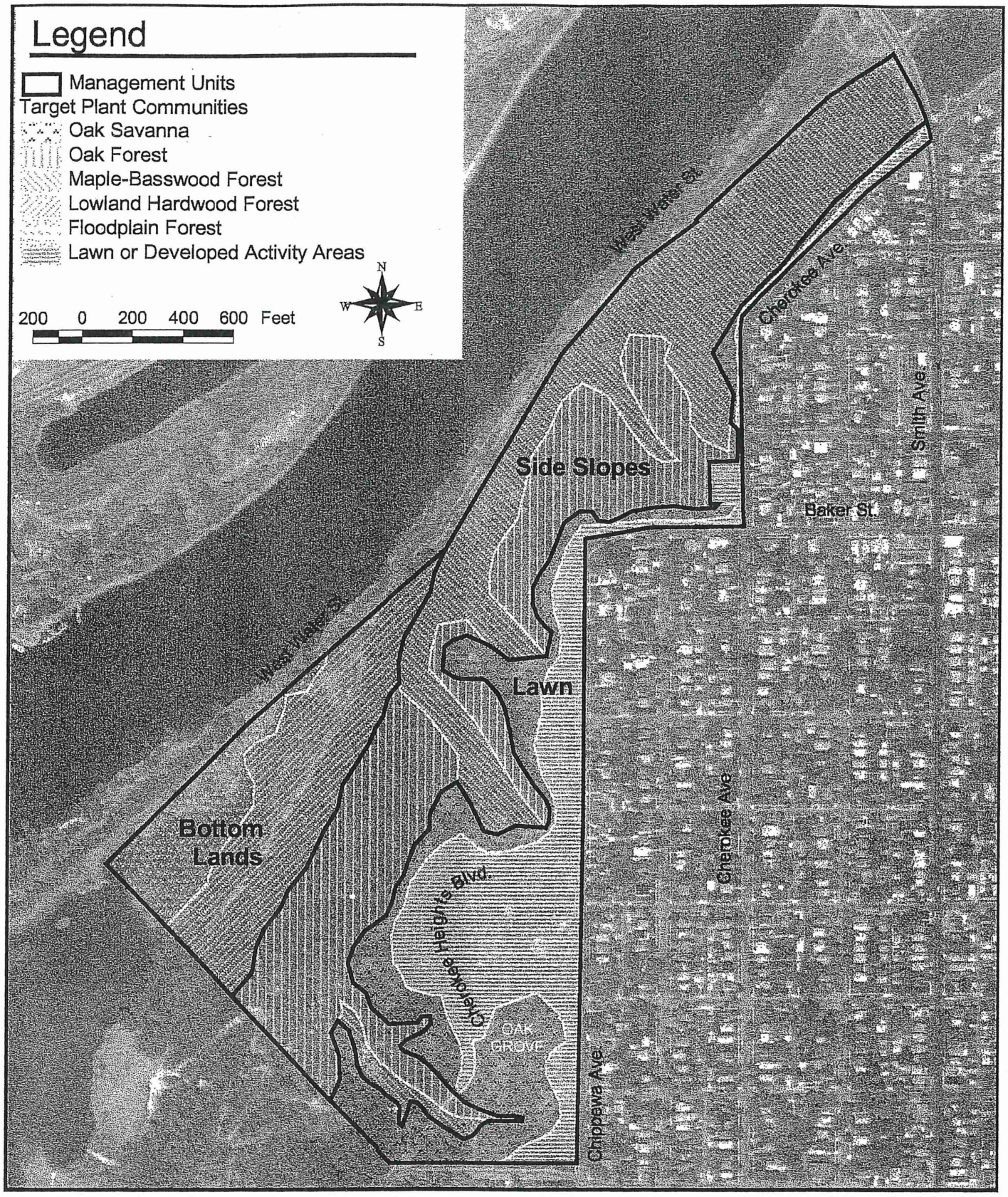

Cherokee Park Management Units and Target Plant Communities

Partners: West Side Citizens' Organization - Bluff Task Force and the City of St. Paul Division of Parks and Recreation

Map created June 10, 2003, E. Fuge, Great River Greening

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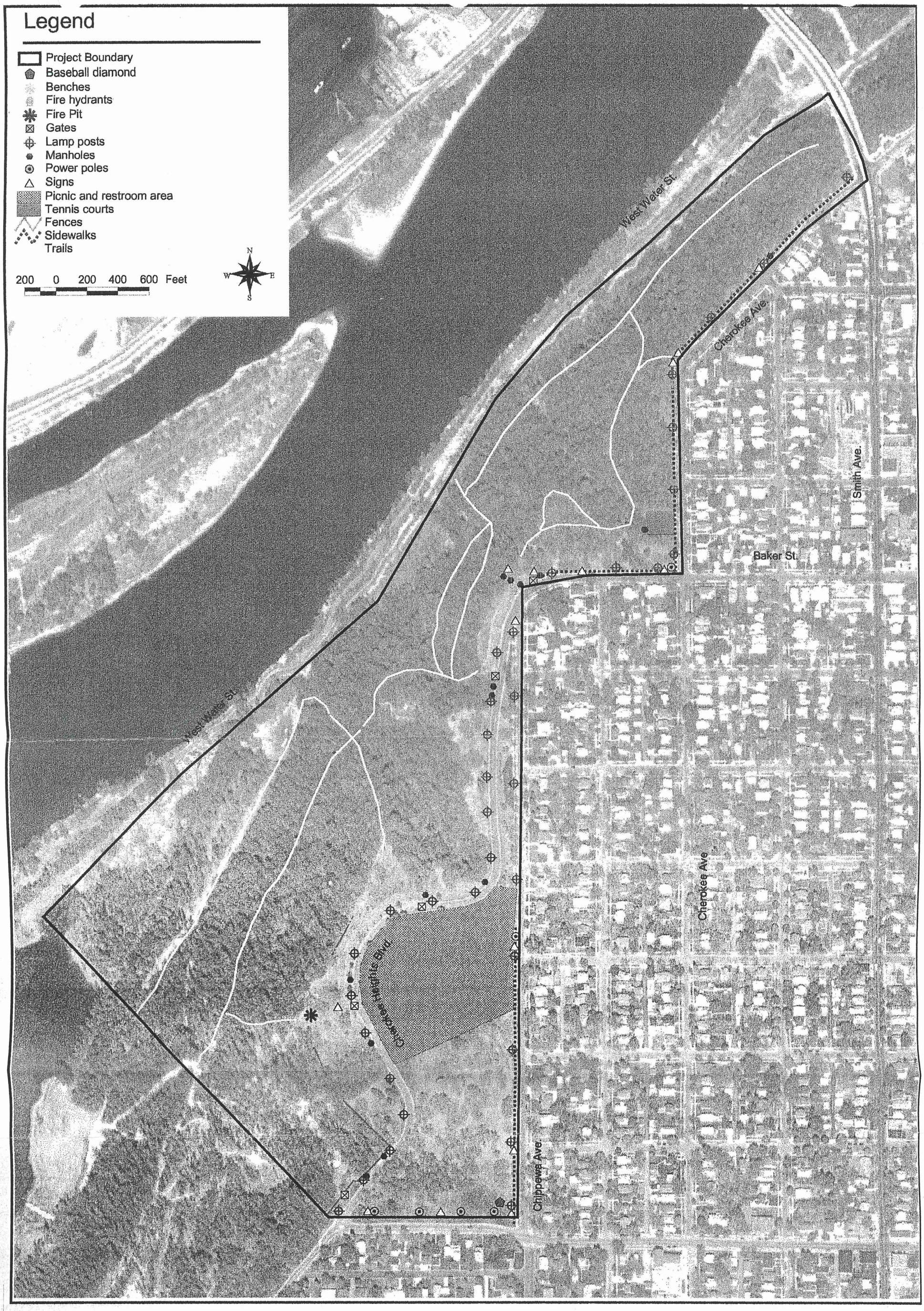


Cherokee Park Cultural Features

Partners: West Side Citizens' Organization - Bluff Task Force and the City of St. Paul Division of Parks and Recreation

Map created June 10, 2003, E. Fuge, Great River Greening

With Funding as Recommended by the Legislative Commission on Minnesota Resources

Appendix A: Fact Sheets for Exotic and Invasive Plants

The following pages contain information on the habitat, phenology, and niche of exotic and invasive plants found or potentially found in the Cherokee Park plant communities. These fact sheets pertain to troublesome plants that compete with the native plants typical of undisturbed native communities and 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. Additional fact sheets for common buckthorn, box elder, Tartarian honeysuckle, Siberian elm, staghorn sumac, burdock, leafy spurge, garlic mustard, and poison ivy can be found in Appendix B of the West Side Bluff Ecological Inventory and Vegetation Management Plan.

Forbs:	
Canada thistle	*Circium arvense*
Purple loosestrife	*Lithrum salicaria*
Sweet clovers	*Melilotus officinalis*
	M. alba
Grasses:	
Bluegrass	*Poa pratensis, P. compressa*
Reed canary grass	*Phalaris arundinacea*
Smooth bromegrass	*Bromus inermis*

Effective management of these species, which are present or potential problems in Cherokee Park, is described in the following fact sheets. Except for the reed canary grass and purple loosestrife, wetland plants, most of the invasive plants are found in and threaten the woodlands.

Buckthorn is generally established throughout the woodlands of the park with some areas of heavier concentrations. Much of the buckthorn was cut and treated in the fall of 2002. Seedlings are still prevalent and resprouts will occur. Consequently, continued treatment is recommended initially. In the future, periodic surveys and localized cutting may only be required every two years or so.

Garlic mustard was not found in Cherokee Park in 2003, but is a potential invader to watch for, especially in the wooded areas. Invasive exotics such as burdock, bluegrass, European brome, Canada thistle and the sweet clovers are nuisances in young prairie and savanna restorations.

Canada Thistle *(Cicium arvense)*

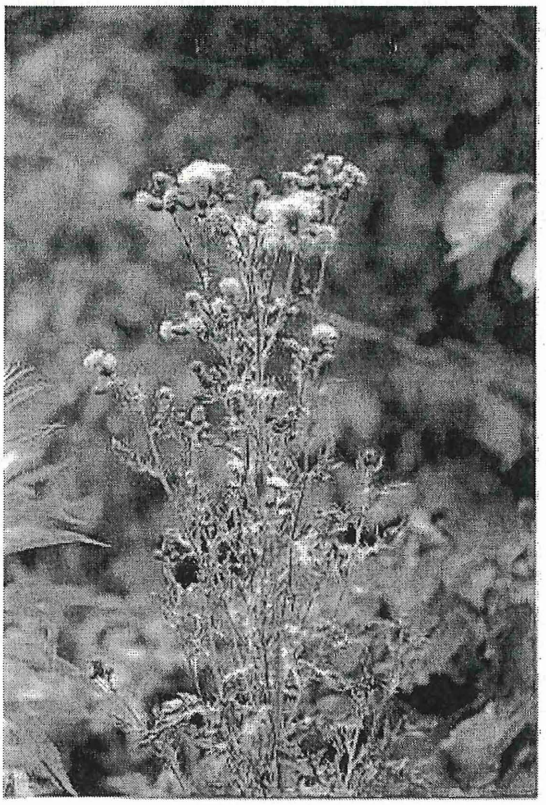


Photo by Merel R. Black

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.

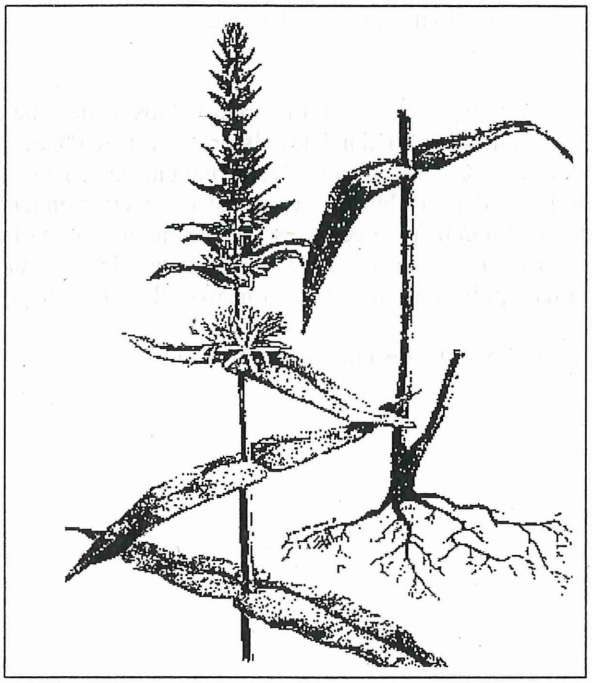
Chemical Control:
Control of this species with herbicides in natural areas is not recommended, as the herbicide can damage native vegetation more than the damage caused by the thistle. However, spot application of the amine formulation of 2,4-D using a wick applicator or hand sprayer can control individual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

Purple Loosestrife *(Lithrum 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.

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.

Yellow Sweet Clover (*Melilotus officinalis*)
White Sweet Clover (*Melilotus alba*)

Photo by John M. Randall, TNC

Effects of Invasion:
Sweet clovers are fire-influenced, aggressive, weedy plants that produce populations with high rates of fluctuation. Both species degrade native grasslands by overtopping and shading native sun-loving species. Sweet clovers are members of the legume family.

Both white and yellow sweet clovers are biennials. After germination in late spring or summer, the plants put their energy into developing a healthy root system. Plants are strictly vegetative in the first year and have a small, branched stem with clover-like leaves. First-year plants can be found in late summer. In the second year, plants may be seen in late April or early May. By that time, individuals have a strong taproot and a root crown from which new shoots appear. Plant height is dependent on root development and growing conditions; healthier plants are taller. Sweet clovers flower from late May through September, set seed, and die. Both plants produce small, hardy seeds that remain viable in the soil for as many as thirty years.

Burning produces excellent growing conditions for clover by scarifying seeds and stimulating germination. During the next year following a burn, many flowering plants generally emerge.

Size: In the second year, plants may appear bushy, and grow from three to six feet in height.
Habit: First year seedlings are leafy, green, few-stemmed and around a foot tall. Second year plants generally have three main stout stems arising from the root crown. The 3 – 6 foot plants are conical and bushy.
Leaves: Leaves are alternate, divided into three finely toothed leaflets, with the middle leaflet occurring on a distinct stalk.

Fruit: The legume is ovoid, leathery and wrinkled, longer than the calyx, and scarcely dehiscent, with one or two small seeds.
Flower: Yellow and white sweet clovers appear very similar except for the distinguishing yellow or white flowers. Yellow sweet clover is usually smaller than white sweet clover and blooms earlier. The flowers are packed densely on the top four inches of an elongated stem. Each small flower is attached to the stem by a minute stalk.
Origin: Sweet clovers are native to Europe and Asia. They were brought to North America in the late 1600's as an agricultural crop for forage and honey production. These clovers also fix nitrogen, and thus became popular as soil enhancers. The chemical used in the production of the blood thinner Warfarin was first discovered in sweet clover. Due to the economic values of white and yellow sweet clover, these species will continue to be planted despite the problems they pose for land managers. Both species are found in all fifty states, although they are most frequently found in the states of the Upper Midwest and Great Plains. Sweet clovers grow well in direct sunlight or in partial shade. Neither species can tolerate complete shade. Sweet clovers seem to prefer calcareous or loamy soils, and are most frequently found in open, disturbed, upland habitats such as prairies, savannas, and dunes.

Mechanical Control
On grasslands managed with prescribed burning, it is possible to greatly reduce sweet clover by burning two years in a row. Burning should be done early the first year (before green-up--usually in early to mid-April) to stimulate germination. The burned area should be checked in late summer for first year plants. If plants are found, another burn should be conducted the next year in early to mid May. If burning is conducted before the buds are developed, the plants will resprout. Heavily infested areas may need this burning sequence repeated after a few years. The fire may be of low intensity--just enough to touch the stems. Damaged plants wither quickly if they are not completely destroyed by fire. For small patches or those areas not completely burned, a flame gun (torch) may be used when the vegetation is damp to avoid burning surrounding prairie. Another burning strategy is to mow later in the summer, allow the cut plants to dry, and then burn. This can be stressful to the native vegetation and should not be done annually.

