Natural Resource Management Plan
for
Riverside Park, St Paul Park

Photo 1. Riverside Park entrance

December 2018

Prepared by
Karen Schik, Senior Ecologist
Friends of the Mississippi River
101 East Fifth St, Suite 2000
St Paul, MN 55101

TABLE OF CONTENTS

List of Tables

List of Figures

Acknowledgements

Friends of the Mississippi River would like to acknowledge the 3M Foundation for funding that made this management plan possible and for partnership with the City of St Paul Park, the National Park Service and Mississippi Park Connection (MPC). Initial restoration activities have been funded by grants from the Outdoor Heritage Fund of the Clean Water, Land and Legacy Amendment, and from MPC.

I. EXECUTIVE SUMMARY

This document was developed for the City of St Paul Park, as a first step for Friends of the Mississippi River to provide assistance in ecological management of Riverside Park, a city-owned 14-acre park located on the Mississippi River. Although small, the park is ecologically important as part of a linear habitat complex along the Mississippi River and provides important wildlife habitat and water quality benefits, as well as a popular community amenity.

Historically, the property was likely dominated by oak savanna and smaller areas of oak forest. Prior to becoming a city park, the property was never apparently heavily used, but was used for moderate pasturing. The city used a small area for a composting site.

In the absence of natural fires, native trees and shrubs have filled in, so the current land cover is primarily oak forest. Non-native invasive plant and animal species have established, especially earthworms and common buckthorn. Although very dense throughout the site, the buckthorn is mostly small diameter, indicating a relatively recent invasion. The composting area was seeded to native prairie grasses in the early 2000's.

The site was managed for many years by the National Park Service, starting in the late 1990's until a few years ago. The exact extent of the management is not known, but it appears that buckthorn removal may have occurred on about half of the park. Managed areas have since grown back with dense buckthorn, which was fairly young (6 to 8 feet tall) in 2018. Although the current native forest plant diversity is low, the NPS recorded a good diversity in past years. Given additional management there is good reason to believe the native plant diversity can be recovered.

This document describes the recommendations, methods and approximate costs for enhancing the ecological health of this project area and restoring natural communities. The primary proposed restoration involves removing invasive, non-native shrubs and plants throughout the site, restoring the grassland to savanna, and enhancing the woodland and forest.

Friends of the Mississippi River is committed to collaborating on the long-term management and restoration of this site.

Removing non-native invasive woody plants is by far the largest expense for management of this property. The estimated cost for the initial removal for the entire site is about $78,000. It is also the highest priority and should be initiated as soon as possible. Restoration of the savanna would be approximately $10,000 more. The timeframe for the entire park would be approximately five years to get to a point where the grassland is mostly native savanna species, and the buckthorn in the woods is only small plants and roughly half of the current abundance. Full control of the buckthorn to a point where it requires only modest annual maintenance could take 10 years or more. However, each year the investment will be less. The buckthorn, nor most of the other invasives, will never be fully eradicated because they are abundant in the landscape around the park. Volunteer events, such as brush can help offset the costs and will serve as a chance to connect the community to the site. FMR has obtained grant funding for initial restoration and enhancement steps that will be adequate for the first two years of work. FMR is also able to help with the longer-term coordination and management of restoration activities.

II. INTRODUCTION

This Natural Resource Management Plan (NRMP) presents the site analysis and recommended management and land use activities for 14.4-acre Riverside Park owned by the City of St. Paul Park, Minnesota.

Prior to European settlement, the vegetation at the project area consisted primarily of oak savanna – loosely described as prairie plants with scattered clusters of bur oak trees and brushland. As settlement occurred, both prairie and savanna communities were converted to agricultural and other uses, leaving less than 1% of each of these plant communities on the landscape, where they previously occupied over one-third of the state. What little was left has largely been degraded by lack of fire and invasion of non-native species, leading to a dominance of those species, decline of native species, and succession of savanna and grassland to forest. Riverside Park has been similarly altered, and is currently dominated by oak forest, with small areas of planted prairie, floodplain forest and disturbed deciduous forest.

This plan was developed to:

- Identify the existing condition of natural communities on the property
- Identify target natural communities and restoration goals
- Identify methods for improving the wildlife habitat value of the property

The over-arching goal for the property is to restore ecological functions so that, where appropriate, the property approximates conditions and functions that would have been present at the time of European colonization, approximately 1840. Historical conditions are not always appropriate when succession has moved a community too far in one direction, or where there are other desired uses for a site, such as recreation. The existing conditions at the Riverside Park are mostly too far advanced past savanna to a forested community.

Specific ecological and cultural goals are to:

- Restore a complement of native plant communities
- Improve habitat for wildlife, including birds and pollinators.
- Provide connectivity with other natural areas in the landscape
- Maintain and manage the property for water quality by avoiding or controlling any erosion that may develop, and retaining continuous ground cover throughout the site
- Increase biological diversity
- Create a model of responsible land stewardship for park visitors
- Provide close-to-home opportunities for people to enjoy and interact with nature
- Utilize this property to enhance and expand the ecological functions of the property and of the larger Metro Conservation Corridor.
- Provide ecological services, including filtering pollutants from soil and water, reducing soil erosion, and absorbing air pollutants and carbon dioxide.

III. SITE INFORMATION

A. Location and governance

Address: Riverside Park is located along the Mississippi River, at the west end of 13th Avenue in St Paul Park, MN (**Figure 2**). The park is approximately 1,300 feet long and 690 feet wide at its widest, with about 750 of shoreline along a back channel of the River. The address is (approximately) 101 13th Avenue, St Paul Park, MN 55071

Legal Description: Township 27, Range 22, Sections 11, 12, 13, 14 (small areas in each section where they converge)

Watershed: South Washington. Sub-Watershed: East Mississippi (3,397 ac)

Watershed Organization: South Washington Watershed District

Parcel Identification Numbers (**Figure 1**):
1202722330015 (5.0 ac)
1202722330009 (0.7 ac)
1202722330010 (4.0 ac)
1202722330017 (4.7 ac)

Total Acres: 14.4

Riverfront: 755 feet

Ecological Land Classification:
Province: Eastern Broadleaf Forest
Section: Minnesota and Northeast Iowa Morainal
Subsection: St. Paul Baldwin Plains and Moraines

Figure 1. Parcel information

Access to Property:
Public access to the property is from 13th Ave. From Highway 61, exit at Summit Ave (70th Street) turn west. Turn right at Pullman Ave, left at 3rd St, right at 13th Ave. Parking is on-street, at the west end of 13th Ave.

Primary Site Administrator:
Jeff Dionisopoulos, Public Works Supervisor
City of St Paul Park
600 Portland Avenue
St. Paul Park MN 55071
(651) 459-3730 email: jeff.dion@stpaulpark.org

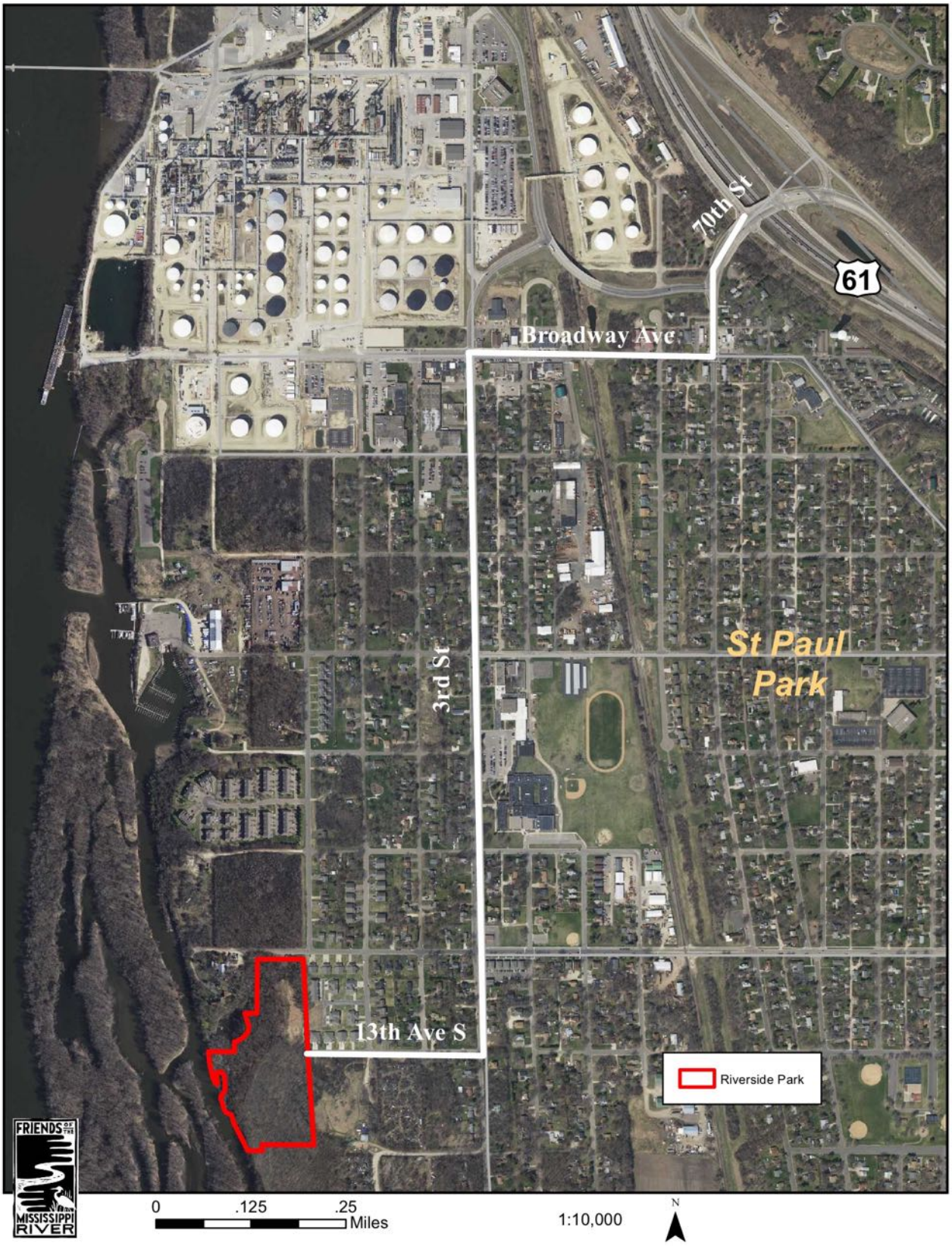

Figure 2. Site Location

B. Landscape Context

A. Proximity to established greenways

Riverside Park lies within the Metro Conservation Corridors, a regional land protection plan of the Department of Natural Resources (DNR) (**Figure 3**), which identifies lands that create a network of connectivity across the landscape for movement of wildlife and plants. The Park is also located within the Mississippi National River and Recreation Area, a 72-mile park that flanks the river, established by Congress in 1988. Riverside Park is also within the Mississippi River Twin Cities Important Bird Area, a designation of the Audubon Society for sites that provide critical habitat to individuals or groups of vulnerable bird species.

B. Ecological significance

Riverside Park is a significant ecological feature in the landscape due to its location along the Mississippi River and its proximity to other natural areas. The Mississippi River is a globally significant flyway for migratory birds, with 60% of North American species using the corridor. The park provides important habitat for migratory and non-migratory bird species, many of which are declining throughout their range, in part due to habitat loss. The park is located a mile upstream and across the river from the Pine Bend Natural Area, a 1,300-acre area that is one of the most ecological diverse areas along the Mississippi River in the Twin Cities and which includes Pine Bend Bluffs Scientific and Natural Area (SNA) (**Figure 3**). A short distance downstream from the Park is Grey Cloud Dunes SNA, a very high diversity dry prairie on the river terrace. Upstream of the park the landscape is more industrial until the Pig's Eye area, about 4 miles distance. The Park, along with other undeveloped islands and small riparian patches, serves an important role as a small connector between these larger natural areas.

The Department of Natural Resources County Biological Survey (1990) did not identify the park as having significant biological diversity, but the islands to the west were designated in the DNR county biological survey as moderate biodiversity significance (**Figure 3**).

Because of the adjacent urban development, this park is a high priority natural area, both for the species that depend on forest habitat, and for providing access to forested lands for public enjoyment. It is the only natural parkland in St Paul Park.