Small amounts of sweet clover can be controlled by hand-pulling in late fall after first-year plant root-crown buds have developed, or in May or June before second-year plants flower. Pulling is easier when the soil is wet. Plants can also be cut at ground level with brush loppers. If pulling is tried too early, many plants may be missed, and those with succulent stems may break off and resprout. But pulling must be done before seeds are set; otherwise cut plants will have to be removed from the natural area. It is necessary to inspect the area a couple of times in summer for late flowering plants.

For very dense small patches, cutting with a power brush-cutter using a heavy duty saw blade is effective. The stand should be cut just before flowering, and checked a week later for individuals missed or partly cut.

It is necessary to conduct annual inspections to remove scattered individual plants. Disturbed areas such as fox dens provide habitats that can allow sweet clover to greatly increase over time if not controlled. Habitats adjacent to managed areas should also be inspected to reduce sweet clover invasion on managed sites. Due to the long viability of sweet clover seeds (up to 30 years) and continued agricultural use, these plants generally must be managed on a continuous basis.

Chemical Control
Sweet clover can be managed using mechanical controls, and should not require chemical use.

Source: Wisconsin Department of Natural Resources, 2002; The Nature Conservancy, 2002

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.

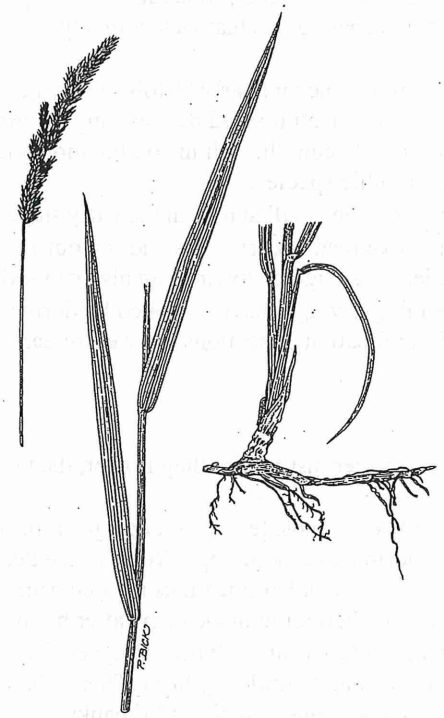
When converting areas dominated by cool-season grasses into prairie, it is helpful to reduce the grass cover and seed bank before planting native seeds. This can be accomplished by any combination of tilling, smothering the grass, or applying herbicide. Till several times a year for at least one season 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

Cut and spray

- Tie the stems of small clones together just before they flower, then cut them and apply glyphosate in a 33% solution to the cut stems.
- Perform foliar application of a 5% glyphosate solution designed for use in wetlands in early spring when most native species are dormant to the foliage. 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 B: Species Lists for Proposed Restoration Target Communities

The following species lists contain the common plants of intact remnant communities in Minnesota. These species lists have been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

- Dry prairie species list (Appendix B Table 1)
- Oak savanna species list (Appendix B Table 2)
- Maple-basswood forest species list (Appendix B Table 3)
- Dry oak forest species list (Appendix B Table 4)
- Lowland hardwood forest species list (Appendix B Table 5)
- Floodplain forest species list (Appendix B Table 6)
- Mixed emergent marsh species list (Appendix B Table 7)
- Willow swamp species list (Appendix B Table 8)

Appendix B Table 1. Dry Prairie species list

This species list has been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Shrubs	
Amorpha canescens	Lead-plant
Prunus americana	American plum
Prunus virginiana	Choke cherry
Rhus glabra	Smooth sumac
Rosa arkansana	Prairie rose
Symphoricarpos occidentalis	Wolfberry

Forbs	
Anemone cylindrica	Long-fruited Thimbleweed
Antennaria plantaginifolia	Large-leaved pussytoes
Apocynum cannabinum	Indian Hemp
Apocynum sibiricum	Clasping Indian Hemp
Artemisia ludoviciana	White Sage
Asclepias syriaca	Common Milkweed
Asclepias tuberosa	Butterfly Milkweed
Asclepias verticillata	Whorled Milkweed
Asclepias viridiflora	Green milkweed
Aster ericoides	Heath Aster
Aster oolentangiensis	Sky-blue aster
Campanula rotundifolia	Harebell
Comandra umbellata	Bastard toadflax
Coreopsis palmata	Stiff tickseed or bird foot coreopsis
Dalea purpureum	Purple prairie clover
Delphinium virescens	Prairie larkspur

Euphorbia corollata	Flowering spurge
Gnaphalium obtusifolium	Sweet everlasing
Hedioma hispida	Mock pennyroyal
Helianthemum bicknellii	Hoary frostweed
Helianthus pauciflorus (rigidus)	Stiff sunflower
Heuchera richardsonii	Alum root
Lespedeza capitata	Round-headed bush-clover
Liatris aspera	Rough blazing star
Liatris punctata	Dotted blazing star
Lithospermum canescens	Hoary puccoon
Lithospermum incisum	Narrow-leaved puccoon
Physalis heterophylla	Ground-cherry
Potentilla arguta	Prairie cinquefoil
Rosa arkansana	Prairie rose
Solidago nemoralis	Gray goldenrod
Solidago ptarmicoides	White aster
Solidago rigida	Stiff goldenrod
Tradescansia occidentalis	Western spiderwort
Viola palmata var. *pedatifida*	Prairie Violet

Grasses and Sedges	
Andropogon gerardii	Big bluestem
Bouteloua gracilis	Blue grama grass
Bouteloua hirsuta	Hairy grama grass
Bouteloua curtipendula	Side-oats grama
Carex heliophila	A species of sedge
Cyperus lupulinus	Hop-like cyperus
Elymus canadensis	Canada wild rye
Koeleria macrantha	Junegrass
Panicum oligosanthes	Scribner's panic grass
Muhlenbergia cuspidata	Plains muhley
Schizachyrium scoparium	Little Bluestem
Sorghastrum nutans	Indian Grass
Sporobolus heterolepis	Prairie dropseed
Stipa spartea	Porcupine grass

Appendix B Table 2. Oak Savanna species list

This species list has been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Trees	
Quercus macrocarpa	Bur oak
Quercus ellipsoidalis	Northern pin oak
Populus tremuloides	Quaking aspen
Prunus serotina	Black cherry

Shrubs	
Amorpha canescens	Leadplant
Ceanothus americanus	New Jersey tea
Cornus racemosa	Gray dogwood
Corylus americana	American hazelnut
Rhus glabra	Smooth sumac
Rosa arkansana	Prairie rose
Prunus virginiana	Chokecherry
Amelanchier sanguinea	Round-leaf serviceberry
Symphoricarpos occidentalis	Wolfberry
Salix humilis	Prairie willow

Forbs:	
Anemone cylindrica	Thimbleweed
Antennaria neglecta	Pussytoes, white
Antennaria plantaginifolia	Plantain-leafed or large-leafed pussytoes
Aristida tuberculosa	Butterfly weed
Artemisia ludoviciana	Prairie sage
Artemisia frigida	Prairie sagewort
Asclepias tuberosa	Butterfly milkweed
Asclepias verticillata	Whorled milkweed
Asclepias viridiflora	Green milkweed
Aster ericoides	Heath aster
Aster oolentangiensis	Azure aster
Aster sericeus	Silky aster
Astragalus crassicarpus	Buffalo-bean, ground-plum
Besseya bullii	Kitten-tails
Calylophus serrulata	Toothed-leafed evening primrose
Campanula rotundifolia	Harebell
Coreopsis palmata	Stiff tickseed or bird-foot coreopsis
Dalea candidum	White prairie clover
Dalea purpureum	Purple prairie clover
Delphinium virescens	Prairie larkspur
Desmodium illinoense	Illinois tick-trefoil
Euphorbia corollata	Flowering spurge
Fragaria virginiana	Wild strawberry
Galium boreale	Northern bedstraw
Geum triflorum	Prairie smoke

Gnaphalium obtusifolium	Sweet everlasting
Helianthemum bicknellii	Hoary frostweed
Helianthus hirsutus	Woodland sunflower
Helianthus occidentalis	Western sunflower
Hilianthus rigidus	Rigid sunflower
Heliopsis helianthoides	Early sunflower
Heterotheca villosa	Hairy golden aster
Heuchera richardsonii	Alum root
Hieracium longipilum	Long-bearded hawkweed
Lespedeza capitata	Round-headed bush-clover
Liatris aspera	Rough blazing star
Liatris punctata	Dotted blazing star
Lithospermum canescens	Hoary puccoon
Lithospermum caroliniense croceum	Hairy puccoon
Lobelia spicata	Rough-spiked lobelia
Monarda fistulosa	Wild bergamot
Oenothera biennis	Evening primrose
Oxalis violacea	Violet wood sorrel
Penstemon gracilis	Slender beard-tongue
Penstemon grandiflorus	Large-flowered beard-tongue
Physalis virginiana	Ground cherry
Rudbeckia hirta pulcherrima	Black-eyed Susan
Sisyrinchium campestre	Blue-eyed grass
Smilacina stellata	Starry false Solomon's seal
Solidago nemoralis	Gray goldenrod
Solidago ptarmicoides	White aster
Solidago rigida	Stiff goldenrod
Teucrium canadense	Germander
Tradescantia occidentalis	Western spiderwort
Verbena stricta	Hoary vervain
Viola pedatifida	Prairie violet

Grasses and Sedges	
Andropogon gerardii	Big bluestem
Aristida basiramea	Three-awn grass
Bouteloua curtipendula	Side-oats grama
Bouteloua hirsuta	Hairy grama
Carex muhlenbergii	Muhlenberg's sedge
Carex pennsylvanica	Pennsylvania sedge
Elymus canadensis	Canada wild rye, nodding wild-rye
Koeleria macrantha	June grass
Muhlenbergia cuspidata	Plains muhley
Panicum oligosanthes	Scribner's panic grass
Panicum virgatum	Switch grass
Schizachyrium scoparium	Little bluestem
Sorghastrum nutans	Indian grass
Sporobolus heterolepis	Prairie dropseed
Stipa comata	Needle grass
Stipa spartea	Porcupine grass

Appendix B Table 3. Maple-basswood Forest species list

This species list has been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Trees - Canopy	
Acer saccharum	Sugar maple
Celtis occidentalis	Hackberry
Juglans cinerea	Butternut
Juglans nigra	Black walnut
Prunus serotina	Black cherry
Quercus alba	White oak
Quercus macrocarpa	Bur oak
Quercus rubra	Northern red oak
Tilia americana	Basswood
Ulmus americana	American elm
Ulmus rubra	Slippery elm

Trees – Sub-canopy	
Betula papyrifera	Paper-birch
Carpinus caroliniana	Blue beech
Carya cordiformis	Bitternut hickory
Fraxinus nigra	Black ash
Fraxinus pennsylvanica	Green ash
Ostrya virginiana	Ironwood
Pinus strobus	White pine
Prunus americana	Wild plum
Prunus virginiana	Chokecherry

Shrubs	
Cornus alternifolia	Pagoda dogwood
Cornus foemina	Gray dogwood
Dirca palustris	Leatherwood
Ribes americanum	Wild black currant
Ribes cynosbati	Prickly gooseberry
Ribes missouriense	Missouri gooseberry
Sambucus canadensis	Common elder
Sambucus pubens	Red-berried elder
Staphylea trifolia	Bladdernut

Vines	
Celastrus scandens	Climbing bittersweet
Parthenocissus inserta	Five-leafed Virginia creeper
Parthenocissus quinquefolia	Virginia creeper

Forbs	
Actaea rubra	Red baneberry
Adiantum pedatum	Maidenhair fern

Allium burdickii	Burdick's leek
Allium tricoccum	Wild leek
Amphicarpaea bracteata	Hog-peanut
Anemone quinquefolia	Wood-anemone
Anemone virginiana	Virginia thimbleweed
Anemonella thalictroides	Rue-anemone
Aquilegia canadensis	Columbine
Aralia nudicaulis	Wild sarsaparilla
Arisaema triphyllum	Jack in the pulpit
Asarum canadense	Wild ginger
Aster cordifolius	Heart-leafed aster
Athyrium angustum	Lady-fern
Botrychium virginianum	Rattlesnake fern
Campanula americana	Tall bellflower
Caulophyllum thalictroides	Blue cohosh
Cirsium discolor	Field thistle
Claytonia caroliniana	Carolina spring-beauty
Claytonia virginica	Virginia spring-beauty
Corallorhiza	Coral-root
Cypripedium calceolus	Yellow lady-slipper
Cystopteris bulbifera	Bulblet bladder-fern
Cystopteris fragilis	Fragile bladder-fern
Desmodium glutinosum	Pointed-leafed tick-trefoil
Dicentra cucullaria	Dutchman's breeches
Dryopteris cristata	Crested fern
Equisetum pratense	Meadow horsetail
Erythronium albidum	White trout-lily
Eupatorium rugosum	Common snakeroot
Galearis spectabilis	Showy orchis
Galium concinnum	Elegant bedstraw
Galium triflorum	Three-flowered bedstraw
Geranium maculatum	Wild geranium
Helianthus hirsutus	Woodland sunflower
Hepatica acutiloba	Sharp-lobed hepatica
Hydrophyllum virginianum	Virginia waterleaf
Isopyrum biternatum	False rue-anemone
Lilium michiganense	Michigan lily
Lonicera canadensis	Fly honeysuckle
Maianthemum canadense	Canada mayflower
Matteuccia struthiopteris	Ostrich-fern
Menispermum canadense	Canada moonseed
Onoclea sensibilis	Sensitive fern
Osmorhiza claytonii	Clayton's sweet cicely
Osmorhiza longistylis	Anise-root
Osmunda claytoniana	Interrupted fern
Panax quinquefolium	American ginseng
Phlox divaricata	Blue phlox
Polygonatum commutatum	Giant Solomon's-seal
Polygonatum pubescens	Hairy Solomon's seal
Prenanthes alba	White rattlesnake-root
Ranunculus abortivus	Kidney-leaf buttercup
Rubus occidentalis	Black raspberry

Rubus strigosus	Red raspberry
Rudbeckia laciniata	Goldenglow
Sanguinaria canadensis	Bloodroot
Thalictrum dioicum	Early meadowrue
Trillium cernuum	Nodding trillium
Uvularia grandiflora	Yellow bellwort
Uvularia sessilifolia	Pale bellwort
Viola pratincola	Meadow violet
Viola pubescens	Yellow violet
Viola sororia	Common blue violet

Grasses and Sedges	
Carex blanda	Charming sedge
Carex pedunculata	Long-stalked sedge
Carex pennsylvanica	Pennsylvania sedge
Carex rosea	Stellate sedge
Carex sprengelii	Sprengel's sedge
Elymus hystrix	Bottlebrush grass
Elymus villosus	Downy wild rye
Festuca obtusa	Nodding fescue
Milium effusum	Woodland millet grass
Oryzopsis asperifolia	Mountain rice-grass
Oryzopsis asperifolia	Mountain rice-grass
Oryzopsis racemosa	Black-fruited rice-grass
Schizachne purpurascens	False medic grass

Appendix B Table 4. Dry Oak Forest species list

This species list has been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Trees – Canopy	
Ostrya virginiana	Ironwood
Populus tremuloides	Quaking Aspen
Quercus alba	White Oak
Quercus ellipsoidalis	Northern Pin Oak
Quercus macrocarpa	Bur Oak

Trees – Sub-canopy	
Prunus serotina	Black Cherry
Quercus macrocarpa	Bur Oak
Acer rubrum	Red maple

Shrubs	
Amelanchier laevis	Smooth Juneberry
Amelanchier sanguinea	Round-leaf Juneberry
Cornus racemosa	Gray Dogwood
Corylus americana	American Hazelnut
Diervilla lonicera	Bush Honeysuckle
Prunus virginiana	Choke Cherry
Ribes cynosbati	Prickly Gooseberry
Ribes missouriense	Missouri Gooseberry
Rosa blanda	Smooth Wild Rose
Sambucus canadensis	Common Elder
Symphoricarpos alba	Snowberry
Vaccinium angustifolium	Lowbush Blueberry
Viburnum lentago	Nannyberry
Viburnum rafinesquianum	Downy Arrow-wood