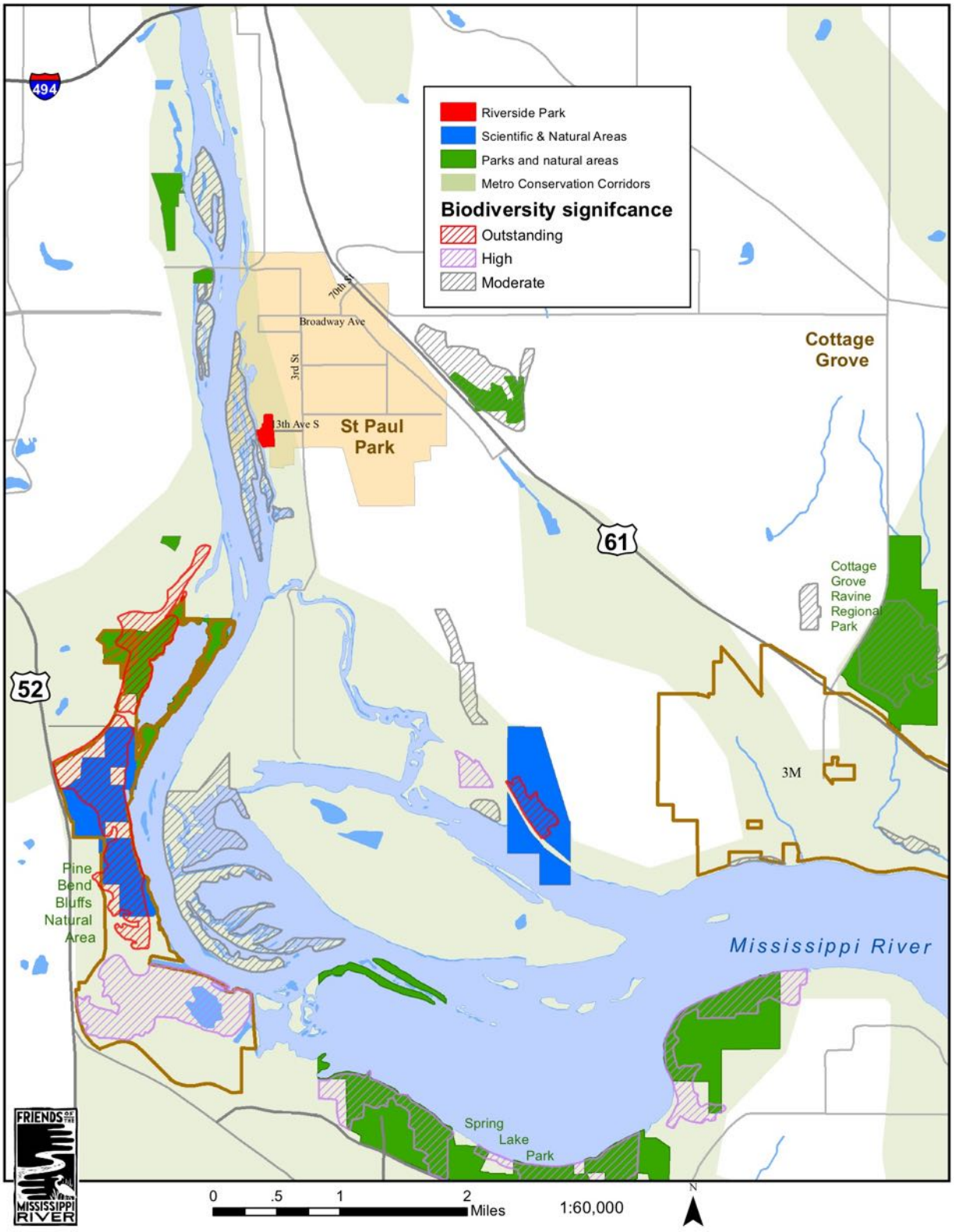

Figure 3. Regional Context

C. Land Use

1. Historical and Existing Land Use of the Park

European settlement significantly changed the Washington County landscape, beginning in the mid-1800's. As agricultural development occurred, most of the prairie land was converted to cropland, forests and woodlands were cleared, and wetlands were drained. Fire, which had been a formative feature of the landscape, was suppressed as intense agricultural practices and urban development ensued. By 1990, the Washington County Biological Survey conducted by the Minnesota Department of Natural Resources showed only about 3% of the native plant communities that had been present in the 1850's remained. Landscape changes continue today in a somewhat different direction, with agricultural lands being converted primarily for residential and commercial uses.

Some of the best evidence of past land use at the Park is depicted in historical aerial photographs (**Figures 4, & 5)**. The photos show that the park has been largely untouched over the decades. It was likely grazed for some decades, but current conditions indicate that grazing pressure was modest. A heavily grazed site would have a different plant species composition, with abundant thorny plants as well as certain sedge species.

Also visible in 1927 was a road that diagonally crossed the northern leg of the site. The roadbed was elevated and is still a prominent feature at that part of the site.

While the Park area may not have been heavily used, the site has undergone significant changes from the past. Natural processes, primarily fire, that had acted on the landscape were suppressed. In the absence of fire, the historically more open canopy gradually filled in with trees and shrubs, resulting in a virtually closed canopy by the 1990's. Other human-related forces were also acting upon the land. Non-native, invasive plant species probably began to appear at the site in the 1980's. Common buckthorn may have been one of the first plant species, but in all likelihood it was preceded by a group of non-native animals – earthworms. Minnesota does not have any native earthworms, because any that had been here would not have survived glaciation. And they disperse so slowly that they have not arrived here from southern locations. The plant communities that evolved after glaciation, therefore, did so in the absence of earthworms. Earthworms were introduced from Europe and have since drastically altered soil and vegetation conditions where they have become established (see Earthworm discussion later in this document). They also greatly facilitated the invasion of common buckthorn and garlic mustard.

In more recent history, an area on the eastern side of the Park was used for a city compost site, as seen in the 2002 aerial (**Figure 5**). The compost site was closed a few years later and the area was restored to native prairie vegetation.

The exact year that the property became a city park is not known, but ecological management of the park by the National Park Service began in the mid-1990's (see the Land Management section for further discussion). It is the only natural park in the City of St Paul Park and is a very popular amenity for the community.

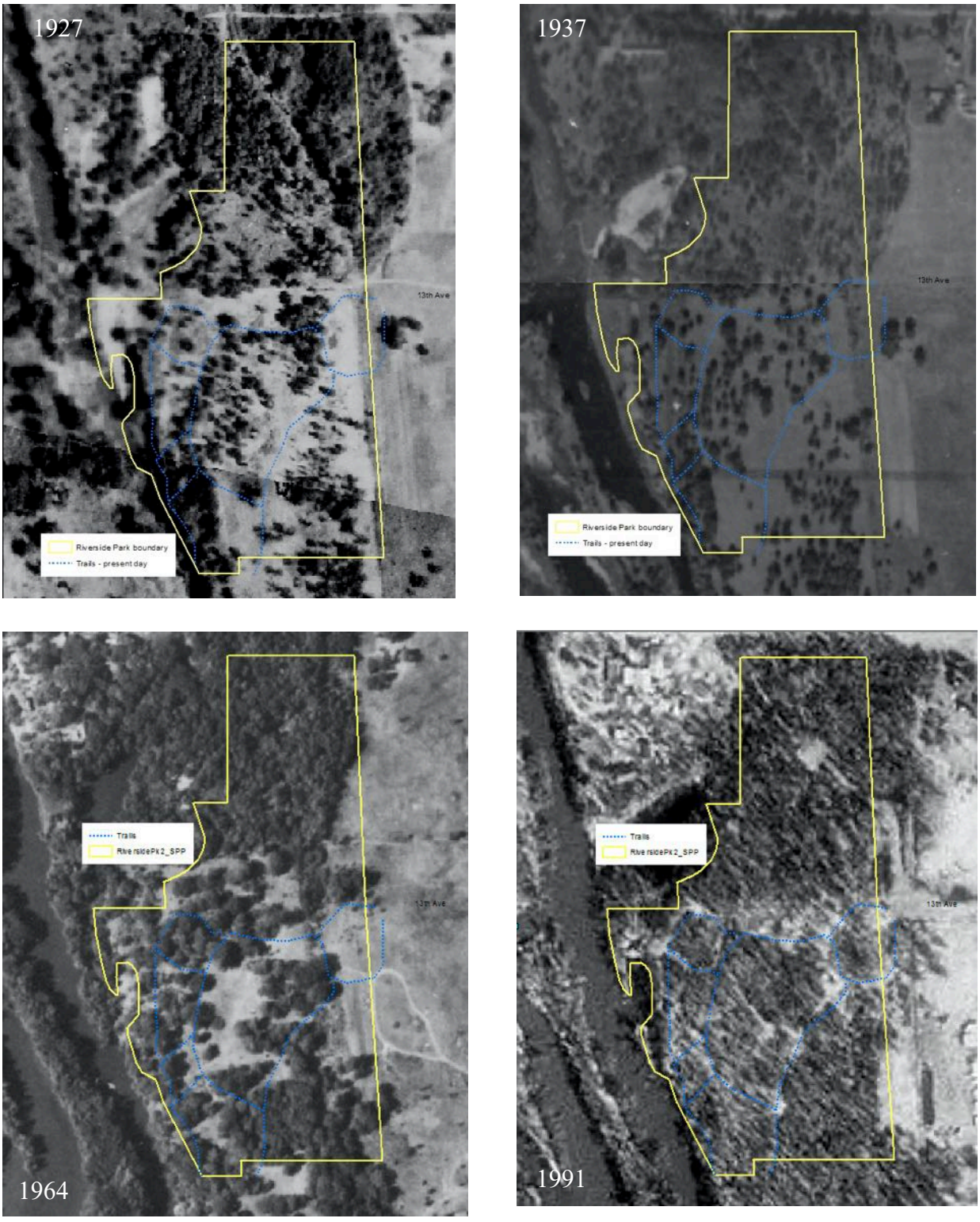

Figure 4. Historical aerial photographs 1927-1991.

Shows steady increase in woody cover, from fairly open savanna-type cover to closed canopy forest. Land use activities on-site and surrounding were mostly moderate agricultural uses, especially pasture.
Aerial images source: MnGeoSpatial Commons, Dakota County.

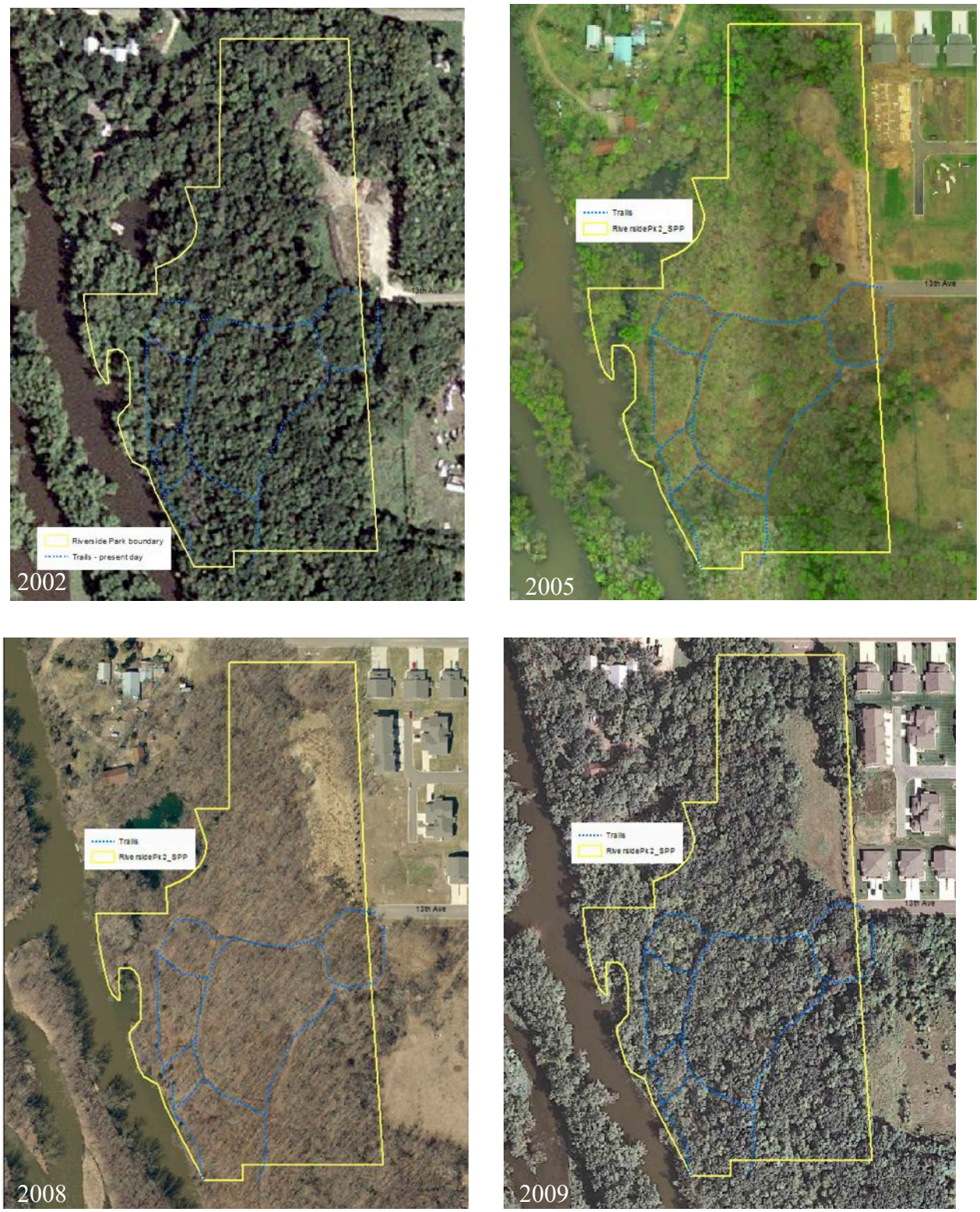

Figure 5. Historical aerial photographs 2002-2009.