Vines	
Lonicera prolifera	Yellow Vine Honeysuckle

Forbs	
Agrimonia gryposepala	Common Agrimony
Amphicarpa bracteata	Hog-peanut
Anemone cylindrica	Long-headed Thimbleweed
Anemone quinquefolia	Wood Anemone
Anemone riparia (virginiana)	Tall Thimbleweed
Anemonella thalictroides	Rue Anemone
Apocynum androsaemifolium	Spreading Dogbane
Aquilegia canadensis	Canada Columbine
Aralia nudicaulis	Wild Sarsaparilla
Arenaria lateriflora	Grove Sandwort
Aster macrophyllus	Large-leaved Aster
Aster sagittifolius (urophyllus)	Arrow-leaved Aster
Athyrium felix-femina	Lady Fern
Botrychium dissectum	Dissected Grape-fern

Botrychium virginianum	Rattlesnake Fern
Cerastium nutans	Nodding Chickweed
Desmodium glutinosum	Pointed-leaved Tick-trefoil
Euphorbia corollata	Flowering Spurge
Fragaria virginiana	Thick-leaved Wild Strawberry
Galium aparine	Cleavers
Galium boreale	Northern Bedstraw
Galium concinnum	Shining Bedstraw
Galium triflorum	Sweet-scented Bedstraw
Geranium maculatum	Wild geranium
Hackelia virginiana	Virginia Stickseed
Helianthus hirsutus	Woodland Sunflower
Helianthus strumosus	Rough-leaved Sunflower
Heuchera richardsonii	Alum-root
Maianthemum canadense	Canada Mayflower
Monarda fistulosa	Wild Bergomat
Osmorhiza claytonii	Clayton's Sweet-cicely
Phryma leptostachya	Lopseed
Polygonatum biflorum (commutatum)	Giant Solomon's Seal
Pteridium aquilinum	Bracken Fern
Pyrola elliptica	Common Shinleaf
Sanicula gregaria	Clustered Snakeroot
Sanicula marilandica	Black Snakeroot
Smilacina racemosa	False Solomon's Seal
Smilacina stellata	Starry false Solomon's Seal
Smilax ecirrhata	Cat-briar
Smilax herbacea	Cat-briar
Solidago hispida	Hairy Goldenrod
Trientalis borealis	Starflower
Triosteum perfoliatum	Perfoliate Horse-gentian
Uvularia sessilifolia	Sessile-leaved Bellwort
Veronicastrum virginicum	Culver's Root
Viola pubescens	Yellow Violet

Grasses and Sedges	
Carex cephalophora	Oval-headed Sedge
Carex gracillima	Graceful Sedge
Carex hirtifolia	Hairy-leaved Sedge
Carex peckii	Peck's Sedge
Carex pensylvanica	Pennsylvania Sedge
Carex rosea	Stellate Sedge
Elymus hystrix (Hystrix patula)	Bottlebrush Grass
Oryzopsis asperifolia	Rough-leaved Ricegrass
Schizachne purpurascens	False Melic Grass

Appendix B Table 5. Lowland Hardwood Forest species list

This species list has been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Trees - Canopy	
Acer rubrum	Red maple
Betula papyrifera	Paper birch
Celtis occidentalis	Hackberry
Fraxinus nigra	Black ash
Fraxinus pennsylvanica	Green ash
Populus tremuloides	Trembling aspen
Quercus alba	White oak
Quercus macrocarpa	Bur oak
Quercus rubra	Red oak
Tilia americana	Basswood
Ulmus americana	American elm
Ulmus rubra	Red elm

Trees – Sub-canopy	
Acer saccharum	Sugar maple
Betula papyrifera	Paper birch
Carpinus caroliniana	American hornbeam (blue beech)
Carya cordiformis	Bitternut
Celtis occidentalis	Hackberry
Fraxinus pennsylvanica	Green ash
Juglans cinerea	Butternut
Ostrya virginiana	Ironwood
Ulmus rubra	Red elm

Shrubs	
Alnus incana	Speckled alder
Cornus alternifolia	Pagoda dogwood
Cornus foemina	Gray dogwood
Corylus americana	American hazelnut
Euonymus atropurpureus	Wahoo
Ilex verticillata	Winter berry
Prunus virginiana	Chokecherry
Ribes americanum	Wild black current
Ribes missouriense	Missouri gooseberry
Sambucus canadensis	Common elder
Zanthoxylum americanum	Prickly ash

Vines	
Menispermum canadense	Canada moonseed
Parthenocissus spp.	Virginia creeper
Rhus radicans	Poison ivy
Vitis riparia	Wild grape

Forbs	
Amphicarpa bracteata	Hog peanut
Adiantum pedatum	Maidenhair fern
Aralia nudicaulis	Wild sarsaparilla
Arisaema triphyllum	Jack-in-the-pulpit
Asarum canadense	Wild ginger
Aster lateriflorus	Side-flowering aster
Athyrium felix-femina	Lady fern
Campanula americana	Tall bellflower
Circaea lutetiana	Enchanter's nightshade
Cryptotaenia canadensis	Honewort
Equisetum sylvaticum	Woodland horsetail
Galium aparine	Cleavers
Galium triflorum	Three-flowered bedstraw
Geum canadense	White avens
Hydrophyllum virginianum	Virginia waterleaf
Impatiens capensis	Spotted touch-me-not
Laportea canadensis	Wood nettle
Maianthemum canadense	Canada mayflower
Matteuccia struthiopteris	Ostrich fern
Osmunda claytoniana	Interrupted fern
Osmunda cinnamomea	Cinnamon fern
Panax quinquifolium	Ginseng
Pilea pumila	Clearweed
Rudbeckia laciniata	Goldenglow
Scutellaria lateriflora	Skullcap
Silphium perfoliatum	Cup plant
Smilacina racemosa	False Solomon's seal
Smilax spp.	Carrion flower
Stachys palustris	Woundwort
Thalictrum dioicum	Early meadow-rue
Teucrium canadense	Germander
Urtica dioica	Stinging nettle

Grasses and Sedges	
Carex gracillima	A species of sedge
Carex typhina	A species of sedge
Carex pedunculata	A species of sedge
Elymus virginicus	Virginia wild rye
Festuca subverticillata	Nodding fescue
Leersia virginica	White grass
Muhlenbergia frondosa	Swamp satin grass
Oryzopsis asperifolia	Mountain ricegrass

Appendix B Table 6. Floodplain Forest species list

This species list has been compiled from Curtis (1959), Wovcha et al. (1994) and from plant inventory lists compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Trees - Canopy	
Acer saccharinum	Silver maple
Acer negundo	Boxelder
Fraxinus nigra	Black ash
Fraxinus pennsylvanica	Green ash
Populus deltoides	Cottonwood
Quercus macrocarpa	Bur oak
Ulmus americana	American elm
Ulmus rubra	Red elm

Trees – Sub-canopy	
Acer negundo	Boxelder
Acer saccharinum	Silver maple
Celtis occidentalis	Hackberry
Salix nigra	Black willow
Fraxinus pennsylvanica	Green ash
Populus deltoides	Cottonwood
Tilia americana	Basswood
Ulmus americana	American elm

Shrubs	
Cephalanthus occidentalis	Buttonbush
Salix interior	Sandbar willow
Staphylea trifolia	Bladdernut
Zanthoxylum americanum	Prickly ash

Vines	
Parthenocissus spp.	Virginia creeper
Rhus radicans	Poison ivy
Vitis riparia	Wild grape

Forbs	
Amphicarpa bracteata	Hog-peanut
Apios americana	Groundnut
Aster ontarionis	Ontario aster
Bidens spp.	Beggar-ticks
Boehmeria cylindrica	False nettle
Cryptotaenia canadensis	Honewort
Echinocystis lobata	Wild cucumber
Eupatorium rugosum	White snakeroot
Galium aparine	Cleavers
Hydrophyllum virginianum	Virginia waterleaf
Impatiens capensis	Spotted touch-me-not
Laportea canadensis	Wood nettle

Lobelia cardinalis	Cardinal flower
Lycopus virginicus	Virginia water horehound
Physostegia virginiana	False dragonhead
Pilea pumila	Clearweed
Rudbeckia laciniata	Goldenglow
Scutellaria lateriflora	Skullcap
Sicyos angulatus	Bur cucumber
Stachys hispida	Smooth hedge nettle
Stachys tenuifolia	Narrow-leaved hedge nettle
Urtica dioica	Stinging nettle

Grasses and Sedges	
Carex crinita	A species of sedge
Carex tribuloides	A species of sedge
Carex typhina	Cattail sedge
Cares lupulina	A species of sedge
Echinochloa walteri	Walter's barnyard grass
Elymus virginicus	Virginia wild rye
Leersia oryzoides	Rice cut-grass
Leersia virginica	White grass

Appendix B Table 7. Mixed Emergent Marsh species list

This species list has been compiled by Cynthia Lane, Ph.D., former staff ecologist with Great River Greening.

Latin Name	Common Name
Trees	
Acer saccharinum	Silver maple
Celtis occidentalis	Hackberry
Fraxinus pennsylvanica	Green ash
Salix exigua interior	Sandbar willow
Shrubs	
Amorpha fruticosa	False indigo
Betula pumila	Bog-birch
Cornus sericea	Red-osier dogwood
Salix eriocephala	Heart-leaved willow
Salix petiolaris	Meadow willow
Sambucus canadensis	Common elder
Spirea tomentosa rosea	Steeple-bush
Vines	
Cuscuta spp.	Dodder
Decodon verticillatus laevigatus	Water willow
Echinocystis lobata	Wild cucumber
Menispermum canadense	Common moonseed
Smilax hispida	Green-briar
Forbs	
Acorus calamus	Sweet flag
Alisma subcordatum	Heart-leaved water-plantain
Alisma triviale	Ordinary water-plantain
Amaranthus tuberculatus	Tall water hemp
Ambrosia trifida	Great ragweed
Apocynum androsaemifolium	Spreading dogbane
Artemisia serrata	Leafy mugwort
Asclepias incarnata	Swamp milkweed
Aster ontarionis	Ontario aster
Bidens spp.	Beggar-ticks
Boehmeria cylindrica	False nettle
Campanula aparinoides	Marsh bellflower
Cicuta bulbifera	Bulb-bearing water-hemlock
Cicuta maculata	Spotted water-hemlock
Epilobium spp.	Willow-herb
Eupatorium maculatum	Spotted Joe-pye weed
Eupatorium perfoliatum	Common boneset
Eupatorium purpureum	Sweet Joe-pye weed
Eupatorium rugosum	Common snakeroot
Galium labradoricum	Marsh bedstraw

Galium tinctorium	Small bedstraw
Galium trifidum	Three-cleft bedstraw
Impatiens spp.	Spotted touch-me-not
Iris versicolor	Northern blue flag
Laportea canadensis	Wood-nettle
Lathyrus palustris	Marsh vetchling
Lemna spp.	Lesser duckweed
Lobelia cardinalis	Cardinal flower
Ludwigia palustris	Water purslane
Lycopus americanus	Cut-leaved bugleweed
Lycopus asper	Bugleweed
Lycopus uniflorus	Northern bugleweed
Lycopus virginicus	Virginia bugleweed
Lysimachia ciliata	Fringed loosestrife
Lysimachia terrestris	Yellow loosestrife
Lysimachia thyrsiflora	Tufted loosestrife
Mentha arvensis glabrata	Common mint
Mimulus ringens	Purple monkey-flower
Nymphaea cmx.	Water lily
Oenothera biennis	Common evening-primrose
Oxalis cmx.	Wood-sorrel
Physostegia virginiana	Obedient plant
Pilea spp.	Clearweed
Polygonum amphibium stipulaceum	Water smartweed
Polygonum amphibium	Swamp smartweed
Polygonum lapathifolium	Nodding smartweed
Polygonum pensylvanicum	Pennsylvania smartweed
Polygonum punctatum	Dotted smartweed
Polygonum sagittatum	Arrow-leaved tearthumb
Polygonum virginianum	Virginia knotweed
Ranunculus pensylvanicus	Bristly buttercup
Rorippa palustris	Yellow cress
Rudbeckia laciniata	Goldenglow
Rumex maritimus fueginus	Golden dock
Rumex orbiculatus	Great water dock
Sagittaria latifolia	Broad-leaved arrowhead
Scutellaria galericulata	Marsh skullcap
Scutellaria lateriflora	Mad-dog skullcap
Sium suave	Water-parsnip
Solidago gigantea	Giant goldenrod
Sparganium androcladum	Bur reed
Sparganium emersum	Bur-reed
Sparganium eurycarpum	Giant bur-reed
Spirodela polyrhiza	Greater duckweed
Stellaria longifolia	Long-leaved chickweed
Teucrium canadense	Germander
Typha spp.	Cattail
Urtica dioica gracilis	Stinging nettle
Verbena hastata	Blue vervain

Grasses and Sedges	
Calamagrostis canadensis	Bluejoint
Carex aquatilis	Water sedge
Carex comosa	Bristly sedge
Carex diandra	Lesser-panicled sedge
Carex haydenii	Hayden's sedge
Carex lacustris	Lake-sedge
Carex pellita	Woolly sedge
Carex stricta	Tussock-sedge
Cyperus bipartitus	Nut grass (a type of sedge)
Cyperus diandrus	Nut grass (a type of sedge)
Cyperus erythrorhizos	Nut grass (a type of sedge)
Cyperus odoratus	Nut grass (a type of sedge)
Cyperus strigosus	Nut grass (a type of sedge)
Elymus virginicus	Virginia wild rye
Equisetum fluviatile	Water horsetail
Dulichium arundinaceum	Three-way sedge
Echinochloa muricata	Barnyard grass
Eleocharis ovata	Spike rush
Eleocharis pauciflora fernaldii	Spike rush
Glyceria canadensis	Rattlesnake grass
Leersia oryzoides	Rice cut grass
Leersia virginica	White grass
Phalaris arundinacea	Reed canary-grass
Phragmites australis	Common reed
Scirpus acutus	Hard-stemmed bullrush
Scirpus cyperinus	Wool-grass
Scirpus fluviatilis	River bulrush
Scirpus validus creber	Softstem bullrush
Spartina pectinata	Prairie cord-grass
Thelypteris palustris	Northern marsh-fern
Zizania palustris	Wild rice

Appendix B Table 8. Willow Swamp species list

This species list has been compiled from Wovcha et al. (1994).

Latin Name	Common Name
Shrubs	
Salix gracilis	Slender willow
Salix discolor	Pussy willow
Salix bebbiana	Bebb's willow
Alnus incana rugosa	Speckled alder
Cornus stolonifera	Red-osier dogwood
Betula glandulifera	Bog birch

Forbs	
Thelypteris palustris	Northern marsh fern
Sagittaria latifolia	Broad-leaved arrowhead
Campanula aparinoides	Marsh bellflower
Cicuta bulbifera	Bulb-bearing water-hemlock
Eupatorium maculatum	Joe-pye weed
Potentilla palustris	Marsh cinquefoil
Rumex orbiculatus	Great water dock
Impatiens capensis	Spotted touch-me-not
Lysimachia thyrsiflora	Tufted loosestrife

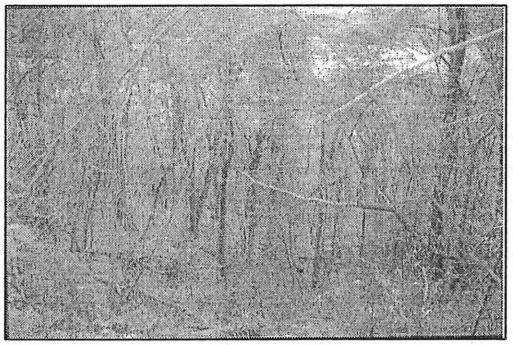
Grasses and Sedges	
Calamagrostis canadensis	Blue-joint grass
Carex lacustris	Lake sedge
Carex stricta	Tussock sedge

Appendix C: Cherokee Park Inventory Results

Introduction

This report presents the results of an ecological inventory of Cherokee Park conducted during the growing season of 2002. Cherokee Park is a city park that is located on the south side of the Mississippi River in St. Paul. Land-cover maps developed through the Minnesota Land Cover Classification System (MLCCS) were used to develop species lists. Separate species lists were compiled for each land-cover type within the project area. Plants are listed by vegetation form and are listed alphabetically by scientific name. Written descriptions summarizing the ecological condition of each land-cover type are included in the report.

Maple-basswood forest - 12.35 acres



The maple-basswood forest at the project site generally faces northeast and is on a relatively steep portion of bluff. Maple-basswood forest species are most dominant within ravines while ridge tops are often dominated with dry to mesic oak forest species. Sugar maple trees and ironwood dominate the maple-basswood forest along with basswood, red oak and hackberry.

Generally, the shrub and ground layers are diverse. Shrub species that are common but not generally seen in other Twin Cities woodlands include bladdernut, roundleaf dogwood, and leatherwood. Also uncommon in the Twin Cities area are spring ephemerals. It is believed that combination of erosion, trampling and non-native earthworms are causing spring ephemeral populations to decline. Within the maple-basswood forest at Cherokee Park many spring ephemeral can be found. Some species include sharp-lobed hepatica, bloodroot, rue-anemone and wild sarsaparilla. Sedges are also common in the maple basswood forest and include Pennsylvania sedge, woodland sedge, Sprengell's sedge and *Carex eburina*. *Carex eburina* is a sedge with very fine leaf blades and it is found in dense groupings on some steeper portions of the bluff. These sedges play an important role in preventing erosion. Although erosion is a natural process of steep slopes and ravines, hiking/animal trails and increased water runoff from above are significantly accelerating erosion in the park.

The most common invasive species include common buckthorn and Tartarian honeysuckle. Common buckthorn comprises about 20% of the mid-story and Tartarian honeysuckle makes up about 1% of the shrub layer.

Canopy trees

Latin Name	Common Name	Percent Cover
Acer saccharum	Sugar maple	25%
Carya cordiformis	Bitternut hickory	4%
Celtis occidentalis	Hackberry	8%
Juglans cinerea	Butternut	7%
Populus deltoides	Eastern cottonwood	8%
Quercus alba	White oak	5%
Quercus ellipsoidales	Pin oak	5%
Quercus macrocarpa	Bur oak	3%
Quercus rubra	Red oak	10%
Tilia americana	American basswood	15%
Ulmus americana	American elm	5%
Ulmus rubra	Red elm	10%

Mid-Story trees

Ostrya virginiana	Ironwood	25%
Rhamnus cathartica	Common buckthorn	20%

Shrub layer

Amelanchier laevis	Smooth serviceberry	1%
Catalpa speciosa	Catalpa	<1%
Cornus alternifolia	Pagoda dogwood	<1%
Cornus racemosa	Grey dogwood	4%
Cornus rugosa	Round-leafed dogwood	<1%
Dirca palustris	Leatherwood	<1%
Juniperus virginiana	Red Cedar	<1%
Lonicera tartarica	Tartarian honeysuckle	1%
Prunus americana	Chokecherry	10%
Rhus typhina	Staghorn sumac	<1%
Ribes cynosbati	Gooseberry (thornless)	<1%
Ribes missouriensis	Prickly gooseberry?	<1
Sambucus spp.	Elderberry	<1%
Staphylea trifolia	Bladdernut	1%
Symphoricarpos occidentalis	Wolfberry	1%
Viburnum lentago	Nannyberry	<1%
Viburnum rafenesquianum	Downy arrowood viburnum	3%
Xanthoxylum americanum	Prickly ash	<1%

Groundlayer vines

Amphicarpa bracteata	Hog peanut	1%
Parthenocissus inserta	Virginia creeper	1%
Rhus toxicodendron	Poison ivy	1%
Vitis riparia	Riverbank grape	<1%

Forbs or seedling trees

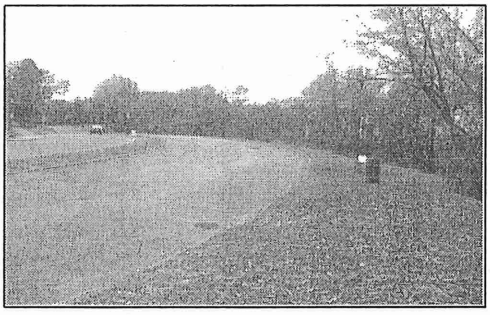
Anemone cylindrica	Thimbleweed	<1%
Aquilegia canadense	Columbine	<1%
Aralia nudicaulis	Wild sarsaparilla	<1%
Arctium minus	Burdock	<1%

Arisaema atrorubens	Jack-in-the pulpit	<1%
Asarum canadense	Wild ginger	<1%
Aster laevis	Smooth aster	<1%
Desmodium glutinosum	Pointed-leaved tick trefoil	<1%
Equisetum pratense	Horsetail	<1%
Galium boreale	Northern bedstraw	<1%
Helianthus divaricatus	Woodland sunflower	<1%
Hepatica acutiloba	Sharp lobed hepatica	<1%
Hydrophyllum virginianum	Virginia waterleaf	<1%
Lactuca canadensis	Wild lettuce	<1%
Maianthemum stellatum	False Solomon's seal	<1%
Melilotus officinalis	Yellow sweet clover	<1%
Sanguinaria canadensis	Bloodroot	<1%
Smilax rotundifolia	Greenbriar	<1%
Solidago flexicaulis	Zig-Zag goldenrod	1%

Grasses and sedges

Carex blanda	Woodland sedge	<1%
Carex eburina	A species of sedge	1%
Carex pennsylvanica	Pennsylvania sedge	5%
Hystrix patula	Bottlebrush grass	<1
Oryzopsis racemosa	Black-seeded rice grass	<1%

Short grasses and mixed trees with 26-50% impervious cover - 13.35 acres



This land-cover area along Cherokee Heights Boulevard and Cherokee Avenue is made up of mown lawn with scattered boulevard trees. Of the wide variety of tree species planted species planted along Cherokee Heights Boulevard and Chippewa Avenue, hackberry is the most common. Other common deciduous trees include white oak, red oak and little-leaf linden. A number of evergreens have also been planted here including Scotch pine, Norway spruce, Colorado blue spruce and red cedar.

The lawn is a typical park lawn composed of a variety of grasses and weeds. Much of the lawn extends to the edge of the bluff, allowing rainwater to flow at an accelerated rate over the edge, adding to erosion on the bluff face. In this regard, converting a band of lawn adjacent to the wooded slopes to prairie, savanna and forest edge species would help to reduce runoff and slow erosion of the bluff.

Canopy trees

Latin Name	Common Name	Percent Cover
Acer Platanoides	Norway maple	3%
Celtis occidentalis	Hackberry	50%
Fraxinus americana	White ash	5%
Fraxinus pennsylvanica	Green ash	4%
Juniperus virginiana	Red cedar	1%
Picea abies	Norway spruce	2%
Picea glauca	White spruce	3%
Pinus strobus	White pine	5%
Pinus sylvestris	Scotch pine	1%
Quercus alba	White oak	25%
Quercus macrocarpa	Bur oak	1%
Quercus rubra	Red oak	2%
Tilia cordata	Little-leaf linden	8%
Ulmus americana	American elm	2%

Mid-Story trees

Acer ginnala	Amur maple	1%
Malus sp.	Crab apple	3%
Rhamnus cathartica	Common buckthorn	<1%

Shrub layer

Syringa sp.	Lilac	<1%

Groundlayer vines

None		

Forbs or seedling trees

Alisma plantago	Common Plantain	2%
Arctium minus	Burdock	1%
Glechoma sanguinalis	Creeping Charlie	2%
Melilotus alba	Yellow sweet clover	<1%
Melilotus officinale	White sweet clover	<1%
Taraxacum officinale	Dandelion	2%
Trifolium repens	White clover	2%

Grasses and sedges

Agropyron repens	Quack grass	3%
Digitaria sanguinalis	Crabgrass	3%
Poa pratensis	Kentucky bluegrass	90%

Short grasses and sparse tree cover on upland soils - 9.06 acres

This land-cover area makes up the recreational portion of Cherokee Park with picnic tables, a playground and restrooms. This land-cover has many species in common with the land-cover type along Cherokee Heights Blvd. and Chippewa Ave. (short grasses and mixed trees with 26-50% impervious cover) but contains a large stand of red and bur oak trees. Other common tree species include hackberry and two non-native species, little leaf linden and Norway maple. Generally the lawn areas have enough variation in topography to retain stormwater. Since most of this land-cover unit is heavily used by park visitors it would be difficult to incorporate many native plant reconstructions. The large grove of mature oak trees in the south part of this land cover area is a potential site for savanna restoration.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer platanoides	Norway maple	8%
Aesculus glabra	Horse chestnut	1%
Celtis occidentalis	Hackberry	5%
Fraxinus americana	White ash	5%
Fraxinus pennsylvanica	Green ash	5%
Picea abies	Norway spruce	2%
Pinus resinosa	Red Pine	2%
Pinus sylvestris	Scotch pine	2%
Quercus alba	White oak	3%
Quercus macrocarpa	Bur oak	10%
Quercus rubra	Red oak	5%
Tilia cordata	Little-leaf linden	3%
Ulmus rubra	Red elm	3%

Mid-Story trees

Acer ginnala	Amur maple	1%
Acer rubrum	Red maple	1%
Malus sp.	Crabapple	1%
Syringa reticulata	Japanese tree lilac	1%

Shrub layer

Spiraea sp.	Spiraea	1%

Groundlayer vines

None		

Forbs or seedling trees

Alisma plantago	Common Plantain	2%
Arctium minus	Burdock	1%
Glechoma hederacea	Creeping Charlie	2%
Melilotus alba	Yellow sweet clover	<1%
Melilotus officinale	White sweet clover	<1%
Taraxacum officinale	Dandelion	2%
Trifolium repens	White clover	2%

Grasses and sedges

Agropyron repens	Quack grass	3%
Digitaria sanguinalis	Crabgrass	3%
Poa pratensis	Kentucky bluegrass	90%

Boxelder - green ash disturbed native forest (Northwest portion) – 10.56 acres

Between 1883 and 1973 a brick yard operated adjacent to the southwest edge of this land cover area. Extensive disturbance as a result of this operation included two railroad tracks that have since been abandoned, ditches and brick/soil disposal piles. Due to the resulting irregular soil surface, there are a variety of moisture conditions within the forest and most trees are relatively young.

Ditches are dominated by species such as reed canary grass, red-osier dogwood and American elm. Disturbed upland soils such as those along the railroad berms are dominated by species such as quaking aspen, cottonwood, Siberian elm, smooth brome and Canada goldenrod. The disturbed nature of the forest has made it ideal habitat for invasive species. Garlic mustard, Siberian elm, common buckthorn, Tartarian honeysuckle, smooth brome, black locust, creeping Charlie, reed canary grass and Kentucky bluegrass are all found at the site. Since this area is generally flat, erosion is not a significant problem. Deposition of eroded materials from the slopes above is extensive at some points along the base of the bluff.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer nigra	Boxelder	5%
Acer saccharum	Sugar maple	2%
Catalpa speciosa	Catalpa	<1%
Celtis occidentalis	Hackberry	1%
Fraxinus pennsylvanica	Green ash	60%

Populus deltoides	Cottonwood	5%
Populus tremuloides	Quaking aspen	10%
Quercus alba	White oak	<1%
Robinia pseudoacacia	Black locust	<1%
Salix nigra	Black willow	<1%
Ulmus americana	American elm	15%

Mid-Story trees

Rhamnus cathartica	Common buckthorn	10%
Ulmus pumila	Siberian elm	1%

Shrub layer

Amorpha fruticosa		<1%
Cornus sericea	Red-osier dogwood	10%
Lonicera tartarica	Tartarian honeysuckle	3%
Prunus virginiana	Chokecherry	1%
Ribes	Gooseberry	1%
Rubus sp.	Raspberry	<1%
Salix exigua	Sandbar willow	1%
Viburnum lentago	Nannyberry	<1%
Viburnum rafinesquianum	Arrowwood viburnum	<1%

Groundlayer vines

Amphicarpa bracteata	Hog peanut	<1%
Parthenocissus inserta	Virginia creeper	<1%
Rhus toxicodendron	Poison ivy	<1%

Forbs or seedling trees

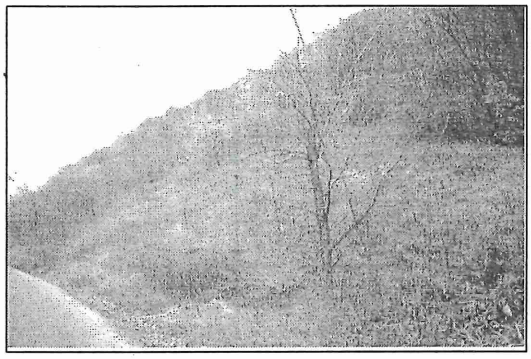
Alliaria petiolata	Garlic mustard	<1%
Arctium minus	Burdock	<1%
Aster puniceus	Red -stem aster	<1%
Aster sp.	Aster	4%
Aster-novae angliae	New England aster	<1%
Cornus serotina	Black cherry	<1%
Equisetum sp.	Equisetum	1%
Eupatorium rugosum	White snakeroot	1%
Glechoma hederacea	Creeping Charlie	3%
Helianthus divaricatus	Woodland sunflower	<1%
Nepeta cataria	Catmint	<1%
Pilea pumila	Clearweed	<1%
Rhus glabra	Smooth sumac	<1%
Rudbeckia laciniata	Giant coneflower	<1%
Solidago canadensis	Canada goldenrod	3%
Solidago canadensis	Canada goldenrod	<1%
Sonchus sp.	Sow thistle	<1%
Ulmus americana	American elm	<1%

Grasses and sedges

Bromus inermis	Smooth brome	5%
Carex blanda	Woodland sedge	<1%
Elymus canadensis	Canada wild rye	<1%

Leersia oryzoides	Rice-cut grass	<1%
Phalaris arundinacea	Reed canary grass	1%
Poa pratensis	Kentucky bluegrass	10%
Setaria glauca	Yellow foxtail	1%

51% to 75% Impervious cover with deciduous trees (Northern portion) - .45 acres



This is a small land-cover unit located along West Water Street at the base of the bluff. It is an area of open grasses surrounded by relatively high quality maple-basswood forest. It appears that this area experienced soil slumping in the past or may have been an area where soils were mined. Due to past disturbance, the non-native grass species smooth brome and Kentucky bluegrass dominate the land-cover unit. The invasive legume species, crown vetch and alfalfa are also abundant, indicating that the site may have been planted with a slope stabilization mix in the past. Early successional tree species are starting to colonize the site. Eastern cottonwood, boxelder, black locust, common buckthorn and green ash are all present. It is likely that the trees will eventually create too much shade for the smooth brome and Kentucky bluegrass to persist. Weedy understory species will most likely replace the grasses.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer negundo	Boxelder	30%
Fraxinus pennsylvanica	Green ash	3%
Populus deltoides	Cottonwood	20%
Robinia pseudoacacia	Black locust	3%