Shows development of the adjacent lands to residential housing. The 2002 image shows a city compost area on-site, which was converted to native prairie, most clearly seen in the 2008 photo.

2. Adjacent Land Use

The adjacency of a site to parkland, cultivated land, open areas, and residential sub-divisions can affect vegetation and wildlife management options, and may present opportunities to enlarge existing habitat areas, create corridors for wildlife movement, and determine the characteristics of local surface water hydrology.

Since European colonization, the landscape around the park was almost entirely in low-level agricultural use. The 1927 aerial photograph shows cropland to the southeast, but much of the land, including the park, was likely in very moderate pasture use (**Figure 6**).

Figure 6. Surrounding landscape in 1927.

Residential development gradually expanded from the center of St Paul Park, with each decade bringing housing a little closer to the park.

One homestead to the northwest of the park was present in 1927 (see **Figure 4**). This property was later expanded to the small auto body shop present today. The adjacent land use has otherwise been residential and undeveloped. Residential housing began along the northern half of the east side of Riverside Park in the early 2000's and currently occupies about half of the east side of the park.

Figure 7. Adjacent land ownership.

Other land around the park is currently undeveloped, including a 7-acre parcel directly north of the Park that is owned by the City of St Paul Park (**Figure 7**). Islands to the west are owned by St Paul Park Refining and by Gordon Nesvig, who also owns the undeveloped (upland) parcels directly south of the park. Opportunities to expand the park in the future are highly encouraged as it would greatly enhance its value not only for wildlife but for community residents.

D. Physical Conditions

The natural resources at Riverside Park are influenced and in large part determined by numerous physical conditions, especially local bedrock and surficial geology, soils, topography, and local and regional hydrology.

1. Geology

All the bedrock in Washington County formed from marine sedimentary rock as a result of ancient oceans that covered the area in the Paleozoic age. Sand and clay and marine animals became compressed and formed a variety of sedimentary rock layers with different depths and characteristics.

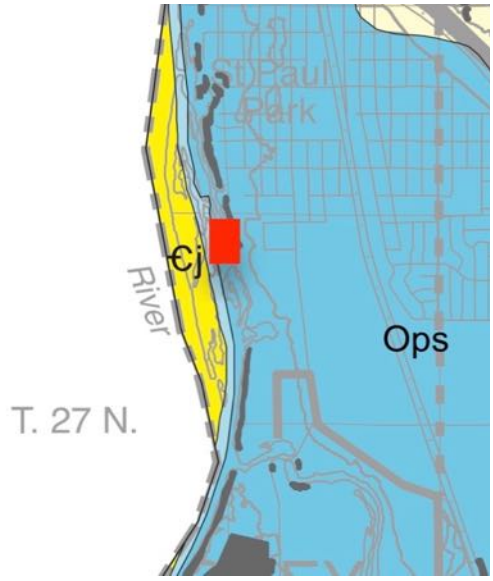

Figure 6. Bedrock geology

The bedrock at Riverside park is classified as Shakopee Formation (Ops in **Figure 8**), which is comprised of dolostone, sandstone and shale. It is a common outcrop of the bluffland along the Mississippi River and the rock type that is quarried at nearby aggregate facilities. It is generally within 5 feet of the surface, with some outcropping. Due to the shallow soils, bedrock is the primary influence on the landscape at this site.

Glaciers were the primary force that shaped the landscape in Washington County. The landscape feature on which Riverside Park sits is the lower terrace (T1) of the Mississippi River (**Figure 9**). Formed by deposits from the Glacial River Warren, the terrace is generally composed of coarse sand and gravel, with up to 10 feet of loamy sand on top. Bedrock in the area of the park is within 10 feet of the surface and outcrops are common.

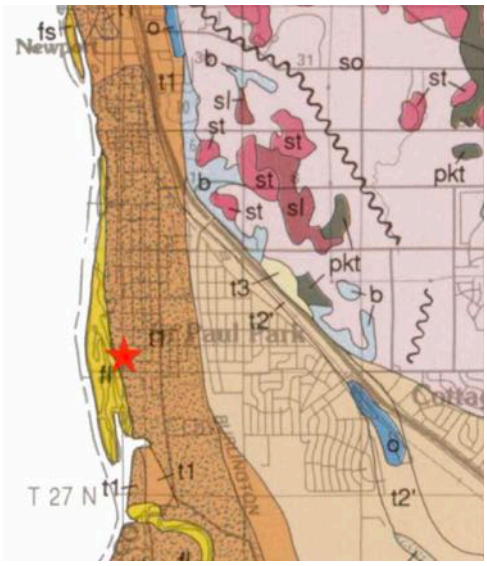

Figure 9. Surficial Geology.

2. Soils

Soil formation is the result of the interaction of five soil-forming factors: parent material (e.g. bedrock), climate, organisms, topographic position or slope, and time (Foth, 1990). Taken collectively, these factors can help determine the dominant plant and animal communities that helped form the soils. The "Soil Survey of Washington County Minnesota" (1980), provides a generalized depiction and descriptions of soils in Dakota County. Soil types are important because they affect the vegetative and hydrologic features of the property and suggest the most appropriate vegetation type or use of the land.

There are two soil types at Riverside Park (**Figure 10**); Copaston Loam soil, 0-6% slope is dominant, with Dorerton-Rock outcrop complex, 25-65% slope, along the river side of the site. Copaston forms a 12 to 20-inch mantle of loamy glacial drift (deposited by glacial meltwater) over bedrock. This soil has low fertility, moderate organic matter, and very low available water capacity, making it subject to drought. Surface runoff is slow due to the gentle slopes. Groundwater pollution is a hazard due to the shallow soil on top of fissured bedrock.

The Dorerton-Rock complex has slopes of 25 to 65 percent. It is a well-drained soil, with about 10 inches of sandy loam, except were bedrock outcrops occur. This soil is highly susceptible to erosion.

3. Topography

Topography and the orientation of slopes (aspect) are important factors in the development and formation of soil, potential for erosion, and the type and stability of vegetation that will grow in a given location. In general, more topographic variation will result in more complexity and diversity of vegetation communities and hydrologic features. South and southwest facing slopes tend to be drier and warmer than north and north-east facing slopes.

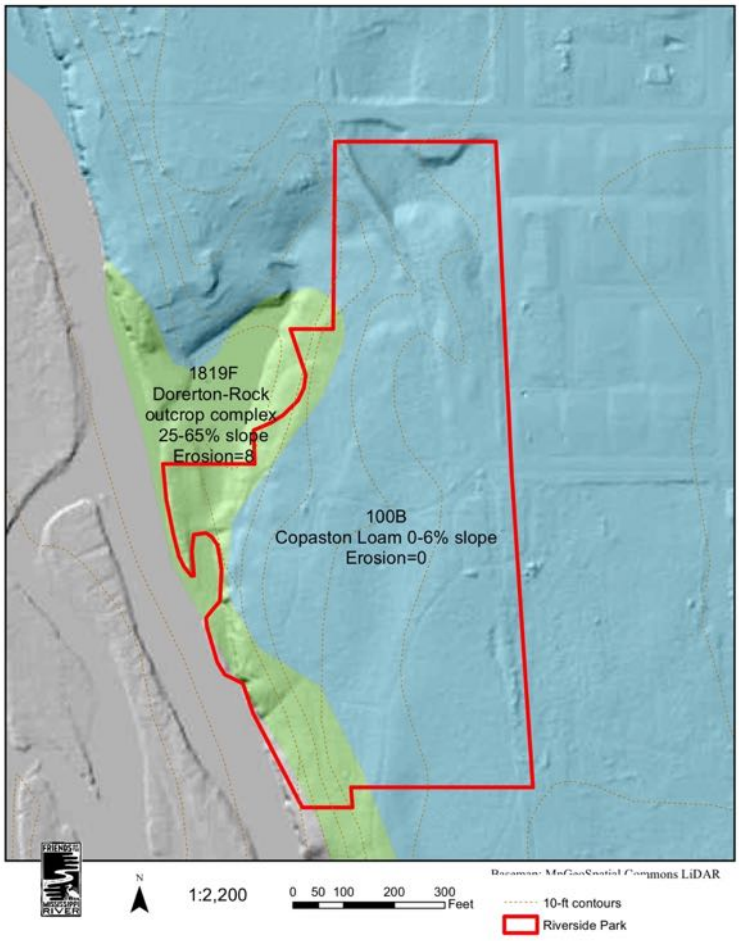

Figure 10. Soils and topography

Riverside Park has a fairly simple landscape, with mostly level terrain over much of the site and steep bluffs along the river (**Figure 10**). The site slopes gently toward the river, then drops steeply at the river edge. The elevation is about 730 feet at the east side and 690 feet at the river. Drainage is by surface runoff to the west, carried by small drainageways. There is, however, more topography at the far north end, where remains of an old roadbed cut diagonally from the northwest corner to the existing park entrance. The roadbed creates a significant rise at the north end, and also somewhat encloses the northeast corner to create something of a "bowl." With drainageways altered, soils retain more moisture and support a slightly different array of species in that area.

4. Hydrology

There are two key interrelated hydrologic components of the property: groundwater and surface water. Groundwater accumulates below the surface of the land and is stored in complex, underground geologic layers of sand, gravel and porous rock. Groundwater provides drinking water for most Washington County, irrigation water for agricultural crops, and process and cooling water used by industrial and manufacturing companies. Most of the County's groundwater is "highly sensitive" to surface contamination. Once an aquifer is polluted, it is very expensive or prohibitive to improve its quality to drinking water standards.

Given its importance and potential vulnerability, it is important to be aware of the potential for groundwater contamination from pesticide and herbicide use. Factors to consider during natural resource management activities are depth to groundwater and the ability of the overlying material to filter or pollutants.

Five relative classes of geologic sensitivity are based on time of travel ranges (Very High to Very Low). The pollution sensitivity is inversely proportional to the time of travel.

Riverside Park located in an area where groundwater sensitivity to contamination is determined to be **very high** due to the shallow depth to bedrock (**Figure 11**); contaminants will reach the groundwater in hours to months.

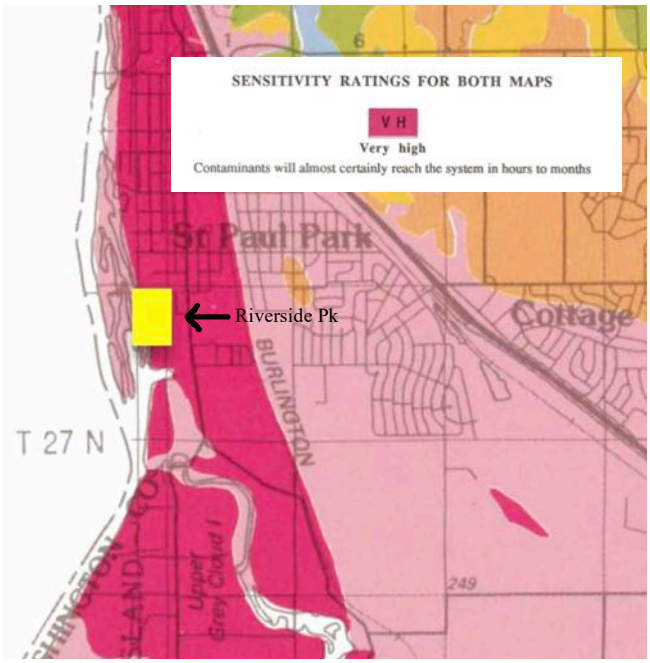

Figure 7. Sensitivity of Groundwater to Contamination.

High Sensitivity classification has management implications for ecological restoration work. The use of all chemicals should be done with extreme care on this site given the high potential for groundwater contamination. In addition, while there are no water bodies or wetlands at Riverside Park the property itself, it is located along a back channel of the Mississippi River. This is an important consideration when using herbicides to manage vegetation.

Glyphosate is considered safe for groundwater because it binds to soil particles and is generally not mobile. However, some studies have detected glyphosate in groundwater. When used at this site, the aquatic safe formula (e.g. Rodeo) should be used, which is safe for aquatic organisms.

Triclopyr-based herbicides like Garlon 3a and Vastlan are more mobile in water, but are also considered safe for aquatic organisms and can be used near water. Given the uncertainty about mobility and effects from any herbicide, all herbicides should be used with utmost caution. A foam or wick applicator should be used to minimize overspray. Oil-based herbicides (such as Garlon 4) should not be used.

E. Rare Species And Wildlife

1. Rare Species

A search of the DNR Natural Heritage database* revealed no rare plant or animal species have been recorded at Riverside Park. Several aquatic plant and animal species are recorded within one mile: a state-endangered plant (*Sagittaria brevirostra*), a state-endangered mussel (*Arcidens confragosus*), and three state-threatened species - a mussel species (*Quadrula nodulata*), a fish (*Ictiobus niger*) and a plant (*Sagittaria calycina var. calycina*). While the park may not harbor rare species, its may be a small factor in the presence of the organisms found in the river. Well-vegetated native plant communities along the riverbanks are very important for protecting streambanks and reducing erosion and runoff. Good water quality is vital for most of these rare species.

In addition, Upland Deciduous Hardwood Forest is considered a Key Habitat for the St Paul Baldwin Plains and Moraines Ecologoical Subsection, because forest was a significant component (more than 5%) of the 1890's landcover and it had declined by more than 50% at the time of the 1990 survey (DNR 2006).

**State of Minnesota, Department of Natural Resources (DNR). 2017. Rare Features Data included here were provided by the Division of Ecological and Water Resources, Minnesota DNR, and were current (as of June 2017). These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.*

2. Wildlife

A wildlife survey was not completed for the park, but numerous bird species were noted during spring visits (Table 1). Some of these were spring migrants, headed further north, including the vivid golden-winged warbler, a species of conservation concern due to declining populations. The presence of these migrants at the park is confirmation of its value as a stop-over site to help them rest and refuel on their journey.

A few other animals noted at the park were gray squirrel, garter snake, painted turtles, and tree frog.

Table 1. Bird species noted during site visits.

Neotropical Migrant	Summer resident	Year-round resident	Species
	x		America robin
		x	American goldfinch
	x		Bald eagle
x	x		Baltimore oriole
x			Black and white warbler
		x	Black-capped chickadee
x	x		Blue-gray gnatcatcher
	x		Brown-headed cowbird
	x		Canada goose
x	x		Common yellowthroat
		x	Downy woodpecker
x			Golden-winged warbler*
x	x		Great-crested flycatcher
x	x		House wren
x	x		Least flycatcher
		x	Northern cardinal
	x		Northern flicker
x			Northern parula
x	x		Ovenbird
		x	Red bellied woodpecker
x			Tennessee warbler
x	x		Wood thrush
x	x		Yellow warbler

*Species of greatest conservation need (SGCN)

F. Historical Vegetation

One important consideration for developing a comprehensive natural resources management plan is to understand the types of vegetation found at a property or in the local area prior to European colonization. This information can be a helpful indicator of what plants may thrive on the property. Fortunately, field notes on vegetation were taken during original territorial surveys in the 1840s and compiled by Francis Marschner into a map entitled "The Original Vegetation of Minnesota", published in 1974.

According to Marschner's map, the predominant plant community at Riverside Park in the 1840s was river bottom forest (**Figure 12**), based on two bearing trees - elm and basswood. However, the scale of the mapping was very broad, and the survey likely only accounted for the trees located in the lowland near the river. Most of the park is located on a ledge above the river, not in the bottoms. This area has shallow soils over bedrock, which would not have supported river bottom species.

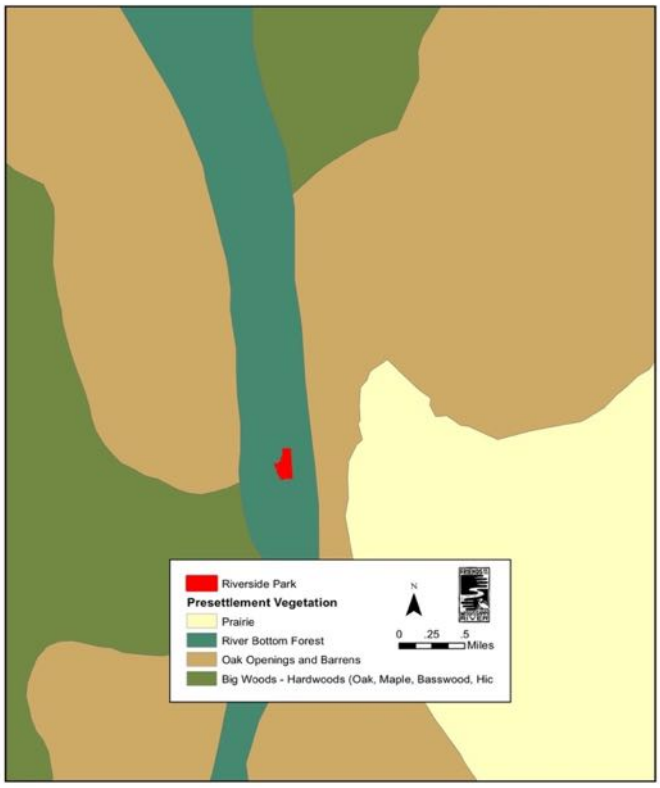

Figure 12. Pre-European Settlement Vegetation

The vegetation just to the east of the park was mapped as "oak openings and barrens," which is what we commonly refer to as oak savanna today. There is good evidence that the southern two thirds of the park were likely composed of oak savanna. In addition to having suitable soil type for savanna, historical aerial photographs show very open vegetation in 1927 and 1932 (**Figure 4**), with scattered trees. However, there are still large oak trees with wide-spreading branches, indicative of the historical open canopy at the site.

Approximately the northern third of the park was likely more forested in the past. There is more topography and heavier soils, both of which would have kept the area more moist and more fire resistant. This area may have been more of a mixed woodland or bottomland composition.

Oak openings and barrens (or oak savanna) is a transitional area between prairie and forest. It occurs on dry to moderately moist (mesic) sites throughout the deciduous forest-woodland zone and locally in the prairie zone. Although there are few relicts left to inform us what it may have looked like historically, a simple image of savanna is a complex of open grassland areas, dominated by prairie grasses and forbs, with scattered open grown oak trees, patches of aspens and scrub brush. The principal canopy species are bur, northern pin, northern red, and white oak. Shrub cover is variable as but common species are blackberry, raspberry, gooseberry, dogwood, cherry, hazelnut, and prickly ash.

IV.ECOLOGICAL EVALUATION

The Department of Natural Resources (DNR) developed a system called the Minnesota Land Cover Classification System (MLCCS), which defines and classifies all types of land cover. Washington County has been entirely mapped in the MLCCS and this information was used as a basis for the site evaluation, which was conducted by FMR's ecologist in spring and summer 2018. Using the polygons defined by the MLCCS, information for each land cover type was recorded. A primary focus was the existing plant species and their percent coverage in each vegetation layer (tree, shrub, and ground layer) (**Appendix A**) [Note that within the text portion of this document, only the common names of plant species are used unless a species is not listed in one of the appendices, in which case the scientific name will also be shown]. Other site features evaluated and recorded were ecological concerns, such as erosion, invasive species, disease, etc. The field observations then informed the land cover classification, which was modified as needed (**Figure 13).** Each of the land cover units is described in the paragraphs below.

A. Oak Forest

Oak forest encompasses most of Riverside Park– about 11.3 acres. According to the DNR Plant Communities of Minnesota (2005), the official name for this plant community is Southern Mesic Oak-Basswood forest (MHs38b).

Photo 2. Trails and bench at the park.

Ecological management of the park began, as far as anyone knows, in about 1995 when the National Park Service (Mississippi National River and Recreation Area) hired Fortin Consulting to work on invasive species management and other issues (Duncan, personal communication). The city created the existing trail system approximately in the late 1990s (**Photo 2**). According to Nancy Duncan, buckthorn was cleared from large areas of the park for several years. The state threatened species kittentail (*Besseya bullii*) came in abundantly after that, especially along trails. In the early 2000s the city compost area was seeded with native prairie species (see "Grassland" section). Buckthorn management continued for several years, but as funding dwindled, most of the park has not been managed for about five years or more.

In 2018, the tree canopy cover at the site was generally dense, 75 percent or more, with a few areas where it was more open. Red oak was dominant with diameters from 8 to 36 inches.

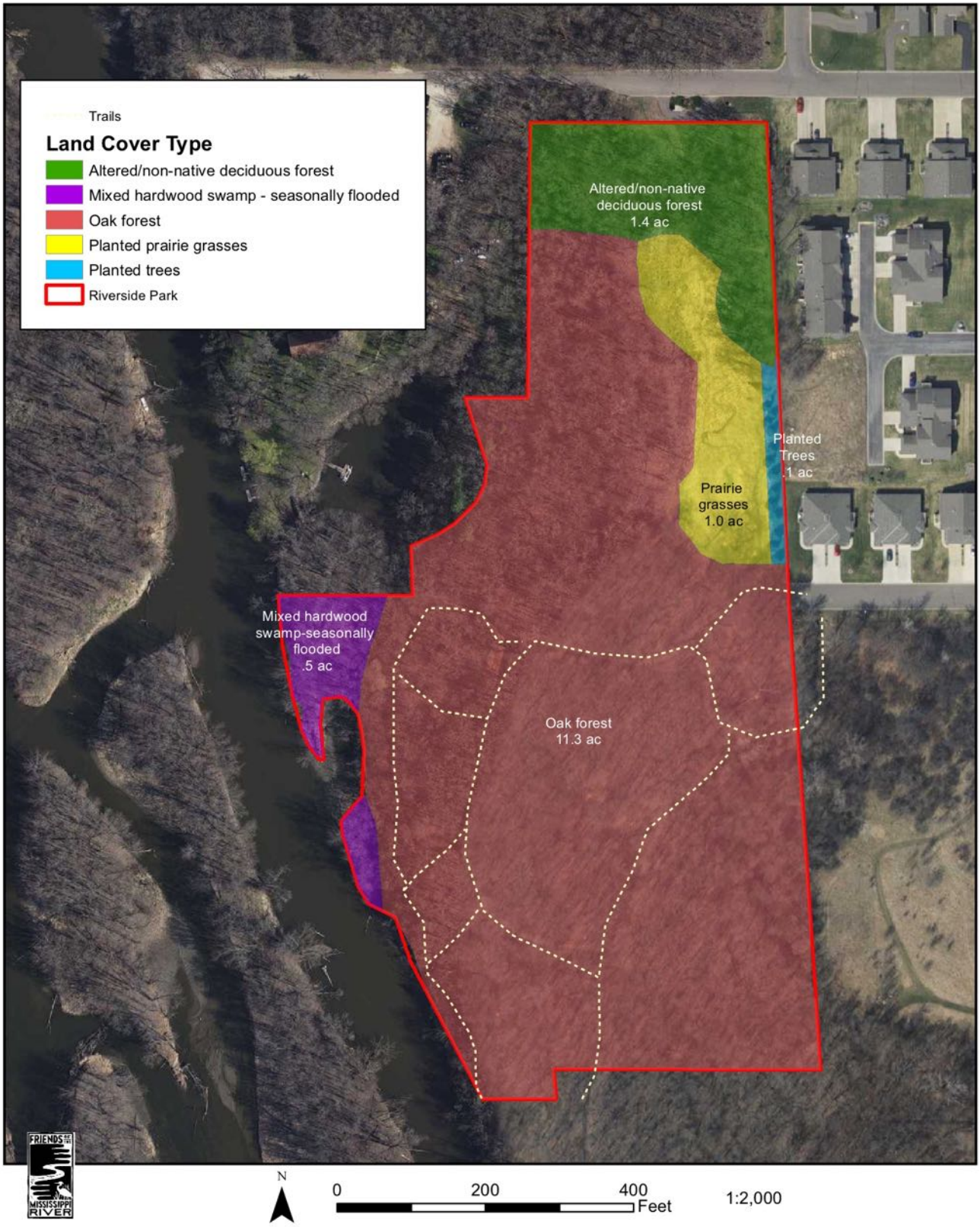

Figure 13. Existing Land Cover

Bur oak and American basswood also very abundant, and were also large diameter, from 8 to 24 inches (**Photo 3**). Green ash was of similar size, but less abundant. Smaller diameter trees were the species that established later, especially after fire suppression, and included quaking aspen, American elm, hackberry, black cherry and ironwood.