Mid-Story trees

Rhamnus cathartica	Common buckthorn	5%

Shrub layer

Cornus serecia	Red-osier dogwood	3%
Rhus typhina	Staghorn sumac	3%

Groundlayer vines

Vitis riparia	River-bank grape	<1%

Forbs or seedling

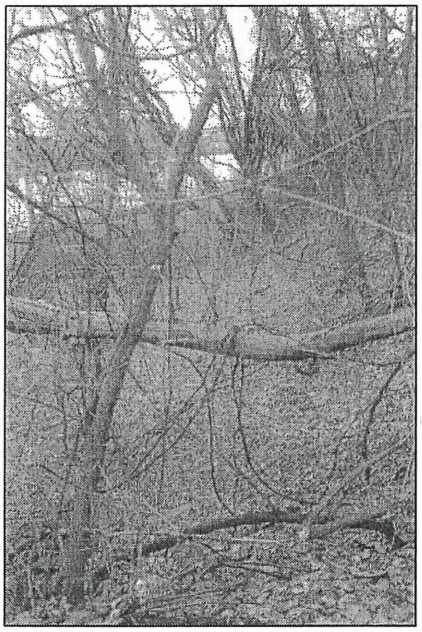
Arctium minus	Burdock	20%

Coronilla varia	Crown vetch	40%
Medicago sativa	Alfalfa	20%
Solidago canadensis	Canada goldenrod	3%

Grasses and sedges

Bromus inermis	Smooth brome	100%
Poa pratensis	Kentucky bluegrass	20%
Typha latifolia	Broad-leaved cattail	2%

51% to 75% Impervious cover with deciduous trees (Southern portion) - .22 acres



This small land-cover unit is West Water Street southwest of the bluff where the land flattens out in the floodplain. The site has signs of significant soil disturbance that may have occurred when an adjacent parking area was constructed. The site is dominated by boxelder trees that occupy nearly 100% of the canopy. Other canopy species include eastern cottonwood and green ash. None of the tree species appear over 30 years old. Little understory is present probably as a result of the dense shade produced by the boxelder. Riverbank grape and Canada goldenrod were the only two ground layer species present during the inventory.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer negundo	Boxelder	100%
Celtis occidentalis	Hackberry	<1%
Fraxinus pennsylvanica	Green ash	5%
Juglans nigra	Black walnut	<1%
Populus deltoides	Cottonwood	5%

Mid-Story trees

Rhamnus cathartica	Common buckthorn	<1%

Shrub layer

None		

Groundlayer vines

Vitis riparia	Riverbank grape	<1%

Forbs or seedling trees

Solidago gigantea	Giant goldenrod	<1%

Grasses and sedges

None		

Disturbed deciduous woodland (Northern portion) – 4.43 acres

This area of disturbed deciduous woodland is found in the northernmost portion of the project area. The woodland is located just south of the Smith Avenue bridge and is on a very steep slope. It is likely that a combination of factors including bridge construction, erosion, the presence of invasive species and tree cutting have all contributed to the disturbed nature of the woodland. Both common buckthorn and Tartarian honeysuckle are common on the slope. Other invasive species present during the inventory include black locust, Siberian elm, smooth brome, creeping Charlie and reed canary grass. Young sugar maple and ironwood trees are common within the woodland indicating that it may be developing into maple-basswood forest. There is little understory vegetation common to maple-basswood forests.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer negundo	Boxelder	7%
Acer platanoides	Norway maple	4%
Acer saccharum	Sugar maple	30%
Carya cordiformis	Bitternut hickory	<1%
Catalpa speciosa	Catalpa	<1%
Fraxinus pennsylvanica	Green ash	7%
Pinus nigra	Austrian pine	4%
Populus deltoides	Cottonwood	3%
Quercus ellipsoidalis	Northern pin oak	2%
Robinia pseudoacacia	Black locust	<1%
Tilia americana	American basswood	12%
Ulmus americana	American elm	3%
Ulmus pumila	Siberian elm	<1%
Ulmus rubra	Red elm	3%

Mid-Story trees

Crataegus sp.	Hawthorn	<1%
Ostrya virginiana	Ironwood	30%
Prunus americana	Choke cherry	4%
Rhamnus cathartica	Common buckthorn	10%

Shrub layer

Lonicera tartarica	Tartarian honeysuckle	3%
Ribes cynosbati	Gooseberry (no thorns)	<1%
Ribes missouriense	Black currant	<1%
Salix exigua	Sandbar willow	1%
Sambucus pubens	Elderberry	<1%
Xanthoxylum americanum	Prickly ash	<1%

Groundlayer vines

Parthenocissus inserta	Virginia creeper	<1%
Vitis riparia	Riverbank grape	4%

Forbs or seedling trees

Arctium minus	Burdock	<1%
Asarum canadense	Wild ginger	<1%
Aster cordifolius	Heart leaved aster	<1%
Glechoma hederacea	Creeping Charlie	<1%
Glechoma hederacea	Creeping Charlie	<1%
Hydrophyllum virginiana	Virginia waterleaf	<1%
Impatiens capensis	Jewelweed	4%
Leonurus cardiaca	Motherwort	<1%
Smilax rotundifolia	Greenbriar	<1%
Solidago canadensis	Canada goldenrod	<1%
Solidago flexicaulis	Zig-zag goldenrod	1%
Solidago gigantea	Giant goldenrod	<1%
Violet sp.	Violet	<1%

Grasses and sedges

Bromus inermis	Smooth brome	4%
Carex blanda	Woodland sedge	1%
Carex pennsylvanica	Pennsylvania sedge	1%
Phalaris arundinacea	Reed canary grass	<1%

Disturbed deciduous woodland (Southern portion) – 10.64 acres

This area of disturbed deciduous woodland is located at the south end of the site. The woodland extends uphill (east) from a road that parallels the base of the bluff. The road was part of the brick yard operation located southwest of the project area. Overall, this area has had a significant amount of human disturbance for a long time. A number of sandstone caves found at the base of the bluff were primarily used for storage in the past.

The woodland extends approximately 1/3 of the way up the bluff where it meets a plateau supporting oak forest and boxelder-green ash disturbed native forest. None of the canopy trees in the unit are very old, showing that this is a relatively young forest. Common buckthorn dominates the shrub layer of this woodland. Other invasive species such as garlic mustard and Tartarian honeysuckle are also common. American elm and cottonwood are common canopy trees. There is little ground layer vegetation most likely due to trampling and the presence of invasive species. Garlic mustard is a common invasive species in the ground layer. The lack of ground layer vegetation on the steep slope contributes to erosion, particularly in ravines and where trails lead down the slope.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer saccharum	Sugar maple	20%
Betula papyrifera	Paper birch	1%
Carya cordiformis	Bitternut hickory	1%
Catalpa speciosa	Catalpa	<1%
Celtis occidentalis	Hackberry	8%
Fraxinus pennsylvanica	Green ash	20%
Populus deltoides	Cottonwood	20%
Quercus rubra	Red oak	7%
Tilia americana	American basswood	1%
Ulmus americana	American elm	10%
Ulmus rubra	Red elm	10%

Mid-Story trees

Ostrya virginiana	Ironwood	5%
Prunus americana	Choke cherry	<1%
Rhamnus cathartica	Common buckthorn	50%

Shrub layer

Amelanchier laevis	Smooth serviceberry	1%
Cornus alternifolia	Pagoda dogwood	<1%
Lonicera tartarica	Tartarian honeysuckle	3%
Staphylea trifolia	Bladdernut	<1%
Viburnum lentago	Nannyberry	<1%
Viburnum rafinesquianum	Arrowwood viburnum	1%
Xanthoxylum americanum	Prickly ash	<1%

Groundlayer vines

Amphicarpa bracteata	Hog peanut	1%
Echinocystis lobata	Wild cucumber	<1%
Parthenocissus inserta	Virginia creeper	<1%

Rhus toxicodendron	Poison ivy	4%

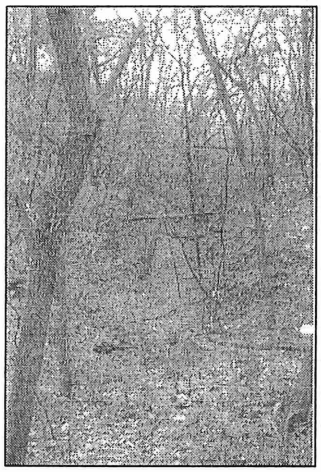
Forbs or seedling trees

Alliaria petiolata	Garlic mustard	10%
Aquilegia canadensis	Columbine	<1%
Asarum canadense	Wild ginger	<1%
Desmodium glutinosum	Pointed leaved tick trefoil	<1%
Hepatica acutiloba	Sharp lobed hepatica	<1%
Hydrophyllum virginiana	Virginia waterleaf	1%
Solidago flexicaulis	Zig-zag goldenrod	1%

Grasses and sedges

Carex blanda	Woodland sedge	<1%
Carex eburina	A species of sedge	1%
Carex pennsylvanica	Pennsylvania sedge	1%
Oryzopsis racemosa	Black-seeded rice grass	<1%

Boxelder - green ash disturbed native forest (Southeast portion) – 6.82 acres



This area of forest follows a ravine that leads from the picnic area of Cherokee Park, under Cherokee Heights Boulevard and down about 2/3 of the bluff. From the ravine, the boxelder-green ash disturbed native forest continues northeast along a moist plateau.

Sugar maple, ironwood, green ash, boxelder, and basswood dominate the forest canopy of the ravine. About ten percent of the shrub layer of the forest is occupied by common buckthorn. Other invasive species present during the inventory include Siberian elm, Tartarian honeysuckle and reed canary grass. In areas where buckthorn is not dominant and where trampling is less severe, ground layer sedges and forbs occur. The most common vine and ground layer species include greenbriar, Virginia creeper, Virginia waterleaf, and zigzag goldenrod. Wild ginger is also common in a portion of the ravine just north of Cherokee Heights Boulevard.

The head of the ravine closest to the picnic area is heavily used and contains few ground layer species due to trampling. The ravine also has a high degree of disturbance north of Cherokee Heights Boulevard near the location of the brick yard operation. Some adjacent slopes are still experiencing erosion due to the operation while others are re-vegetating.

Canopy trees

Latin Name	Common Name	Percent Cover
Acer negundo	Boxelder	25%
Carya cordiformis	Bitternut hickory	<1%
Celtis occidentalis	Hackberry	6%
Fraxinus pennsylvanica	Green ash	8%
Juglans nigra	Black walnut	<1%
Pinus strobus	Eastern white pine	<1%
Populus deltoides	Cottonwood	10%
Quercus alba	White oak	18%
Quercus bicolor	Swamp white oak	<1%
Quercus rubra	Red oak	3%
Salix nigra	Black willow	<1%
Tilia americana	American basswood	25%
Ulmus americana	American elm	5%

Mid-Story trees

Ostrya virginiana	Ironwood	2%
Prunus americana	Choke cherry	2%
Prunus americana	Choke cherry (purple cultivar)	<15%
Rhamnus cathartica	Common buckthorn	3%
Ulmus pumila	Siberian elm	1%

Shrub layer

Cornus foemina	Grey dogwood	<1%
Cornus serecia	Red-osier dogwood	15%
Lonicera tartarica	Tartarian honeysuckle	4%
Rhus typhina	Staghorn sumac	<1%
Ribes cynosbati	Gooseberry (no thorns)	<1%
Rosa sp.	rose	<1%
Sambucus sp.	Elderberry	<1%
Viburnum lantana	Wayfaring bush	<1%
Viburnum lentago	Nannyberry	<1%
Viburnum rafinesquianum	Arrowwood viburnum	<1%

Groundlayer vines

Rhus toxicodendron	Poison ivy	<1%
Parthenocissus inserta	Virginia creeper	<1%

Forbs or seedling trees

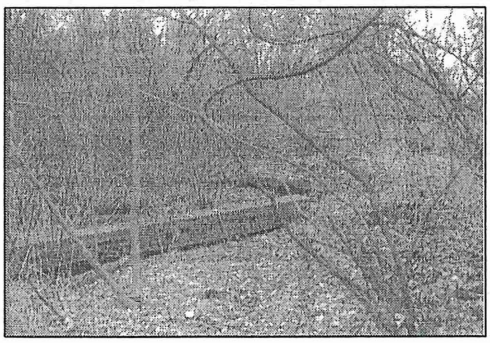
Anemone virginiana	Cylindrical thimbleweed	<1%
Apocynum androsaemifolium	Dogbane	<15
Aquilegia canadensis	Columbine	<1%
Arctium minus	Burdock	<1%
Arisaema atrorubens	Jack in the pulpit	<1%
Asarum canadense	Wild ginger	2%
Asparagus officinalis	Asparagras	<1%
Aster cordifolius	Heart leaved aster	<1%
Desmodium glutinosum	Pointed leaved tick trefoil	<1%
Equisetum sp.	Equisetum	<1%

Eupatorium rugosum	White snakeroot	<1%
Helianthus divartica	Woodland sunflower	<1%
Hydrophyllum virginianum	Virginia waterleaf	<1%
Laportea canadensis	Wood nettle	<1%
Monarda fistulosa	Wild bergamot	<1%
Rubus spp.	Raspberry	<1%
Scirpus atrovirens	Green bulrush	<1%
Solanum nigrum	Black nightshade	<15
Solidago canadensis	Giant goldenrod	<1%
Solidago flexicaulis	Zig-zag goldenrod	<1%
Taraxacum officinale	Dandelion	<1%
Violet sp.	Violet	<1%

Grasses and sedges

Carex blanda	Woodland sedge	<1%
Carex eburina	A species of sedge	<1%
Carex pennsylvanica	Pennsylvania sedge	<1%
Leersia oryzoides	Rice-cut grass	<1%
Phalaris arundinacea	Reed canary grass	<1%
Typha latifolia	Cattail	<1%

Lowland hardwood forest - .48 acres



This small area of lowland hardwood forest is located in an area of disturbed soil. The soil is generally mounded and contains a large amount of rock and wood, indicating that it was material dumped at the site. Green ash and American elm dominate the canopy. Common buckthorn makes up about 10% of the shrub layer. Red-osier dogwood, gooseberry and chokecherry are other common shrubs in the relatively dense shrub layer. The generally sparse ground layer is dominated by *Aster spp.* and riverbank grape.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Fraxinus pennsylvanica	Green ash	75%
Ulmus americana	American elm	15%

Mid-Story trees

Prunus americana	Choke cherry	1%
Rhamnus cathartica	Common buckthorn	10%

Shrub layer

Cornus serecia	Red-osier dogwood	40%

Ribes Missouriense	Missouri gooseberry	2%
Ribes sp.	Gooseberry	1%

Groundlayer vines

Vitis riparia	Riverbank grape	5%

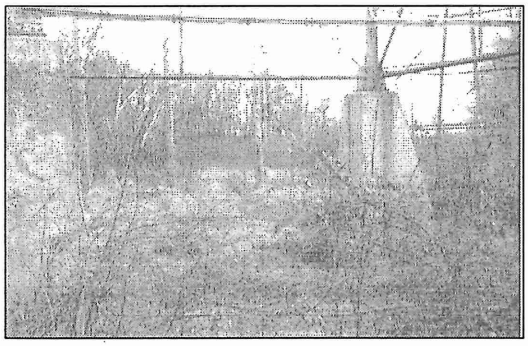
Forbs or seedling trees

Arctium minus	Burdock	<1%
Aster sp.	Aster	<1%
Rubus spp.	Raspberry	<1%

Grasses and sedges

None		

Mixed emergent marsh (Northern portion) - .81 acres



This mixed emergent marsh is quickly becoming a willow swamp. The marsh is dominated by the invasive species, reed canary grass. Reed canary grass forms dense stands that spread readily by rhizomes and seed. More desirable species such as wild iris, lake sedge, smartweed, river bulrush, and Joe-pye weed are present. Sandbar willow is the dominant shrub in the marsh and it is spreading quickly, currently covering about 20% of the marsh. Red-osier dogwood is another shrub species that is present in the marsh. The shrubs may be spreading due to a change in hydrology within the marsh. In areas where the willows have become thick, the reed canary grass is less robust. A powerline runs along the northern edge of the marsh. Trimming of trees and shrubs likely occurs in the power line right-of-way.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
None		

Mid-Story trees

None		

Shrub layer

Cornus serecia	Red-osier dogwood	2%
Salix exigua	Sandbar willow	15%

Groundlayer vines

None		

Forbs or seedling trees

Arctium minus	Burdock	<1%
Asclepias incarnata	Swamp milkweed	<1%
Eupatorium maculatum	Joe-pye weed	4%
Hibiscus palustris	Hibiscus	5%
Iris versicolor	Wild iris	<1%
Polygonatum sp.	Smartweed	1%
Urtica dioica	Stinging nettle	<1%