Photo 3. Large bur oak with spreading branches. Note dense sapling buckthorn in ground cover below it.

The subcanopy was generally less than 50 percent cover, but where the tree canopy was more open the subcanopy was more dense, especially with basswood, green ash and elm. The subcanopy species were mostly the same as the canopy species, with the addition of bitternut hickory. A few species found in the more open edge near the river included butternut and red cedar.

A total of sixteen tree species were recorded in the canopy and subcanopy. Most tree species were represented as seedlings and saplings. However, while seedlings of both oak species were found in the ground cover, saplings were largely absent. Their regeneration will be promoted by removal of competing woody plants, especially buckthorn. Overall there was a good distribution of age classes in the forest.

The shrub layer was also a very dense canopy cover of 50 to 75 percent. Common buckthorn accounted for the vast majority of the coverage (**Photo 4**), with Tartarian honeysuckle dense along edges and openings. There were also some white mulberry and black locust (both non-native invasive trees) near the river trail. Buckthorn stems were mostly 0.5 to 0.75 inches in diameter, with scattered large stem, 2 to 4 inches diameter. Most of the buckthorn was fairly young, and much of it was not yet producing fruit. Given this fairly recent invasion, there is a good chance that there is an intact seedbank of native species. If buckthorn is eradicated, the native ground cover species may regenerate.

Many of the canopy tree species were also found in the shrub layer, along with choke cherry, gooseberry, raspberry, blackberry, nannyberry, prickly ash and arrowwood viburnum. Red oak was dominant. Several sapling white mulberry and black locust, both non-native trees (the latter very invasive), were found on the southernmost trail to the river.

Photo 4. The buckthorn shrub layer was nearly impenetrable in some areas.

The ground layer cover was generally fairly dense, except where both the canopy and shrub layers were dense, then the ground cover was sparse. Common buckthorn seedlings dominated the composition. A few seedlings of another non-native invasive shrub, pea shrub, were also found near the park entrance.

The herbaceous plant diversity seemed much declined over previous records (completed by Fortin Consulting, prior to 2013), which correlates with the increase in buckthorn. Although nearly 50 native woodland wildflower species were detected at the site in 2018, the majority of the coverage was from hardy generalists such as hog peanut, enchanter's nightshade, Virginia waterleaf and jewelweed. Other species found in low abundances included columbine, Jack in the pulpit, pointed-leaved tick trefoil, Dutchman's breeches, wild geranium, lopseed, and large-leafed aster.

Also among the herbaceous plants were several non-native invasive species: garlic mustard, narrowleaf bittercress, and Japanese hedge nettle. None were extremely abundant yet, but the bittercress was widespread and the garlic mustard was in patches. In general these species were most abundant along trail edges. They are still at a stage where control is possible, but significant action will be needed soon. Mississippi Park Connection was able to send a Conservation Corps Minnesota crew to the site in May 2018 to hand-pull as much of the two mustard species as possible. Similar efforts will need to be repeated annually for several years to gain control.

Spotted knapweed, an invasive prairie species, was also found in the open edges along the river.

B. Altered Non-native Deciduous Forest

Photo 5. The old roadbed at the north end of the park.

About 1.4 acres at the north end of the park was altered many decades ago by construction of a roadbed (**Photo 5**). The canopy cover was similar to the oak forest, but green ash (22" dbh) and boxelder (10"-20" dbh) were dominant. Other trees included also very large basswood (24" dbh), red oak (22" dbh) American elm (14" dbh), hackberry (12" dbh), and small butternut. There was also a sapling catalpa tree.

The understory (shrub layer) was fairly open in some areas, but common buckthorn and honeysuckle were dense along the north edge, scattered to the south of that, then dense again toward the south end of the unit.

Common ground cover species included hog peanut, clearweed, Virginia creeper and white snakeroot. Other species found were American figwort, jack in the pulpit, yellow avens, enchanter's nightshade, honewort, and whitegrass. The old road bed was very weedy with an abundance of creeping Charlie (dominant) and some creeping bellflower, but also an abundance of clearweed (native). Burdock and garlic mustard were present, though not abundant. Common tree seedlings were hackberry, elm and occasional bur oak.

C. Grassland

Photo 6. Native grass cover was fairly good at the planting, but native forb diversity was low.

This unit consisted of the one-acre area north of the park entrance that was seeded to native prairie species in approximately 2006. It served as the city compost facility for many years prior to that. We refer to it as a grassland rather than prairie because, while the planting still retained good coverage of native grasses (**Photo 6**), the native forb component was very low and there were a lot of non-native invasive species. It does not adequately reflect the composition of a prairie.

Big bluestem and Indian grass were the dominant grasses, although the non-native Kentucky bluegrass was very abundant.

The forb (flowering plants) coverage was dominated by non-native invasive species: Canada thistle, crown vetch, bird's foot trefoil, and burdock. Less abundant invasives were bull thistle and curly dock. Canada goldenrod, a native but invasive species, was also abundant. Desirable forbs were few, but included common milkweed, blue vervain and a few aster species.

The most abundant herbaceous plant was common burdock, which formed a dense, virtually impenetrable, monotypic stand along the northwestern borders of the prairie unit (**Photo 7).** This plant not only displaces native plants, but it can be quite harmful to small wildlife species, such as hummingbirds and bats. FMR staff have found these animals trapped by the sticky seed pods of the burdock, where they met their demise, unable to escape. Cannabis was also abundant at the north end. Though generally not considered invasive, it does not provide as much wildlife value as the native plants.

Photo 7. Common burdock formed an impenetrable thicket along the northwest sides of the prairie.

D. Planted Trees

This tiny 0.1 acre unit consisted of a row of pine trees about 15 feet tall that were planted along the east edge of the grassland. They were likely planted as a way to define the park boundary. Although they do not present an ecological concern per se, and they provide cover for some bird species, they are not appropriate for the native plant communities at the park. A more suitable alternative conifer would be red cedar.

E. Mixed Hardwood Swamp, Seasonally Flooded

This 1.5 acre unit along the river is what is commonly referred to as floodplain forest. Access to the floodplain was thwarted in 2018 by continuous water in the small backchannel between it and the upland part of the park. By November the water level had dropped to enable easy access (**Photo 8**). The tree canopy at this unit is dense, with large multi-stemmed silver maple (15-inch diameter or more), cottonwood, hackberry, basswood and elm. The understory is fairly open; no native shrubs were found, but some of the largest buckthorn at the park were found here (**Photo 9**). The ground cover was sparse, but there were large patches of a long-bladed sedge species (**Photo 10**). The mounded soil around the base of the trees is characteristic of a floodplain where sediments are regularly deposited and scouring around tree trunks creates a depression there.

The north end of the floodplain sits a little higher above the river (**Photo 9**), with less frequent flooding. This unit will have a slightly different target plant community, although management tasks will be the same.

Photo 8. South end of the floodplain forest. Note very large buckthorn along river, limestone ledge to the right.

Photo 9. The north end of the floodplain is somewhat higher above the river. Very large buckthorn are abundant.

Photo 10. Long sedges, large buckthorn, scoured soil at base of trees.

F. Ecological concerns

The site has numerous ecological threats, primarily due to invasive non-native plant and animal species including earthworms, and invasive woody and herbaceous plant. **Fourteen** plant species found at the site are listed by the MN Department of Agriculture and the Department of Natural Resources as noxious weeds, including garlic mustard, narrowleaf bittercress, common buckthorn, Tartarian honeysuckle (**Appendix D**).

Photo 11. Earthworms, none of which are native to MN, were at the highest stage of abundance at the site. Arrows point to the middens – uneaten vegetative debris left in piles at the worm holes.

The presence of these species are interconnected and the causes of their invasion cannot necessarily controlled. Earthworms, for instance, play a major role in the establishment of the invasive plant species, by altering the soil structure and consuming seeds of native plants. Buckthorn, in turn, benefits earthworms by providing leaves that are very high in nitrogen. This positive feedback loop ensures that both species continue to thrive at a site. However, we **can** intercept this system. There is currently no method for controlling earthworms so to that extent, the site will always be susceptible to invasion of non-native plant species. However, native plants can co-exist with earthworms, and if there a well-established native plant community, studies have shown it can be quite resistant to invasive plant species. Also, by removing invasive plants, conditions for earthworms decline and their populations also decline.

Earthworms were abundant throughout the property, and were scored as stage 5, the maximum invasion stage. Stage 5 is described as: no forest floor humus or fragmented leaves present, mineral soil present, earthworm casting abundant (>50% of forest floor/mineral soil interface covered), middens abundant (>9 in a 5-m radius) (**Photo 11**). Typically, in today's conditions, as worms alter the soil structure and duff layer, they create conditions that favor non-native invasive plants such as buckthorn and garlic mustard, which then invade and prevent native plants from growing. If those invasives were not present in the landscape, then native plants can gradually adjust to the mineral soil conditions. Although controlling earthworm populations is not feasible, it would be valuable to survey the population over time in high and low quality areas to evaluate any changes over time that may result from management activities. This could be a good volunteer or intern activity.

Common buckthorn can thrive in a wide range of soil and light conditions, enabling it to invade a wide variety of habitats. It forms dense thickets that crowd and shade out native plants, alters nitrogen levels in the soil, hosts fungi that are detrimental to agricultural crops, and contributes to erosion and declining water quality. Recent research suggests it also releases compounds that are toxic to the embryos of native amphibian species. Its fruit is somewhat toxic, with a strong laxative effect on birds and other wildlife. As such, it provides little food value to animals that eat the berries. Studies have shown an increased rate of nest predation and subsequent population

declines for birds that nest in buckthorn. Once established, a virtual carpet of buckthorn seedlings radiate outward from each "mother plant," displacing or preventing native plants from re-establishing these areas. The berries are dispersed by birds throughout the woodland. Trees that offer perches for birds are typically choked with buckthorn plants growing under their crowns. Buckthorn can dominate a vulnerable woodland or forest in a matter of 30 to 50 years.

Like buckthorn, **Tartarian honeysuckle** is an upright, deciduous that was brought here from Europe and Asia. It is a very aggressive colonizer that displaces native forest shrubs and herbaceous plants by its invasive nature and early leaf-out. It also invades grassland areas. It has a very robust root system and a multi-stem trunk and is very difficult to eradicate. Birds eat the red or orange berries, spreading the plant to new locations.

Garlic Mustard and narrowleaf bittercress are two species in the mustard family that have significant negative impacts on forest understory. Both species are biennial, having basal rosette of leaves the first year and a flowering stalk the second. They are cool-season species that get a competitive advantage when most native species are dormant. They are prolific seed producers and spread very quickly, displacing native species.

While the ecological concerns for the oak forest are significant, the invasions are still relatively young and there is good indication that the forest community could recover if management is undertaken soon.

As with the forest, the primary concern for the grassland is the prevalence of the non-native invasive species listed above. Beyond that, the site lacks native plant diversity, especially forbs. Forbs are critical for native pollinators and provide food for other wildlife species as well. Management and restoration recommendations are provided in the next section.

Other ecological concerns to be aware of at the site include plant diseases and impacts of over-population of white-tailed deer. Lack of fire has also altered the composition of native plant community compositions. There are also larger threats, especially from climate change, that ecologists don't fully understand yet. See **Appendix C** for additional information on these topics.

V. ECOLOGICAL MANAGEMENT RECOMMENDATIONS

Ecological restoration is a long-term process. It takes time to restore ecosystems to their former functionality and diversity. And even under the best circumstances and human abilities, generally, this can only be approximated. It took many decades to degrade the ecosystem and biological communities on the property, so it will not be restored overnight. Many steps are typically involved in a successful restoration; even deciding when a restoration is complete/successful can be very difficult. Restoration should be viewed as a process and not as an end point. The ultimate goal is to achieve and maintain a diverse natural community at the site, though this will not always proceed in a linear fashion. Using the concept of *adaptive management* will be the key to continual progress at the site. Adaptive management is a strategy commonly used by land managers, which integrates thought and action into the restoration process. It can be described as a strategy that uses evaluation, reflection, communication, and also incorporates learning into planning and management. It is set up like a feedback loop and looks like this: Assess Problem → Design → Implement → Monitor → Evaluate → Adjust → Assess Problem → and so forth. Thus, moving forward with restoration, each round of adaptive management refines and hones the process to better fit the conditions of the site. This strategy should be emphasized on the property.

A. Management Objectives

The overarching objective for Riverside Park is to protect and improve the wildlife and water quality values of the site and to restore the ecological functions that the historical native plant communities provided, including:

- habitat for a diversity of wildlife species
- nutrient and water cycling
- carbon storage
- moderation of water-table levels
- erosion control
- filtration of nutrients, sediments and pollutants
- development and enrichment of soils
- local temperature moderation

The best way to accomplish those objectives is by restoring and enhancing native plant communities to the site. A robust and diverse native plant community offers the best protection against invasive species, climate change effects and loss of animal species diversity. Although the historical plant community was most likely an oak savanna and oak forest complex, oak savanna would be difficult to restore over most of the site, because it has succeeded too far to oak forest and reversing that would cause more degradation to the site. Savanna species would be suitable in the grassland, but overall maintaining and enhancing the mesic oak forest community will be the best management for this site.

According to the 2005 State Wildlife Action Plan for mesic hardwood forests, management practices should be implemented that:

- Use natural disturbance return intervals to guide rotation periods.
- maintain and create large patches of upland forest.
- retain biological legacies (at site level).
- control invasive plants and animals.
- work with Minnesota DNR Division of Fish and Wildlife to determine ecologically and socially desirable deer population levels across the state.
- Collaborate management across ownerships to increase patch size.

In addition, DNR recommendations specify managing habitat for species of greatest conservation need (SGCNs) and monitoring SGCN populations.

B. Target Vegetation Communities

In determining target plant communities for restoration, we considered the following: historical conditions, existing conditions, and cost/benefits. For cost/benefit we consider the expense and potential ecological detriments of restoring a particular community versus the long-term benefit for wildlife and other habitat values. In some cases, a plant community succession may have advanced too far to warrant restoration to the historical condition. A very overgrown savanna, for example, may be better restored to woodland rather than savanna. In other cases, a site that is extremely degraded and/or surrounded by degraded lands with invasive species may simply be a poor candidate for successful restoration.

As a guideline for the target plant community goals, we used the Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province (DNR, 2005). This book describes the system developed by the DNR for identifying ecological systems and native plant community types in the State, based on multiple ecological features, such as major climate zones, origin of glacial deposit, plant composition, and so on. Target plant community recommendations for each of the land cover types is summarized in **Table 2**.

Most of Riverside Park is currently classified as Southern Mesic Oak-Basswood Forest, which has been degraded by invasive species. Although based on our evaluation it appears the park may have been more of a savanna historically, we feel that the plant community type that is now most suitable for the forested parts of the site is to keep it as Southern Mesic Oak-Basswood Forest. The subtype community would be Basswood – Bur oak – (Green Ash) Forest (MHs38b). Oak forest is a key habitat type in the St Paul Baldwin Ecological Subsection, as it was more than 5% of the 1890s landcover and has declined by more than 50% in the 1990s landcover (DNR 2006). While savanna is more imperiled in the landscape, oak forest is also a key habitat type and very important to the area. It would not be cost effective to revert back to savanna.

Specific restoration goals and methods are described for each management unit in the following section.

Table 2. Existing land cover and target plant communities

MLCCS Existing cover	Acres	Soil type	Target Plant Community
Oak forest	11.3	Copaston Loam, 0-6% slope	Southern mesic oak-basswood forest MHs38b
Altered/non-native deciduous forest	1.4	Copaston Loam, 0-6% slope	Southern mesic oak-basswood forest MHs38b
Grassland	1	Copaston Loam, 0-6% slope	Southern dry oak savanna UPs14
Planted trees	0.1	Copaston Loam, 0-6% slope	Southern dry oak savanna UPs14
Mixed hardwood swamp, seasonally flooded (Floodplain Forest)	0.5	Dorerton-Rock outcrop complex, 25-65% slope	Southern Terrace Forest FFs59 and Southern Floodplain Forest FFs68

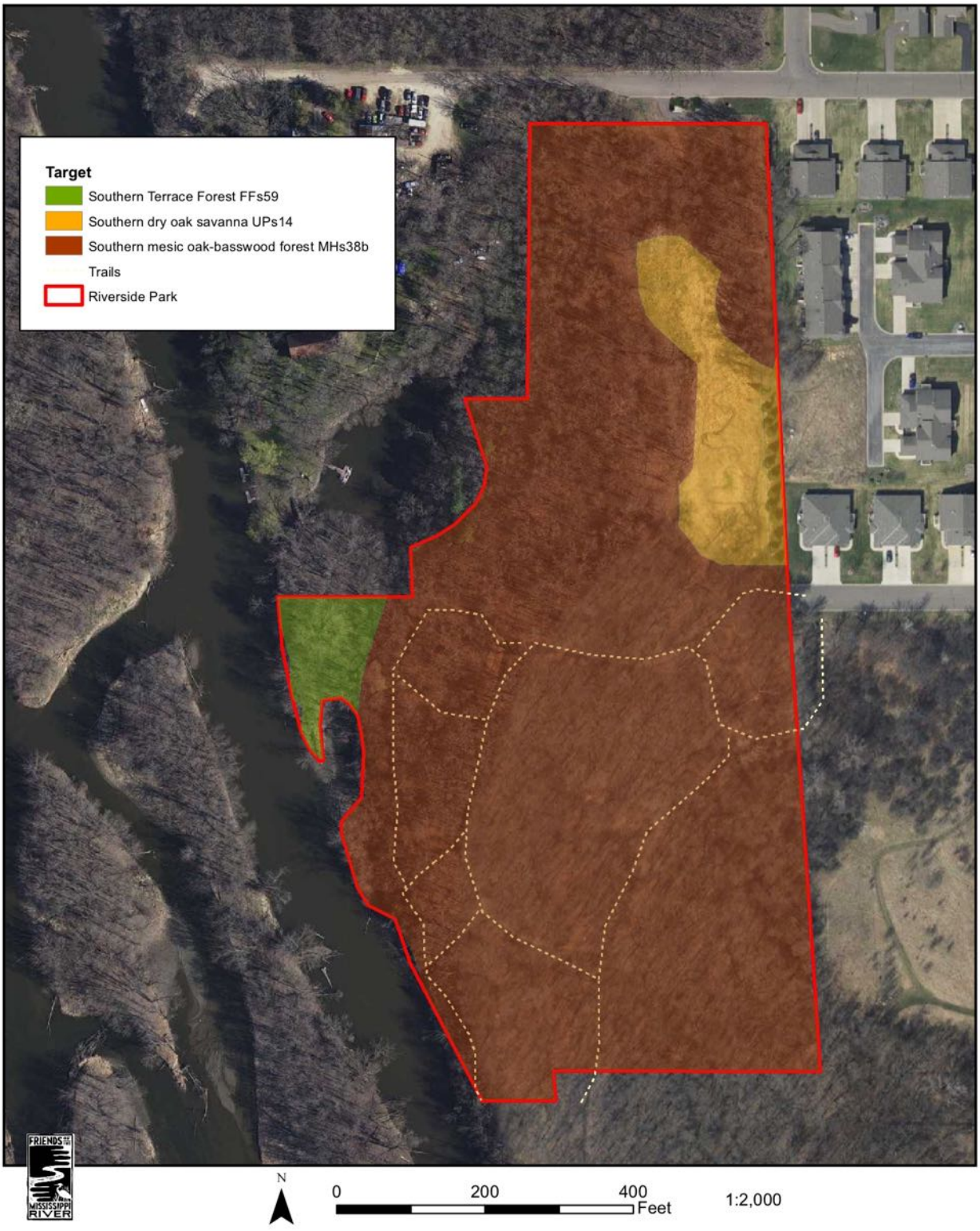

Figure 14. Target Plant Communities for Restoration

C. Ecological Management Recommendations

All of the forested areas of Riverside Park would essentially be managed in the same way, with a target Native Plant Community **Southern mesic oak-basswood forest** (MHs38).The management goals and methods are described below, followed by specific details for each of the units.

Management Goals:

1. Within 6 years, the cover of non-native brush larger than ½ inch diameter has been reduced to less than 10% throughout the site.
2. Within 6 years, the cover of garlic mustard and narrowleaf bittercress throughout the site is less than 5%.
3. Throughout management, impacts to native plant species are minimized. No net loss of native plant species cover or composition.
4. Native herbaceous plant species richness for the oak forest is increased within 8 years.
5. Within 6 years, the oak savanna has 90% cover of native species, invasive species are eradicated, at least 25 native prairie species are present and no species are overly dominant.
6. Information on the breeding bird population is tracked over time.
7. Local community members are engaged in site stewardship.

Management Methods:

- Conduct before and after vegetation surveys to monitor and evaluate the response of the plant community to the management methods.
- Remove non-native, invasive woody plants (primarily buckthorn)
- Minimize non-target impacts:
    - Do not use oil-based herbicides, which leach through soil and create significant “kill-rings.”
    - Due to groundwater sensitivity, do not use water soluble herbicide.
    - Use foam applicator on cut stumps to eliminate overspray.
    - Avoid foliar herbicide application; if needed use wick application.
- Remove garlic mustard and other non-native herbaceous plants by hand-pulling and spot-spraying.
- Use prescribed fire and other natural process and disturbances to maintain forest health and regeneration and reduce seedling buckthorn and other invasives. Historically, light surface fires would have occurred occasionally (35-year rotation).
- Conduct annual surveys of breeding birds and/or other species (e.g. pollinators) to track changes to the animal population over time.
- Host annual restoration activities and/or nature hikes to engage community volunteers and site stewards.

D. Restoration Schedule

1. Work Phases

Project work for each of the work phases will begin with non-native, invasive species control (primarily buckthorn and garlic mustard). After non-native species removal, there will likely be areas that need to be supplemented with native woodland or savanna seed and/or native shrubs.

A four-year Work Plan (**Table 3**) was developed to provide guidelines toward achieving the target communities shown in **Figure 14**. The table shows the work phases, activities, schedules, and estimated costs. A general time frame is shown for each phase, but note that "year 1" for each unit is independent of "year 1" in other units, though they may coincide. Note also that that the costs shown are estimates, based on similar work at other sites, but actual costs may be higher or lower, depending on multiple variables.

2. Ecological Tasks

In general, the ecological tasks below would be completed sequentially for each work phase. Some tasks, however, would necessarily apply to the entire project area, especially the ecological monitoring.

Non-native brush control

Non-native brush control will be the highest priority task for each of the management units (see **Appendix E** for details on woody removal methods). Non-native brush removal can be phased as funding permits, with work units as shown in **Figure 15**. Non-native brush control should be scheduled in approximately 3 to 5 year intervals to make a sweep through each unit and address the ½-inch diameter plants. The site should be monitored annually and brush managed before it begins to produce fruit. We do NOT recommend broadcast foliar treatment for follow-up brush control. Foliar treatment often has significant lethal effects on non-target species, resulting in very little native ground cover in the treated areas. Foliar treatment could be used for occasional plants for which the original treatment was not effective and they have resprouted. There should not be more than about 5% plants that resprout.

Brush disposal will vary among the units. Where access is good and brush density is high - essentially all units except south – the cut brush can be dragged as much as possible to the trails and chipped. Wood chip can be blown back into the woods, being sure to disperse it so it does not accumulate more than about 1.5 inches deep. Chip could also potentially be used on the trail itself, to cover the trails. Where brush is too far to haul, it can be stacked and burned, being sure to locate burn piles away from standing trees, and not on top of high quality native vegetation. A few rot piles can be created, which provide valuable habitat for wildlife. However, piles should be limited to areas that are less visible from the trails, and no more than about one or two per acre. Maximum rot pile size should be about 8 cubic feet.

The target mesic oak forest plant community (MBs38) is not a fire-dependent community, but low-level fires did occur. Fire would be especially useful to reduce the cover of seedling buckthorn after the initial removal.

Garlic mustard control

Garlic mustard is not yet extremely abundant at the park. It is still at a level that is manageable, although action must be taken as soon as possible and diligent annual control will be needed to keep it under control. It will likely always be present at the site, needing regular management. But if native vegetation is very robust it will help to prevent the spread. Hand-pulling is the surest way to control this biennial species. In the spring it should be pulled before flowering, typically late April or early May. Pulled at that stage, the pulled plants can be shaken off to remove the dirt and left lying in the woods. If plants are pulled after flowering, the plants should be put in bags, removed from the site and properly disposed where seeds will not mature or be spread. The downside to pulling in spring is that will cause trampling of the native wildflowers. Very late fall can also be an excellent time to hand-pull. In November most native plants have died back but garlic mustard is still green. The plants are in the basal rosette stage, which is a little more difficult to pull but a dandelion digger is all that is needed. In conjunction with hand-pulling, we suggest contractors also be hired to apply herbicide. Herbicide application should ONLY use foam applicators, which provides very targeted application with no overspray that would affect non-target species (see additional control method details in **Appendix E**).