Grasses and sedges

Carex lacustris	Lake sedge	<1%
Elymus canadensis	Canada wild rye	<1%
Phalaris arundinacea	Reed canary grass	90%
Scirpus fluviatilis	River bulrush	1%
Typha angustifolia	Narrow leaved cattail	3%

Mixed emergent marsh (Southern portion) - .70 acres

This area of mixed emergent marsh is at the southern end of the site and is at the northern end of Pickerel Lake. The wetland is dominated by narrow-leaved cattail but also contains other native species typical of mixed emergent marsh including giant bur-reed, river bulrush, lake sedge, sandbar willow, smartweed and iris. Invasive species include reed canary grass and purple loosestrife. A hibiscus species not native to the area is very common in the wetland with a cover of about 20%. The wetland seems to receive a significant amount of nutrients and fluctuating water levels, which have led to low diversity, and species that can handle these conditions. About 20% of the entire northeast portion of the wetland is dominated by sandbar willow.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
None		

Mid-Story trees

Ulmus pumila	Siberian elm	<1%

Shrub layer

Cornus serecia	Red-osier dogwood	2%

Salix exigua	Sandbar willow	20%

Groundlayer vines

Parthenocissus inserta	Virginia creeper	<1%
Vitis riparia	Riverbank grape	<1%

Forbs or seedling trees

Anemone canadensis	Canada anemone	<1%
Aster sp.	Aster	<1%
Equisetum sp.	Equisetum	2%
Hibiscus palustris	Hibiscus	20%
Impatiens capensis	Jewelweed	<1%
Iris versicolor	Wild Iris	<1%
Lycopus sp.	Bugleweed	<1%
Lythrum salicaria	Purple loosestrife	<1%
Pilea pumila	Clearweed	<1%
Polygonatum sp.	Smartweed	3%

Grasses and sedges

Carex lacustris	Lake sedge	1%
Phalaris arundinacea	Reed canary grass	15%
Scirpus atrovirens	Green bulrush	1%
Sparganium eurycarpum	Giant burreed	1%
Spartina pectinata	Prairie cord grass	<1%
Typha angustifolia	Narrow leaved cattail	30%

Willow swamp - .34 acres

This area of willow swamp is connected to the two areas of mixed emergent marsh at the project site (one to the north and one to the south). The willow swamp has many species in common with the emergent marshes but has more area of open water. Sandbar willow is the dominant shrub species, covering about 15% of the swamp. Reed canary grass dominates the ground layer with a cover of about 30% but clearweed, wild iris, river bulrush and germander are also present. The exotic hibiscus found in the emergent marsh (southern portion) is also found in the willow swamp.

Canopy trees

Latin Name	Common Name	Percent Cover
None		

Mid-Story trees

None		

Shrub layer

Cornus serecia	Red-osier dogwood	5%
Salix exigua	Sandbar willow	15%

Groundlayer vines

None		

Forbs or seedling trees

Circium canadensis	Canada thistle	<1%
Hibiscus palustris	Hibiscus	20%
Impatiens capensis	Jewelweed	1%
Iris versicolor	Wild iris	<1%
Lycopus sp.	Bugleweed	<1%
Lythrum salicaria	Purple loosestrife	<1%
Pilea pumila	Clearweed	<1%
Teucrium canadense	Germander	<1%
Urtica dioica	Stinging nettle	<1%

Grasses and sedges

Phalaris arundinacea	Reed canary grass	30%
Scirpus fluviatilis	River bulrush	10%

Floodplain forest - 2.68 acres

The floodplain forest within the project site is dominated by silver maple. The silver maple covers about 90% of the canopy. Other canopy species include green ash, black willow, hackberry, cottonwood and red oak. The invasives, common buckthorn and Tartarian honeysuckle, are the dominant shrubs. The ground layer is rather sparse but desirable native species that are present include, clearweed, Virginia wild rye, riverbank grape, *Equisetum spp.*, sedges, rice-cut grass and *Aster spp*. The floodplain forest is adjacent to an area of boxelder-green ash disturbed forest where a significant amount of regrading occurred. However, the floodplain forest appears largely intact with some mature tree species.

Canopy trees

Latin Name	Common Name	Percent Cover
Acer saccharinum	Silver maple	90%
Carya cordiformis	Bitternut hickory	<1%
Celtis occidentalis	Hackberry	1%
Fraxinus pennsylvanica	Green ash	5%
Populus deltoides	Cottonwood	10%
Quercus rubra	Red oak	<1%
Salix nigra	Black willow	10%

Mid-Story trees

Rhamnus cathartica	Common buckthorn	3%

Shrub layer

Amorpha fruticosa	Indigobush	<1%
Cornus serecia	Red-osier dogwood	10%
Xanthoxylum americanum	Prickly ash	<1%

Groundlayer vines

Vitis riparia	Riverbank grape	<1%

Forbs or seedling trees

Arctium minus	Burdock	<1%
Aster ontarionis	Ontario aster	1%
Catalpa speciosa	Catalpa	<1%
Equisetum sp.	Horsetail	1%
Pilea pumila	Clearweed	<1%

Grasses and sedges

Carex tribuloides	A species of sedge	<1%
Elymus virginica	Virginia wild rye	1%

Dry prairie/savanna - sand gravel subtype (including prairie edges) - .62 acres

The prairie at the project site is currently a little less than an acre in size yet exhibits good diversity with around 50 native prairie species. It is quickly being invaded by trees and shrubs and potentially will turn into forest within twenty years without management. Both native and non-native species are invading the prairie with prickly ash, green ash, common buckthorn and staghorn sumac being common. There are signs that the area of prairie experienced sluffing in the past, which may have kept it open. In addition there are reports of the prairie burning periodically over the past century. Since it appears that the prairie was adjacent to savanna, there was probably a sufficient seed source for its re-establishment after sluffing occurred. A trail currently traversing the prairie is a significant threat to the long-term existence of this rare native plant community. The trail has caused considerable erosion and appears to be widening and becoming deeper. It is a

popular trail for the neighborhood residents so an alternate route will be necessary if the trail is closed.

Canopy trees

Latin Name	Common Name	Percent Cover
Quercus macrocarpa	Bur oak	10%
Quercus rubra	Red oak	5%

Mid-Story trees

Betula papyrifera	Paper birch	2%
Crataegus spp.	Hawthron	1%
Fraxinus pennsylvanica	Green ash	3%
Ulmus americana	American elm	2%

Shrub layer

Cornus foenea	Gray dogwood	1%
Lonicera tartarica	Tartarian honeysuckle	3%
Rhamnus cathartica	Common buckthorn	2%
Rhus glabra	Smooth sumac	3%
Symphoricarpos occidentalis	Western Snowberry (Buck brush)	1%
Viburnum rafinesquianum	Arrowwood viburnum	1%

Groundlayer vines

Celastrus scandens	Bittersweet	1%
Vitis riparia	River bank grape	1%

Forbs or seedling trees

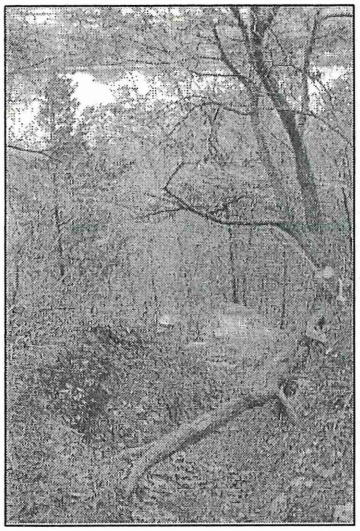
Aquilegia canadensis	Wild columbine	<1%
Amorpha canescens	Leadplant	1%
Anemone cylindrica	Cylindrical thimbleweed	1%
Apocynum cannabinum	Dogbane	1%
Aster ericoides	Heath aster	1%
Aster oblongifolius	Aromatic aster	1%

Campanula rotundifolia	Harebell	1%
Comandra umbellata	Bastard (star) toadflax	1%
Coreopsis palmata	Prairie coreopsis	1%
Dalea candida	White prairie clover	1%
Dalea purpurea	Purple prairie clover	1%
Desmodium canadense	Showy tick trefoil	1%
Eupatorium rugosum	Black snakeroot	1%
Euphorbia esula	Flowering spurge	1%
Fragaria virginiana	Common strawberry	1%
Galium boreale	Northern bedstraw	1%
Helianthus divaricatus	Woodland sunflower	2%
Heliopsis helianthoides	Common oxeye	1%
Lactuca canadensis	White lettuce	1%
Maianthemum stellatum	False solomon's seal	1%
Melilotus alba	White sweet clover	1%
Melilotus officinalis	Yellow sweet clover	1%
Mirabilis nyctaginea	Wild four-o'clock	1%
Monarda fistulosa	Wild bergamot	1%
Ostrya virginiana	Ironwood	1%
Physalis virginiana	Ground cherry	1%
Potentilla arguta	Tall cinquefoil	1%
Pycnanthemum tenuifolium	Narrow-leaved mountain mint	1%
Ratibida pinnata	Grey-headed coneflower	1%
Sanguinaria canadensis	Bloodroot	<1%
Solidago canadensis	Canada goldenrod	1%
Solidago hispida	Hairy goldenrod	1%
Solidago nemoralis	Gray goldenrod	1%
Solidago rigida	Stiff goldenrod	1%
Taraxacum officinale	Dandelion	1%
Tilia americana	Basswood	<1%
Ulmus americana	American elm	1%
Uvularia grandiflora	Large flowered bellwort	<1%
Veronicastrum virginicum	Culver's root	1%

Grasses and sedges

Andropogon gerardii	Big bluestem	2%
Bouteloua curtipendula	Sideoats grama	3%
Carex blanda	Woodland sedge	1%
Carex eburina	A species of sedge	1%
Elymus canadensis	Canada wild rye	3%
Panicum oligosanthes var. scriberianum	Scribner's panic grass	1%
Panicum sp.	Panic grass	1%
Poa pratensis	Kentucky bluegrass	3%
Schizachyrium scoparium	Little bluestem	60%
Sorghastrum nutans	Indiangrass	40%

Oak forest - 17.70 acres



Oak forest makes up a large portion of the project area. Species composition within the oak forest seems to vary considerably between ravines and ridges. Ravines contain many sugar maples and have many species in common with maple-basswood forests while ridges often have relatively widely spaced oak trees and have some characteristics of oak savanna. Overall, red oaks and sugar maple are the dominant canopy trees with 30% cover for each. American basswood, hackberry, white oak, green ash and bur oak are also common. Due to the large number of trees common to maple-basswood forests it appears that the oak forest may be making a successional change to maple basswood-forest. The most prevalent invasive species in the forest are common buckthorn (20% cover) and Tartarian honeysuckle (2% cover).

Erosion is a serious problem in several portions of the oak forest. One large ravine is experiencing serious erosion and other small ravines are eroding to a lesser degree. The Ramsey Soil and Water Conservation District is aware of the ravine with severe erosion and is planning future stabilization efforts. There are many trails within the oak forest and some are causing significant erosion. The trails are also causing soil compaction and habitat fragmentation. A trail plan should be encouraged for the park to determine which trails can be closed, relocated or stabilized.

Canopy trees

Latin Name	**Common Name**	**Percent Cover**
Acer platanoides	Norway maple	<1%
Acer saccharum	Sugar maple	30%
Betula papyrifera	Paper birch	<1%
Carya cordiformis	Bitternut hickory	1%
Celtis occidentalis	Hackberry	7%
Fraxinus pennsylvanica	Green ash	15%
Juglans cinerea	Butternut	3%
Juglans nigra	Black walnut	<1%
Populus deltoides	Cottonwood	3%
Prunus serotina	Black cherry	1%

Quercus alba	White oak	8%
Quercus ellipsoidalis	Northern pin oak	4%
Quercus macrocarpa	Bur oak	5%
Quercus rubra	Red oak	25%
Tilia americana	American basswood	20%
Ulmus americana	American elm	2%

Mid-Story trees

Amelanchier laevis	Smooth serviceberry	<1%
Ostrya virginiana	Ironwood	15%
Prunus americana	Choke cherry	8%
Rhamnus cathartica	Common buckthorn	20%
Sorbus sp.	Mountain ash	<1%

Shrub layer

Cornus alternifolia	Pagoda dogwood	<1%
Cornus foemina	Grey dogwood	2%
Cornus rugosa	Round leaved serviceberry	1%
Lonicera tartarica	Tartarian honeysuckle	2%
Rhus glabra	Smooth sumac	>1%
Rhus typhina	Staghorn sumac	<1%
Ribes cynosbati	Prickly gooseberry	<1%
Ribes missouriensis	Gooseberry	<1%
Rosa blanda	Wild rose	<1%
Sambucus pubens	Red berried elder	<1%
Staphylea trifolia	Bladdernut	<1%
Symphoricarpos occidentalis	Wolfberry	<1%
Symphoricarpos occidentalis	Wolfberry	<1%
Viburnum lentago	Nannyberry	<1%
Viburnum rafinesquianum	Arrowwood viburnum	1%
Xanthoxylum americanum	Prickly ash	2%

Groundlayer vines

Amphicarpa bracteata	Hog peanut	2%
Celastrus scandens	Bittersweet	<1%
Parthenocissus inserta	Virginia creeper	<1%
Rhus toxicodendron	Poison ivy	<1%
Vitis riparia	Riverbank grape	1%

Forbs or seedling trees

Actaea rubra	Baneberry	<1%
Anemone virginiana	Cylindrical thimbleweed	<1%
Anamonella thalictroides	Rue anemone	<1%
Aquilegia canadensis	Columbine	<1%
Aralia nudicaulis	Wild sarsaparilla	<1%
Arctium minus	Burdock	<1%
Arisaema atrorubens	Jack in the pulpit	<1%
Asarum canadense	Wild ginger	<1%
Aster prenanthoides	Crooked stem aster	<1%
Campanula rotundifolia	Harebell	<1%
Desmodium glutinosum	Pointed leaved tick trefoil	<1%

Echinocystis lobata	Wild cucumber	<1%
Eupatorium rugosum	White snakeroot	<1%
Fragaria virginiana	Wild strawberry	<1%
Galium boreale	Northern bedstraw	<1%
Geranium maculatum	Wild geranium	<1%
Helianthus divaricatus	Woodland sunflower	<1%
Hepatica acutiloba	Sharp lobed hepatica	<1%
Impatiens spp	Jewelweed	<1%
Lactuca canadensis	White lettuce	<1%
Maianthemum canadense	Wild lily-of-the-valley	<1%
Maianthemum stellatum	False Solomon's seal	<1%
Melilotus alba	Yellow sweet clover	<1%
Melilotus officinale	White sweet clover	<1%
Oxalis spp.	Wood sorrel	<1%
Rubus spp.	Raspberry	<1%
Sanguinaria canadense	Bloodroot	<1%
Smilax rotundifolia	Greenbriar	<1%
Solidago flexicaulis	Zig-zag goldenrod	<1%
Solidago gigantea	Giant goldenrod	<1%
Thalictrum dioicum	Woodland meadowrue	<1%
Uvularia grandiflora	Large-flowered bellwort	<1%