Re-seeding and re-planting oak forest

Because there has been a history of good native ground cover vegetation at the site, it would be beneficial to delay any seeding effort and observe what native species recur after woody removal. If seeding is ascertained to be needed, suitable species are listed in **Appendix B**. Only local ecotype plant material (genetic origin within 50 miles) should be used. In general, allow at least one growing season after non-native woody removal to see what native species may recover on their own. Large areas with bare soil, however, may need quick-growing species to provide some cover (and to help prevent buckthorn seedling flush). Oats or winter wheat can be used in combination with native grasses and other species. Cover crops and native grasses can also provide fuel for prescribed burns, that will help control buckthorn seedlings.

Seeding is best done just before winter to allow for seed stratification. For live material, shrubs are best planted as bare root, and must be protected from deer browsing (e.g. wire cages). Shrubs should also be well-mulched at the time of installation to retain soil moisture. Allow one to two years after buckthorn removal before installing plant material so as not to interfere with any necessary buckthorn follow up control.

Grassland: Woody removal

Woody plants are not abundant at the grassland unit, but only bur oaks and a few other woody plants belong in savanna, the target community. The seedling green ash that were planted should be cut or pulled. Some or all of the planted pines on the east property line could also be removed. Though not essential, removing the pines would be more consistent with the historical plant communities at the site. If replacement trees are desired, red cedar would be a suitable choice.

Grassland: Weed control, Re-seeding and Re-planting

The goal for the savanna restoration is to maintain as much of the existing native cover as possible, to eradicate the invasive species, and to increase the diversity of native species. The invasive species will need aggressive management, spot-mowing and spot-spraying for several years. A burn should be done as soon as possible, which will make follow-up control of the invasive easier. After the burn, the site should be over-seeded with a mix of native prairie species.

Once the invasive species are controlled, bur oak trees could be planted to restore that component to the savanna community. The site is very small, so very few oaks would be needed, e.g. three to start with. Bareroot or small potted trees could be planted. The ground around them should be cleared of vegetation in a 3-foot ring which would be maintained with mulch cover. The trees should be vigorously protected with strong fencing to prevent deer browse or rubbing, and the trunks should have plastic tubes to protected them from rodents.

Community Engagement

Involving community volunteers in ecological restoration activities and educational nature outings is very important for promoting a stewardship ethic for natural areas. The more that people learn about and are involved in a natural area the more they will care for it and support the long-term management and protection of it. Riverside Park provides various opportunities for engagement. Volunteers could be involved in hauling non-native brush from the woods, in searching for and pulling garlic mustard and bittercress, installing native shrubs, and conducting plant and animal surveys such as earthworms, breeding birds and pollinators. Friends of the Mississippi River has a long history of community engagement and has recruited thousands of volunteers over the years for these kinds of activities.

Ecological Monitoring

Ecological monitoring of the site is critical to provide baseline data on starting conditions and to evaluate changes over time. Plant and animal surveys can be used to better inform management and to adapt and adjust methods as needed. Vegetation survey plots have not been established but a completed sitewide survey provides some baseline data. Annual surveys should be conducted at approximately the same time each year to provide the best comparative data. Ideally two surveys would be done to capture both early and late season species.

Ecological evaluation must also be completed on a longer time-frame to evaluate canopy health and regeneration. As new tree diseases and insect infestations evolve, it will be important to assess conditions and develop methods to counteract the impacts, such as tree removal and planting tree seedlings. Given the impacts from disease, windthrow and other impacts, the natural disturbance levels are not likely to need “assistance”, but selective tree harvesting should also be considered if needed. Disturbance is an important component of a forest and critical for regenerating both canopy and herbaceous species.

Figure 15. Work Units

Table 3. Four-Year Work Plan

Year	Season	Work Units	Ecological Task	Acres	Est Cost/ac	Est cost
OAK FOREST & FLOODPLAIN FOREST						
1	Winter	1-4	Cut & stump treat all non-native trees and shrubs > 0.5 inch diam. Haul and chip or stack/burn. (e.g. buckthorn, honeysuckle, black locust, pea shrub, mulberry).	13	$ 1,100.00	$ 14,300.00
1	May	1-4	Hand-pull garlic mustard and narrowleaf bittercress	13	$ 250.00	$ 3,250.00
1	June	1-4	Breeding bird survey	14		$ 1,500.00
1	Apr-Oct	1-4	Spot-spray invasive herbaceous plants, esp garlic mustard, bittercress, creeping bellflower, Japanese hedge-nettle, knapweed, burdock.	13	$ 200.00	$ 2,600.00
1	Fall	1-4	Spot-spray individual resprouted buckthorn.	13	$ 300.00	$ 3,900.00
1	Fall	1-4	Rx burn (excluding floodplain)	12	$ 350.00	$ 4,200.00
1			Project oversight and evaluation, vegetation surveys, reports.			$ 3,825.00
						$ 33,575.00
2	May	1-4	Hand-pull garlic mustard and narrowleaf bittercress	13	$ 250.00	$ 3,250.00
2	June	1-4	Breeding bird survey	14		$ 1,500.00
2	Apr-Oct	1-4	Spot-spray invasive herbaceous plants.	13	$ 200.00	$ 2,600.00
2			Project oversight and evaluation, vegetation surveys, reports.			$ 3,150.00
						$ 10,500.00
3	Winter	1-4	Cut & stump treat non-native trees and shrubs >0.5 inch diam. Scatter.	13	$ 700.00	$ 9,100.00
3	May	1-4	Hand-pull garlic mustard and narrowleaf bittercress	13	$ 250.00	$ 3,250.00
3	June	1-4	Breeding bird survey	14		$ 1,500.00
3	Apr-Oct	1-4	Spot-spray all invasive herbaceous plants.	13	$ 200.00	$ 2,600.00
3	Fall	1-4	Spot-spray individual resprouted buckthorn plants.	13	$ 300.00	$ 3,900.00
3			Project oversight and evaluation, vegetation surveys, reports.			$ 3,150.00
						$ 23,500.00

4	May	1-4	Hand-pull garlic mustard and narrowleaf bittercress	13	$ 250.00	$ 3,250.00
4	June	1-4	Breeding bird survey	14		$ 1,500.00
4	Apr-Oct	1-4	Spot spray all invasive herbaceous plants.	13	$ 200.00	$ 2,600.00
4			Project oversight and evaluation, vegetation surveys, reports.			$ 2,700.00
						$ 10,050.00
			Total Forest 4-years			$ 77,625.00

SAVANNA

1	Winter	5	Cut & stump treat all trees and shrubs, included planted green ash.	1	$ 250.00	$ 250.00
1	Winter	5	Cut and remove some or all of the 14 planted pine trees on the east property line. (optional)	14	$ 250.00	$ 3,500.00
1	Apr-May	5	Spot spray invasive herbaceous plants - crown vetch, thistles, burdock, cannabis etc.	1	$ 400.00	$ 400.00
1	June-Aug	5	Spot spray invasive herbaceous plants second time. Spot-mow if needed to prevent seeding.	1	$ 200.00	$ 200.00
1	Sept-Oct	5	Spot spray invasive herbaceous plants - third time. Overspray cool-season grasses.	1	$ 200.00	$ 200.00
1	Fall	5	Rx burn (along with forest)	1	$ 500.00	$ 500.00
1	Fall	5	Overseed native prairie mix, primarily forbs.	1	$ 500.00	$ 500.00
						$ 5,550.00

2	Apr-Oct	5	Spot spray/mow invasive herbaceous plants 2-3 times. Do not allow seed formation.	1	$ 600.00	$ 600.00
2	May & June	5	Mow entire unit 2x to promote growth of seeded plants. Mow when vegetation reaches about 12-inches, mow to 5-inches.	1	$ 600.00	$ 600.00
						$ 1,200.00

3	Apr-Oct	5	Spot spray/mow invasive herbaceous plants 2-3 times. Do not allow seed formation.	1	$ 600.00	$ 600.00
3	May & June	5	Mow entire unit 1x to promote growth of seeded plants. Mow when vegetation reaches about 12-inches, mow to 5-inches.	1	$ 300.00	$ 300.00
						$ 900.00

4	May	5	Rx burn	1	$ 900.00	$ 900.00
4	June-Oct	5	Spot spray/mow invasive herbaceous plants 2-3 times. Do not allow seed formation.	1	$ 400.00	$ 400.00
4			Install about 3 bur oak trees, mulch, fencing	3	$ 275.00	$ 825.00
						$ 2,125.00
			Total Savanna 4-years			$ 9,775.00
			Total Park, 4 years			**$ 87,400.00**

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APPENDICES

Appendix A: Plant Species Recorded at the Riverside Park

The following plant species were identified at the site by Friends of the Mississippi River in 2018. Species in Blue font are additional species, recorded in 2013 (Fortin Consulting) but not noted in 2018.

MHs38b Basswood - Bur Oak - (Green Ash) Forest Species

	*Non-Nativ	Scientific Name	Common Name	Cover**	Diam (in)	Comments
	CANOPY			20-80 ft ht	Total Cover: 4-5	
1		*Acer negundo*	Boxelder	1	4	by river
2		*Celtis occidentalis*	hackberry	1	12,15	
3		*Fraxinus pennsylvanica*	green ash	1	8,10,18	
4		*Ostrya virginiana*	ironwood	1	6	
5		*Populus deltoides*	eastern cottonwood			by river
6		*Populus tremuloides*	quaking aspen	1	10	
7		*Prunus serotina*	black cherry	1	8	
8		*Quercus alba*	white oak			
9		*Quercus ellipsoidalis*	northern pin oak		8 to 20	
10		*Quercus macrocarpa*	bur oak	2	20,	sub dom
11		*Quercus rubra*	red oak	3	8,10,36	Dom
12		*Tilia americana*	American basswood	2	8, 24	
13		*Ulmus americana*	American elm	1	8	
	SUBCANOPY			12 to 20 ft ht	Total Cover: 3 to 4	
1		*Acer negundo*	boxelder	+		
2		*Carya cordiformes*	bitternut hickory	+		
3		*Celtis occidentalis*	hackberry	1		
4		*Fraxinus pennsylvanica*	green ash	2	4"	
5		*Ostrya virginiana*	ironwood	+		
6		*Prunus serotina*	black cherry	+		
7		*Juglans cinerea*	butternut	+		Few by river at "boat launch"
8		*Quercus macrocarpa*	bur oak	1		
9		*Quercus rubra*	red oak	1		Dominant
10		*Tilia americana*	Ameriican basswood	2		
11		*Ulmus americana*	American elm	2		
	UNDERSTORY/SHRUB LAYER 4 to 12 ft height				Total Cover: 4	
1		*Acer negundo*	boxelder	+		
2		*Celtis occidentalis*	hackberry	1		
3	x	*Lonicera tatarica*	Tartarian honeysuckle	1 to 2		
4		*Ostrya virginiana*	ironwood	1		
5		*Populus tremuloides*	quaking aspen	1		
6		*Prunus serotina*	black cherry	1		
7		*Prunus virginiana*	choke cherry	+		
8	x	*Rhamnus cathartica*	common buckthorn	4	0.5 to 3/4", occ 2-4"	Dominant. Medium density and height throughout. Scattered large 2-4"
9		*Ribes cynosbati*	prickly gooseberry	1		

	Non-Native	Scientific Name	Common Name	Cover*	Diam (in)	Comments
10		Rubus allegheniensis	blackberry	+		
11		Rubus ideaus	red raspberry	1		
12		Sambucus pubens	red berried elder			
13		Tilia americana	basswood	1		
14		Ulmus americana	American elm	1		
15	x	Morus alba	white mulberry	1		At S trail to River/center trail, other nearby
16	x	Robinia pseudoacacia	black locust	+		By River at S trail (by arrowwood).
17		Viburnum lentago	nannyberry	+		
18		Viburnum rafinesquianum	downy arrowwood	+		by river
19		Zanthoxylum americana	prickly ash	1		

GROUND LAYER — to 4 ft height — Total Cover: 4

Graminoids

1		Carex blanda	eastern woodland sedge	+		
2		Carex pensylvanica	Pennsylvania sedge	2		
3		Brachyelytrum erectum	long-awned wood grass			
4		Bromus pubescens	hairy wood chess			
5		Carex sprengellii	Sprengel's sedge	1		
6		Elymus hystrix	bottlebrush grass			
7		Elymus villosus	hairy wild rye			
8		Leersia virginica	whitegrass	2		