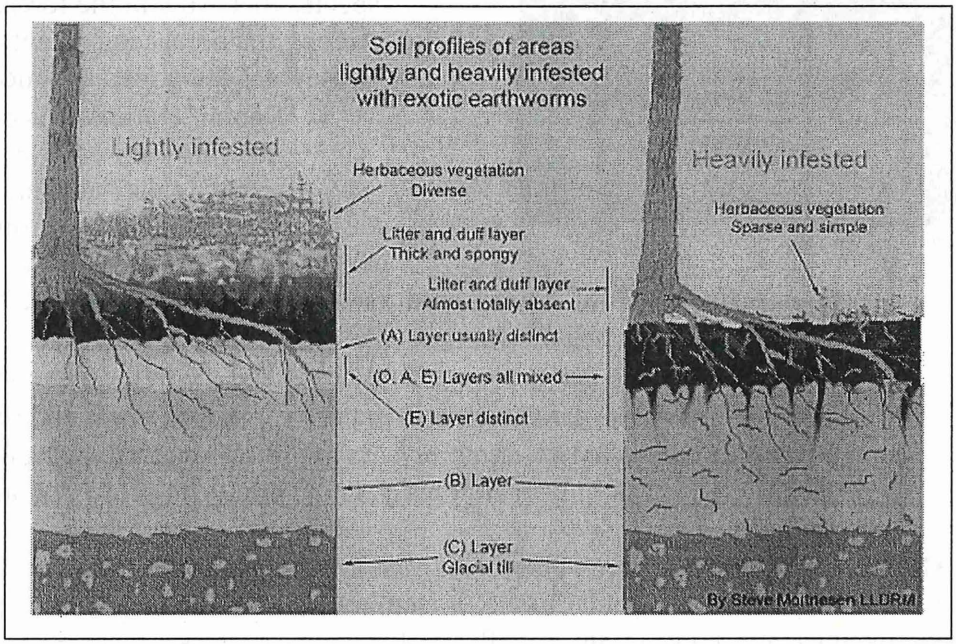
Grasses and sedges

Carex blanda	Woodland sedge	<1%
Carex eburina	A species of sedge	5%
Carex pennsylvanica	Pennsylvania sedge	3%
Carex sprengelii	Sprengel's sedge	<1%
Hystrix patula	Bottlebrush grass	<1%
Juncus tenuis	Path rush	<1%
Oryzopsis racemosa	Black-seeded rice grass	<1%
Poa pratensis	Kentucky bluegrass	<1%

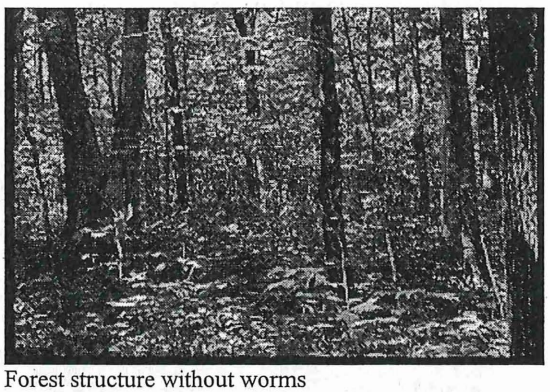
Appendix D: Earthworms

There are many species of earthworms found in North America, both native and exotic. Severe infestations of exotic earthworms damage woodland and forest ecosystems by consuming the humus layer of the forest floor changing its structure, composition and function. Below is an excerpt from the web site for the Minnesota Worm Watch at the University of Minnesota in Duluth.

(From Minnesota Worm Watch, 2002 - -2003, University of Minnesota Duluth, www.nrri.umn.edu/worms/Default.htm) Photo credits University of Minnesota Agricultural Experiment Station



Without earth worms:



Forest structure without worms

The structure of a woodland or forest is determined by several layers of plants: the **canopy** layer is made up of the tallest trees, the **subcanopy** is composed of shorter tree species and tree saplings, the **understory** contains most of the visible plant life found between the sapling layer and forest floor. The **forest floor** is where one would find the roots, bulbs, fungi, seeds, years of accumulated leaves and twigs. Hardwood trees produce tons of **leaf litter** each year, which is high in nutrients. This litter is **decomposed** by bacteria and fungi in the forest floor. The combination of high **productivity** and slow **decomposition** results in the development of a thick forest floor with a unique set of **soil layers** beneath.

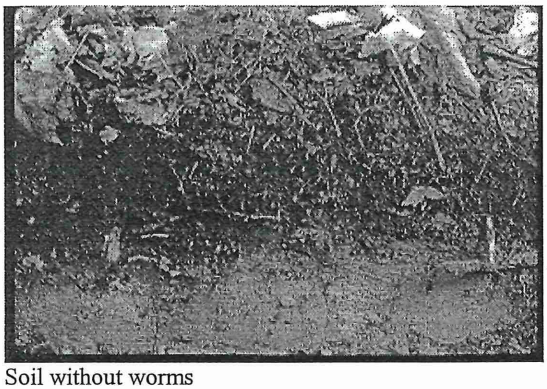
The understory is sometimes understood as anything below the canopy. However, the definition used here includes all plants other than tree species and they usually occupy the area from the forest floor to about 6 feet up. We find the following at this level:

- **Shrubs** are woody species of plants that do not grow into trees. They tend to grow as small to medium sized bushes. There are many shrubs that grow in hardwood forests with some of the more familiar being Raspberry, Gooseberry and Hazelnut.


Understory without worms

- **Herbaceous plants** include grasses and grass-like plants, ferns, flowers and all other non-woody plant species that grow in the forest. Among the herbaceous plants, there are several categories as follows:
  - **Spring ephemerals** begin growing very early in the spring to take advantage of the sun breaking through the leafless trees. Spring ephemerals will grow, flower, produce seeds, and die back by the time the trees start budding and the summer plants start coming up.
  - **Annuals** are plants that grow, produce seeds and die in the same year.
  - **Biennials** take two years to grow to maturity, produce seeds and die.
  - **Perennials** may take two or more years to grow to maturity, produce seeds every year or only occasionally, and continue to grow year after year.
- **Mosses** are common in hardwood forests and are different than herbaceous plants because they have no vascular tissue. **Vascular tissue** inside the stems of plants pumps nutrients and water up from the roots to leaves. Mosses transfer nutrients and water from one cell to another. However, this process is limited by gravity, which explains why moss is found growing low to the ground in moist places.

When looking at how an ecosystem functions, one component that sometimes gets overlooked is what happens IN the ground. The tendency is to take notice of the plants and animals that are above ground as defining the system. However, the soil and forest floor are two of the most important aspects of a hardwood forest ecosystem because they are the foundation on which all life above ground depends. For example, root systems are the foundation of most species of plants. Plants get their nutrients and water from the soil and forest floor through


Soil without worms

their root systems. The roots also anchor the plants in the forest floor or soil. A given plant community depends upon a specific soil. A change in the soil can dramatically change the plants that make up that community.

While we may not have paid much attention to the soil, there have been soil scientists studying different soils all over the world for hundreds of years. One of the interesting things they discovered is that as time passes, soils form layers and that each layer has different characteristics and functions in the ecosystem. The layers in a hardwood forest ecosystem can be broken down into the following:

- The **O horizon** is the layer that makes up the forest floor. This layer is composed of fresh and partially decomposed litter that has accumulated over many years. The litter contains twigs, leaves, seeds, bark, and wood from small fragments to large logs. In the hardwood forests of the Great Lakes region, the O horizon can be up to 10 cm (4 inches) thick. This layer is full of organisms and is very important to the overall functioning of the ecosystem.
- The **A horizon** is a thin layer just below the O horizon in hardwood forests and is considered the top layer of soil. This layer is usually 1 centimeter or less in thickness and a very dark brown or black in color. The color comes from the decomposed litter that is no longer distinguishable, much like the soil that comes out of a compost pile. This is what gardeners and farmers might call "good, black dirt.
- The **E horizon** develops beneath the A horizon. The total thickness may be 10 to 20 centimeters. It is composed of soil deposited both during the retreat of the glaciers and before it was covered by forest. This soil may contain various amounts of clay, sand, silt and rocks. The top of the E horizon is dark black or gray in color and gets lighter in color as soil depth increases. The dark color comes from organic molecules carried down from the A horizon. This process is called leaching.
- The **B horizon** is below the E horizon and is composed of the same material. This layer can be very thick or thin depending on the site and is usually some shade of yellow, brown or red coloring. The coloring comes from the natural color of the soil as it was deposited but also can be affected by dissolved molecules of iron or salts that leach down with rainwater.
- The **C horizon** is below the B horizon and is made up of the same material as E and B horizons but has not been changed by leaching and is virtually identical to what would have been seen after glacial retreat. Because of this, it is often referred to as "parent material."
- **Mineral soil** is a general term that often refers to the E, B & C horizons collectively. These lower layers of soil that have been little changed from the nature of soil that was deposited by glaciers or by rivers and lakes since glacial retreat. The most important distinction is that mineral soil doesn't contain much decomposed litter. So, the color is usually much lighter than the black color of the A horizon.

The forest floor and top layer of soil (the O and A horizons, respectively) are found between the vegetation and the mineral soil. It is the centerpiece of the hardwood forest ecosystem. These two horizons are where most of the **nutrient cycling** takes place and where all the plants **germinate** and grow. One important characteristic of soils is their bulk density. In hardwood forests, the forest floor and upper soil have low **bulk density**, meaning they are very loose and spongy so roots can grow easily through them. The forest floor and upper soil also hold a lot of moisture. The combination of moisture and shade from the canopy create a generally cool **microclimate**, which is an important factor in a hardwood forest ecosystem. A microclimate refers to the unique temperature and moisture conditions created in a small space due to influences of plants, which can be very different than temperature and moisture conditions in open spaces nearby. Many plants and animals rely on this microclimate for their survival.
In winter, the forest floor acts as a blanket that helps protect organisms from freezing conditions. Most of the plants and animals living in this layer have adapted to survive and grow in the particular conditions of the forest floor. Big changes in this layer could mean big changes for all the organisms that depend on a stable hardwood forest ecosystem.
Let's take a look at some of the components of the forest floor:

- **Logs** fall to the forest floor and decompose very slowly. Dead fall, or logs, contain a great deal of nutrients and are home to a number of insects, fungi, and bacteria. The older and more rotted logs often have a layer of moss and other plants growing on them. As a log ages and decomposes, it sinks deeper and deeper into the forest floor, providing habitat for amphibians such as salamanders and small mammals like red-backed voles. The log not only provides protection and moisture for these animals but also food in the form of insects and fungi. A log can be a habitat onto itself for some creatures.
- **Plant roots** grow densely in the forest floor because of the high concentration of nutrients and its loose spongy texture. Very few roots extend below the forest floor. The ones that do are usually for anchoring large plants as opposed to taking up nutrients and water. Besides the fine roots used to take up nutrients, many forest plants also use their roots to store food and reproduce. Perennial plants, for example, store food in different kinds of fleshy roots called bulbs, rhizomes, or corms. As they grow the bulbs or rhizomes will spread and divide, growing new plants. This process is called **vegetative reproduction**.
- **Fungi** grow densely in the forest floor and there are more species than have been identified. Fungi are not green because they don't have chlorophyll and therefore do not produce their own food through **photosynthesis**. Instead, fungi eat dead plant material. Mushrooms growing on a dead log are an example of this.

  There are some fungi that don't get enough food through this process so they work with green plants by attaching themselves to the roots. The fungi form an extensive network of root-like strings, called hyphae, spreading out from the plant roots. This relationship is mutually beneficial because the fungi provide more nutrients and water to the plant and the plant, in exchange, provides extra carbohydrates (made through photosynthesis) to the fungi. Fungi that work in this **symbiotic relationship** are called **mycorrhizae**. There are some hardwood forest

plants that have a hard time absorbing enough food from the forest floor because their roots are very thick, not dense and hairy like grass roots. Plants such as these depend upon mycorrhizae fungi for survival. An example of this would be many ORCHID species. However, most hardwood forest plants, including the trees, have mycorrhizae associated with their roots. Without the presence of mycorrhizae, the diversity of plants that make up the understory would be dramatically reduced.

- **Seeds** are deposited by plants into the forest floor. Because the forest floor is made up of loose, organic material such as leaf litter, many of the seeds are protected from **predation** by small mammals and birds. Also, because the forest floor is moist and full of nutrients, the seeds have a perfect place to germinate. The forest floor and the protection it provides is especially important for some herbaceous plants because their seeds germinate slowly, taking two or more years to develop into a small plant. If not protected from predators or from drying out over a long period of time, the seeds would have no chance of growing into a plant.
- **Leaves and twigs** fall to the forest floor creating a thick layer on top of the soil. The youngest leaves on top are typically brown and easy to identify. However, as one goes deeper, the leaves turn black and are broken apart making identification difficult or impossible. This is due to the work of **bacteria** and fungi, critical partners in the nutrient cycling process.

If one has a compost pile for yard leaves, grass, and vegetable kitchen scraps, then decomposition is a familiar occurrence. If not, most people have picked up or kicked a pile of leaves. The top leaves are dry and easily identifiable. However, the bottom may be moist and black in color. There are probably hundreds of different kinds of bacteria and perhaps millions living in a single handful of leaf litter.

Everything in the forest is a source of nutrients. However, only the nutrients in the forest floor and upper soil are being broken down so they are FREE to be taken up by plants. Going back to our compost example, if vegetable kitchen scraps are thrown into a compost pile and allowed to be broken down by fungi and bacteria, the black, organic mixture that results can be applied to the garden and the plants will respond by taking up the available nutrients. However, if the scraps were thrown directly into the garden, the garden plants would not be able to take up the nutrients. In fact, the scraps may sit on the soil for some time before they break down. The nutrients exist within the scraps but are not available or free to be taken up by the garden plants. In other words, if it weren't for bacteria and fungi, the nutrients in the forest would not get broken down and eventually the forest would run out of nutrients. If that were to happen, then plants could no longer grow and survive!

In a hardwood forest floor, the composting process is controlled by the fungi and bacteria. The nutrients are slowly released over time and taken up by living plants

as fast as the nutrients are produced. Because of this balance between nutrient release and plant absorption, there is little to no loss of nutrients from the system.

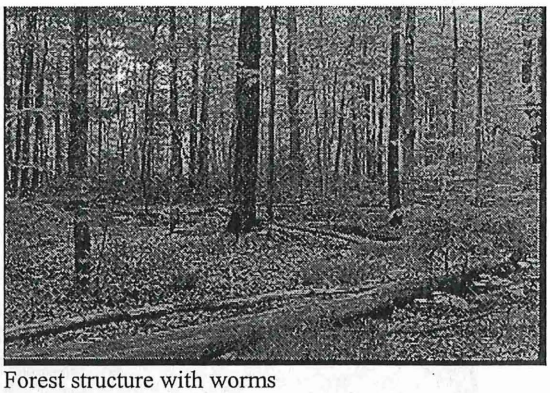
Critters are diverse and numerous in hardwood forests. From Moose to spiders, many creatures use the understory for **habitat**.

- **Animals** living in the forest floor and upper soil are numerous. Hundreds of microscopic animals like protozoa, nematodes, flatworms, and water bears (a tiny animal living in the water film found on the surface of leaves, mosses, and leaf litter - phyllum tardigrada) live in this narrow portion of ground. There are also dozens of land snails and spiders such as Orb Weaver spiders that spin large "orb" webs between trees and branches, "Jumping" spiders that pounce on prey, and "Forest Wolf" spiders which do not spin webs but rather burrow in the forest floor and upper soil and hunt at night.
- **Insects** crawl and fly through the understory eating plants and each other. Insects play an important role by pollinating plant life in the forest and surrounding areas. They are also a food source for many birds and some mammals. Ants, beetles, butterflies, flies, bees, and wasps are all important pollinators for hardwood forest plant life. For example, "Ichneumonid" wasps rely on rotting logs for food and shelter. These wasps lay their eggs on the larvae of other insects living in logs. Without the rotting logs, it would be difficult for these wasps to survive. In fact, bees, ants, beetles, and wasps all rely on rotting logs for survival. A rotting log is a crowded place!
- **Birds** that winter in South and Central America fly thousands of miles to nest and raise young in the hardwood forests of Minnesota and the Great Lakes region. For example, the ovenbird makes its home in the understory of hardwood forests. Ovenbirds build their nest in the thick forest floor. Their nest of leaves, moss and twigs always has a roof so the entrance to the nest is just a tiny slit. Ovenbirds eat a diverse diet of insects, spiders, snails and seeds that they find in the forest floor.
- **Mammals** of all sizes inhabit and make use of hardwood forests. Raccoons, white-tailed deer and bear are just some of the mammals that use the FOREST understory for both cover and a source of food. Bear for example, find hazelnuts and raspberries a great source of food, as they put fat on for winter. Shrews and moles eat insects and tubers and nest under forest debris. The Eastern Chipmunk eats bulbs, fruit, seeds and insects and burrows underground. Deer Mice and Red-backed Voles eat insects, seeds, fruit and fungi, preferring damp conditions and nesting under forest litter, logs, and roots. White-tailed deer browse various plants including tree buds and leaves and many of the herbaceous plants. Eating plants, whether it is from an insect or mammal is called **herbivory**. Herbivory in a hardwood forest ecosystem usually has little impact on plant species in the understory. The total number of plant species is high as are the number of plants within each species. Because of this, the percent of total plants grazed is low, as is the impact due to grazing.
- **Amphibians and reptiles** live in the hardwood forest but are usually hard to see since they tend to make their homes inside or under old, rotting logs or in piles of rotting plant material. Salamanders, like the blue spotted salamander, are

especially adapted to the moist cool conditions of the forest floor. Salamanders do not have lungs and therefore must breath through their skin, which must be wet for this to happen. They feed on insects and other small organisms that live IN(on) the forest floor. There are also several snake species living in the moist, cool and well-protected forest floor of Minnesota's hardwood forests. One example is the beautifully colored milk snake.

With earth worms:

The canopy and sub-canopy do not change much immediately after the worms invade. However, regeneration is very low after the worms invade. So as the canopy and sub-canopy trees age and begin to die, it is possible there will be few, if any, younger trees to replace them. However, because we haven't been able to study the long term effects of these worms on hardwood forest regeneration, it is unclear at this time what the exact effect will be.



Forest structure with worms

Tree Roots extend through all soil horizons, depending on the tree species. The large roots are primarily for anchoring the trees so they don't fall over and can extend a long way from the tree, deep into the soil horizons. The roots that take up water and nutrients are tiny, whitish roots the size of human hair or string, growing from little branches off the large roots. They tend to grow in the upper soil horizons where most of the water and nutrients are.

Understory with worms

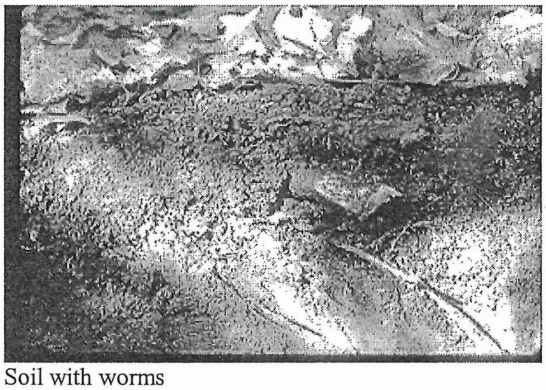
Saplings have most of their roots in the forest floor. When earthworms invade, the first thing they do is eat all of the litter in the forest floor and mix it into the deeper soil layers. This activity both disturbs and exposes the sapling's roots. As a result, many of them die and fall over.

Seedlings also root in the forest floor and most die when the earthworms invade because the earthworms eat the forest floor right out from under their tiny roots. Where previously there were 100 or more tree seedlings in a square meter, now there may only be 1 or 2 and in many areas none are left growing.

Most **native species** (species which are indigenous to a given ecosystem) that make up the understory do not survive after the invasion of earthworms. In a forest that previously had 20 to 40 native species, there may now only be one or just a few remaining. In addition, there is now very little plant cover, as little as 0-20% where there had been 100%. Most of the understory is now bare soil rather than a lush carpet of green plants.

Most **exotic species** (species not indigenous to a given ecosystem) we have in Minnesota came from Europe, including earthworms. This means that European plants have co-evolved with earthworms and are better adapted to living with them than our native species that evolved with no worms. In some forests, after the earthworms invade and the native species die back, some exotic species begin to invade and can start the process of taking over the understory.

Shrubs, Herbaceous plants and mosses all decrease after the earthworms invade. Like the tree saplings and seedlings, these plants had been rooting almost exclusively in the forest floor. When the earthworms eat the forest floor, the plant roots are left exposed. The microclimate (cool and moist) protected these root systems from warm and dry environment is not gone.


Soil with worms

We know that some of these native species can grow in soil containing worms because a lot of us grow them in our gardens and most gardens have earthworms. The difference is that in a garden, plant roots are put directly into the soil. In the forest, worms eat the forest floor so fast that most of the plants don't have a opportunity to get their roots into soil and thus die. It could be the case that if these native plants could establish themselves in the soil, they could recover after the worms invade.

The first thing that Earthworms do when they invade a forest is to eat the O horizon. Within a matter of a few years (3-5), they can consume the whole layer of litter and all the organisms that live in it. In many forests, this layer is completely eliminated so that all that is left is bare soil with small piles of cast material by the entrance to the earthworm burrows. Each fall the trees deposit a new supply of leaves to the forest floor. The earthworms will eat some of these leaves in the fall before winter arrives and they become dormant. During spring and early summer, the worms can usually eat the rest of the litter so by late summer, only bare soil remains.

The *A horizon* was very thin before the earthworms arrived (1 cm), but now it gets very thick, between 10 and 15 centimeters. The soil that makes up this new horizon is composed of the earthworm casts produced after eating the litter. It is a dark black layer with earthworm burrows throughout. The original A horizon was kept loose and moist because of the amount of organic material present. The new A horizon lacks this organic material and therefore is compacted in comparison.

A new *E horizon* develops beneath the new A horizon. It looks pretty much the same as it did before, but now it is lower in the soil.

Earthworm burrows can be seen on the top of the soil and, if you were to dig a hole, all through the A horizon. Each kind of earthworm has its own type of burrow system. The small, reddish worms living in the litter and at the surface usually don't burrow down very far. However, they will create burrows along the surface underneath the litter or logs. If you dig under these a log for example, you will see their "tracks" that are usually 1-2 millimeters in diameter.

The large red worms (night crawlers) create large burrows that go almost straight down into the soil. You can see the holes at the surface of the soil, usually 3-4 millimeters in diameter, surrounded by a small pile of cast material called a **midden**. Night crawlers also line their burrow with cast material. To see this, cut a cross section of a burrow with a hand shovel. Each burrow is home to one night crawler so estimating the population can be done by counting the number of holes and middens in an area.

The whitish gray worms create branching burrows that wind through the A horizon. They are smaller than night crawler burrows, usually 1-2 millimeters in diameter. The burrow will come to the surface occasionally, typically under a log and may connect to night crawler burrows.

The *forest floor*, centerpiece of the hardwood forest ecosystem, has been radically changed and for all practical purposes is gone due to earthworms eating the O horizon. All of the processes that used to occur in the forest floor have been moved into the deeper soil layers. Many of the organisms that used to live in the forest floor have lost their habitat, including food sources. They will either leave or die trying to find another habitat they can live in. The loose, spongy layer of litter is now gone. Plant roots have a harder time growing in the new A horizon than they did in the O horizon. Without the forest floor to insulate the soil, it will get warmer and drier in the summer and colder in the winter. These conditions may make it difficult to survive for organisms that had adapted to the particular conditions of what was the forest floor.

Earthworms do not eat *logs* directly, but once the forest floor is gone, they can begin to dry out and get hard. The hard wood makes it difficult for insects to burrow into them and the log no longer provides the moist, protected habitat and food sources some animals need. The mosses and other plants that require moisture to survive may also die back if the log has dried out. If the log has not dried out, mosses will still grow in under the log for as long as moisture is present. Another exception is a **tip-up mound**, defined as the soil still clinging to the root system of downed tree. The effect earthworms have on this soil is limited, allowing for some plants and mosses to survive.

Plant roots do not grow as densely in the new A horizon as they did in the forest floor. As a result, the remaining plants may become stressed more easily when the weather turns warm and dry. There continues to be plenty of nutrients in the soil because of the nutrient rich casts left behind by the earthworms. However, some plants with poor root systems may not be able to get to the nutrients with the same efficiency. In addition, the tiny roots that plants use to absorb nutrients and water can easily get damaged by earthworms grazing around or on them. Earthworms many not want to eat the root itself,

but they like to eat the bacteria and fungi close to the roots. Earthworms can also cause damage to the bulbs, rhizomes or corms that native perennial plants use to store food. When these fleshy roots are damaged and the stored food is lost or used up, the plant can no longer divide and grow new plants through vegetative reproduction.

Fungi are a preferred food of earthworms and they graze it heavily, which could dramatically impact their abundance in the soil. By grazing fungi on or near plant roots, the earthworms not only can damage the roots, but they prevent the plant and fungi from forming the symbiotic relationship where mycorrhizal fungi exchange nutrients and water for carbohydrates with green plants. If the fungi can't get enough food, they will die back even further. For some of the native plants that need mycorrhizal fungi, especially when the plant is young and small, survival will be difficult if earthworms prevent this relationship from being formed.

Seeds produced by the few surviving plants are no longer protected by the forest floor, allowing animals, including worms, to find and eat the seeds. If the seeds survive to germinate, they are no longer protected from temperature extremes. The seeds will be more vulnerable to death, especially native herbaceous plants that germinate very slowly, taking two or more years to grow into a small plant. Seed that one buys in a garden store will germinate upon putting them in the soil. In a hardwood forest ecosystem, most native plant seeds don't germinate fully in one season. Most need to go through a freezing and warming cycle (winter and summer) at least once and sometimes twice before growing into a small plant. The forest floor protects these seeds and tiny plants from predators and extremes in temperature and moisture, making the loss of the forest floor devastating to native plant production.

Leaves and twigs continue to fall to the forest floor each year but are rapidly eaten by the earthworms. Thus the forest floor never redevelops.

Earthworms change the *nutrient cycling* in the forest by increasing the rate at which litter disappears. They do this in two ways. First, earthworms break up the litter into tiny pieces and second, those tiny pieces get broken down by bacteria. Imagine eating a tootsie roll sucker and your favorite part is the chewy center. To get to the chewy center, you would have to eat through the hard candy exterior. Bacteria prefer the "center" of the litter (sugars and carbohydrates) found on the forest floor but first have to get through the fiber (lignin and cellulose). If you imagine licking your way to the center of a tootsie roll, it would be much slower than biting through the hard candy exterior. Likewise, it takes time for bacteria to get through the fiber except when earthworms are part of the system. Earthworms act as the teeth and expose the sugars and carbohydrates to the bacteria, allowing for a relatively quick breakdown of the litter compared to bacteria consuming the litter alone. The end result is leaf litter will be consumed at a rate faster than it is produced.

Nutrients needed for plants to grow are now found in the new A horizon composed of earthworm casts. Earthworm casts don't have more nutrients than the forest floor (since it came from the forest floor, it couldn't) but as the litter passes through the earthworm gut,

a lot of it is converted to forms of nutrients that plants can easily absorb. Although the total amount of nutrients does not exceed the forest floor, earthworms cause more nutrients to be available to plants at any given time. However, if the plants don't absorb these nutrients quickly, they can be washed away or leached when it rains. Two things increase the likelihood of nutrient leaching. First, there are not enough plants or root systems to absorb the amount of nutrients available. Second, with all of those earthworm burrows, water can wash the dissolved nutrients down through the soil, below the plant roots or out into rivers and streams. Nutrients that would have been cycled within the hardwood forest ecosystem can either be lost underground or transferred out to another system.

Bacteria still primarily breakdown the litter into nutrients that plants can use. However, now most of that activity takes place in the earthworm gut and not in the litter, much like a compost pile.

Most *insects* living in hardwood forests rely upon the forest floor for food and protection. Since earthworms eliminate the forest floor, we would expect that not only the numbers of insects will decrease, but the variety of insects will also decrease.

Amphibians and Reptiles that live in hardwood forests are especially adapted to the moist and cool conditions of the forest floor. When the forest floor is removed, they no longer have this protection from predators and from drying out. With a decrease in the number of insects, a critical food source is diminished which can lead to additional stresses. Taking into account the loss of the forest floor, which impacts plant reproduction, insect, amphibian, and reptile habitat, we can conclude the addition of earthworms into a hardwood forest ecosystem severely impacts the diversity of that system.

Different *mammals* will each be affected according to their dependence on various aspects of the ecosystem. Like amphibians and reptiles, small mammals like voles rely on the forest floor for protection and food. With fewer insects and fungi, their preferred foods, these small mammals will probably die back after earthworms remove the forest floor. If the voles disappear, weasels are threatened because voles are a food source for them. Medium sized mammals like raccoons, hare, and porcupine will also find less food after earthworms invade and will probably look for other habitats to supply their needs. Large mammals like white-tailed deer and bear are only occasional visitors to hardwood forests. If they find their food source has disappeared, they will simply move on and look elsewhere and spend less time in the forest.

Birds that breed and nest in the hardwood forests rely on the forest floor for both food (mostly insects and seeds) and nest sites. With fewer plants, there will be fewer seeds. Other birds use the layers of vegetation that seedling, sapling and shrubs provide for nesting and food. When these layers die back, important nest sites disappear along with important sources of berries and seeds for food. As a result, we would expect to see and hear fewer birds in our forests after earthworms invade.

Herbivory in a hardwood forest ecosystem occurs all the time but doesn't control what plants are or are not present. However, herbivory can have a severe impact when earthworms reduce the diversity and quantity of the remaining plant species. White-tailed deer are an important mammalian herbivore in hardwood forests in Minnesota. They particularly like to eat many of the native herbaceous plants that grow in these forests because they do not have bitter or toxic substances in them. When plants are numerous, deer can eat many of them and still not negatively impact the population over time. We can illustrate how this might happen in this hypothetical scenario:

- Let us suppose there are 10,000 plants in a given area and those 10,000 produce 1,000 new plants every year. If the deer in the area eat 1000 plants in a year, the plant population remains constant.
- When earthworms are added to the equation, their impact on plants is significant because they decrease the number of mature plants and the number of new plants produced each year by eating the seeds and damaging the bulbs, rhizomes and corms.
- After earthworms invade our hypothetical ecosystem, 1000 plants remain with those 1000 plants only producing 50 new plants a year. The deer population stays the same and thus will continue to consume 1000 plants a year as long as they are available. In two years, these plants would be eliminated from this ecosystem.

Jack-in-the-pulpit is one native plant species that has bitter tasting or toxic substances in their leaves, as do many exotic plant species. Deer and other herbivores will avoid eating these plants. After some time, they may take over the forest understory where earthworms are present

Sampling methods for earthworms

If site conditions suggest a worm infestation, the following methods can be used to estimate densities and identify the species of earthworms present.

To collect worm specimens for identification and sample the worm densities, mix 1/3 C. dry yellow mustard with 1 gal water. Using a 1 – 2 ft^2 or 1/3 m^2 frame with 2inch high sides pressed into the ground a ways, pour the solution slowly and evenly over the area within the frame. Collect the worms as they "fly" out and identify.

Lumbricus terrestris (the big earthworms) are the only burrowing worms that leave castings. Counting the castings/m^2 can give an estimate of worm densities.

Planting well-rooted shrubs and forbs into a woodland or forest damaged by worms or after buckthorn removal is a potential way to restore understory diversity and cover. Seed germination is difficult in worm infested areas because they can knock them over and also may consume the young seedlings.

If planting seedlings, place an acidic mulch such as wood chips around the base of each plant. This may minimize worm activity at least for the first growing season.

Appendix E: Resources

Contacts:

National Park Service
Mississippi National River and Recreation Area
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Minnesota Department of Natural Resources (DNR)
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Hannah Dunevitz, Regional Plant Ecologist
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651-772-7570
hannah.dunevitz@dnr.state.mn.us

Division of Forestry:
Art Widerstrom, Area Forester
(651) 982-9820 X224
art.widerstrom@dnr.state.mn.us

Ramsey County
Ramsey Soil and Water Conservation District
2015 Rice St. Roseville, MN
651-488-1476

West Side Citizens Organization
Bluff Task Force

Equipment:

Tree planting, seeding and fire fighting tools and equipment:
Forestry Suppliers, Inc.
205 West Rankin St.
Jackson, MS 39201
(800) 647-5368
www.forestry-suppliers.com

Princeton, MN 55371
(763) 633-4342
www.prairieresto.com

Minnesota Native Landscapes
14088 Hwy. 95 NE
Foley, MN 56329
(320) 968-4222
www.mnNativeLandscapes.com