Forbs, ferns — 2

1		Actaea sp	baneberry (red)	+		
2		Ageratina altissima	white snakeroot	1		
3	x	Alliaria petiolata	garlic mustard	1		
4		Allium tricoccum	wild leek			
5		Amphicarpaea bracteata	hog peanut	2		
6		Anemone virginiana	tall thimbleweed	+		by river
7		Aquilegia canadensis	columbine	+		
8		Aralia nudicaulis	wild sarsasparilla	+		by river
9	x	Arctium minus	burdock	1		
10		Arisaema triphyllum	Jack in the pulpit	+		
11		Asarum canadense	Wild ginger	+		By river
12		Aster pilosus	frost aster	+		
13		Campanula rapunculoides	creeping bellflower	1		Edges. Abundant in areas
14	x	Cardamine impatiens	Narrowleaf bittercress	1		Esp trail edges
15	x	Centaurea stoebe	spotted knapweed	+		by river
16		Circea lutetiana	enchanters nightshade	2		
17	x	Convallaria majalis	Lily-of-the-valley	+		
18		Desmodium glutinosum	pointed leaved tick trefoil	1		
19		Dicentra cucullaria	Dutchman's breeches	+		
20		Fragaria virginiana	wild strawberry	+		
21		Galium aparine	cleavers	+		
22		Galium asprellum	rough bedstraw	1		

	Non-Native	Scientific Name	Common Name	Cover*	Diam (in)	Comments
23		Galium triflorum	sweet-scented bedstraw	1		
24		Geranium maculatum	wild geranium	+		by river
25		Geum canadense	white avens	1		
26		Hackelia virginiana	Virginia stickseed	+		
27		Hedoma hederacea	creeping Charlie	1		Along trails, carpet along river banks.
28		Helianthus stromusus	Woodland sunflower	+		
29		Hydrophyllum virginianum	Virginia waterleaf	2		
30		Impatiens capensis	spotted touch-me-not	2		
31		Laportea canadensis	wood nettle	1		
32	x	Leonurus cardiaca	motherwort	1		edges
33	x	Melilotus alba	white sweet clover	+		by river
34		Mianthemum canadense	false lily of the valley			
35		Mianthemum racemosa	false Solomon's seal	+		
36		Osmorhiza claytonii	sweet cicely	+		
37		Oxalis stricta	yellow oxalis	+		
38		Phryma leptostachya	lopseed	+		
39	x	Plantago major	plantain	+		
40		Polygonatum pubescens	hairy Solomon's seal	+		
41	x	Potentilla recta	Sulphur cinquefoil	+		
42		Lactuca biennis	tall blue lettuce	+		
43		Sanguinaria canadensis	bloodroot	+		
44		Smilax herbacea	carrion plant	+		
45		Smilax sp	green briar	+		
46		Solidago flexicaulis	zig-zag goldenrod	1		
47		Symphyotricum (Aster) macrophyllus	large-leafed aster	+		
48	x	Taraxacum officinale	dandelion	+		
49		Teucrium canadense	germander	1		Prairie/woods edge
50	x	Torilis japonica	Japanese hedge nettle	1		Prairie/woods edge, scattered in woods. Very invasive.
51		Urtica dioica	stinging nettle	+		
52		Uvularia grandiflora	large-flowered bellwort			
53		Uvularia sessilfolia	wild oats			
54		Verbena urticifolia	white vervain	+		edge by prairie
55		Viburnum rafinesquianum	downy arrowwood	+		
56		Viola pubescens	yellow violet			
57		Viola sororia	common blue violet	1		Carpet along river trail

Climbers

1		Dioscorea villosa	Wild yarm	1		
2		Menispermum canadense	moonseed	1		
3		Parthenocissus quinquefolia	Virginia creeper	1		
4		Vitis riparia	grape vine	1		

Woody deciduous (primarily seedling trees and shrubs)

	Non-Native	Scientific Name	Common Name	Cover*	Diam (in)	Comments
2	x	Caragana arborescens	Pea shrub	+		At entry - 3 ft
3		Carya cordiformes	bitternut hickory	+		
4		Celtis occidentalis	hackberry	1		
5	x	Lonicera tartarica	Tartarian honeysuckle	1		
6		Populus tremuloides	quaking aspen	+		
7		Prunus serotina	black cherry	1		
8		Prunus virginiana	choke cherry	1		
9		Quercus macrocarpa	bur oak	+		Seedlings but no saplings
10		Quercus rubra	red oak	+		
11	x	Rhamnus cathartica	common buckthorn	2		
12		Ribes cynosbati	gooseberry	1		
13		Rubus pubescens	dwarf raspberry	+		
14		Tilia americana	basswood	+		
15		Toxicodendron radicans	poison ivy	1		
16		Ulmus americana	American elm	1		
17		Zanthoxylum americana	prickly ash	1		

* Non-native species in red font are species that are also quite invasive and need to be managed.

** Relative Cover Classes for individual species and vegetation layers: + (0-1%), 1 (1-5%), 2 (5-25%), 3 (25-50%), 4 (50-75%), 5 (75-100%).

Grassland Species

Non-Native	Family	Scientific Name	Common Name	Cover*	Comments
Forbs					
x	Asteraceae	Arctium minus	burdock	3	Very dense on north & west edge
	Asclepiaceae	Asclepias syriaca	common milkweed	+	
x	Asteraceae	Cirsium arvense	canada thistle	2	
x	Asteraceae	Cirsium vulgare	bull thistle	1	
x	Fabaceae	Coronilla varia	crown vetch	2	
	Asteraceae	Erigeron strigosus	daisy fleabane	+	
x	Lamiaceae	Glechoma hederacea	creeping charlie	1	
x	Lamiaceae	Leonurus cardiaca	motherwort	1	
x	Fabaceae	Lotus corniculatus	birdsfoot trefoil	2	
x	Asteraceae	Plantago major	plantain	+	
x	Polygonaceae	Rumex crispus	curly dock	+	
	Asteraceae	Solidago canadensis	Canada goldenrod	2	
	Asteraceae	Solidago gigantea	late goldenrod	+	
	Asteraceae	Symphyotricum oolentangiensis	Sky-blue aster	+	
	Asteraceae	Symphyotricum pilosum	frost aster	2	
x	Asteraceae	Taraxacum officinale	dandelion	1	Abund on south edge
	Urticaceae	Urtica dioica	stinging nettle	+	
	Verbenaceae	Verbena hastata	Blue Vervain	1	
Graminoids					
	Poaceae	Andropogon gerardii	big bluestem	3	Dom
	Cyperaceae	Carex sp	tall sedge	1	
	Cyperaceae	Carex sp	sedge	1	
	Poaceae	Elymus canadensis	Canada Wild Rye	1	
	Poaceae	Elymus virginicus	Virginia Wild Rye	1	
x	Poaceae	Poa pratensis	Kentucky bluegrass	2	
	Poaceae	Sorghastrum nutans	Indian Grass	2	Dom
	Poaceae	Spartina pectinata	Prairie cordgrass	+	
Woody					
	Oleaceae	Fraxinus pennsylvanica	Green ash	+	Planted seedlings (2-3 ft)
	Juglandaceae	Juglans cinerea	Butternut	+	
	Fagaceae	Quercus macrocarpa	Bur oak	+	
	Roseaceae	Rosa arkansana	Prairie rose	+	
x	Ulmaceae	Ulmus pumila	Siberian elm	1	2-3 ft tall
	Vitaceae	Vitis riparia	Grapevine	1	

MHs38 - continued -

MESIC HARDWOOD FOREST SYSTEM
Southern Floristic Region

MHs38 Southern Mesic Oak-Basswood Forest — Species Frequency and Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Zigzag goldenrod *(Solidago flexicaulis)*	84	●●
Clayton's sweet cicely *(Osmorhiza claytonii)*	81	●
Bloodroot *(Sanguinaria canadensis)*	77	●
Large-flowered bellwort *(Uvularia grandiflora)*	73	●●
Lopseed *(Phryma leptostachya)*	65	●
Common enchanter's nightshade *(Circaea lutetiana)*	64	●
Early meadow-rue *(Thalictrum dioicum)*	63	●
Virginia waterleaf *(Hydrophyllum virginianum)*	63	●●●
Jack-in-the-pulpit *(Arisaema triphyllum)*	56	●
Erect, Smooth, or Illinois carrion-flower*	55	●
Wild geranium *(Geranium maculatum)*	55	●
Honewort *(Cryptotaenia canadensis)*	54	●
Wild sarsaparilla *(Aralia nudicaulis)*	54	●
Blue cohosh *(Caulophyllum thalictroides)*	53	●
Rattlesnake fern *(Botrychium virginianum)*	50	●
Lady fern *(Athyrium filix-femina)*	50	●
Yellow violet *(Viola pubescens)*	50	●
Common false Solomon's seal *(Smilacina racemosa)*	48	●
Maryland black snakeroot *(Sanicula marilandica)*	48	●
Pointed-leaved tick trefoil *(Desmodium glutinosum)*	47	●
Red baneberry *(Actaea rubra)*	46	●
Maidenhair fern *(Adiantum pedatum)*	44	●
Hog peanut *(Amphicarpaea bracteata)*	44	●
Wild ginger *(Asarum canadense)*	43	●●
Wood anemone *(Anemone quinquefolia)*	41	●
Sweet-scented bedstraw *(Galium triflorum)*	41	●
Sharp-lobed hepatica *(Anemone acutiloba)*	38	●
White avens *(Geum canadense)*	37	●
Canada mayflower *(Maianthemum canadense)*	37	●
Cleavers *(Galium aparine)*	34	●
Shining bedstraw *(Galium concinnum)*	31	●
Grasses & Sedges		
Pennsylvania sedge *(Carex pensylvanica)*	57	●●●
Starry sedge *(Carex rosea)*	41	●
Bland sedge *(Carex blanda)*	31	●
Bottlebrush grass *(Elymus hystrix)*	28	●
Long-stalked sedge *(Carex pedunculata)*	27	●●
Nodding fescue *(Festuca subverticillata)*	20	●
Bearded shorthusk *(Brachyelytrum erectum)*	19	●
Woody Vines		
Virginia creeper *(Parthenocissus spp.)*	80	●
Wild grape *(Vitis riparia)*	39	●
Shrubs		
Prickly gooseberry *(Ribes cynosbati)*	71	●
Chokecherry *(Prunus virginiana)*	64	●
Prickly ash *(Zanthoxylum americanum)*	57	●●
Poison ivy *(Toxicodendron rydbergii)*	57	●
Pagoda dogwood *(Cornus alternifolia)*	53	●
Missouri gooseberry *(Ribes missouriense)*	30	●●
Nannyberry *(Viburnum lentago)*	23	●
Downy arrowwood *(Viburnum rafinesquianum)*	22	●
American hazelnut *(Corylus americana)*	21	●●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Basswood	82	●●●	52	●●	73	●
Northern red oak	60	●●●●	11	●	52	●
Sugar maple	59	●●●●	60	●●●	65	●●●
Ironwood	42	●●●	84	●●●	70	●●
Green ash	36	●●●	16	●	38	●
Bur oak	33	●●●	-	-	18	●
White oak	30	●●●	-	-	9	●
American elm	27	●●	21	●●	32	●
Paper birch	20	●	-	-	-	-
Bitternut hickory	18	●●	26	●●	46	●
Red elm	16	●	19	●	34	●
White pine	12	●●●●	-	-	-	-
Black cherry	9	●	9	●	34	●
Blue beech	-	-	20	●●●	19	●

*Erect, Smooth, or Illinois carrion-flower *(Smilax ecirrata*, *S. herbacea*, or *S. illinoensis)*

UPs14 Southern Dry Savanna — Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Western ragweed *(Ambrosia psilostachya)*	80	●●
Virginia ground cherry *(Physalis virginiana)*	73	●
Hairy puccoon *(Lithospermum caroliniense)*	70	●
Gray goldenrod *(Solidago nemoralis)*	67	●
Hoary frostweed *(Helianthemum bicknellii)*	67	●
Horseweed *(Conyza canadensis)*	60	●
White sage *(Artemisia ludoviciana)*	53	●
Bearded birdfoot violet *(Viola palmata)*	53	●
Starry false Solomon's seal *(Smilacina stellata)*	47	●
Purple prairie clover *(Dalea purpurea)*	47	●
Common milkweed *(Asclepias syriaca)*	40	●
Long-headed thimbleweed *(Anemone cylindrica)*	40	●
Hoary puccoon *(Lithospermum canescens)*	40	●
Prairie pinweed *(Lechea stricta)*	33	●
Round-headed bush clover *(Lespedeza capitata)*	33	●
Skyblue aster *(Aster oolentangiensis)*	33	●
Rough blazing star *(Liatris aspera)*	33	●
Rock spikemoss *(Selaginella rupestris)*	30	●
Missouri goldenrod *(Solidago missouriensis)*	30	●
Bird's foot coreopsis *(Coreopsis palmata)*	30	●
Harebell *(Campanula rotundifolia)*	30	●
Hairy golden aster *(Chrysopsis villosa)*	30	●
Bastard toad-flax *(Comandra umbellata)*	30	●
Heath aster *(Aster ericoides)*	27	●
Showy goldenrod *(Solidago speciosa)*	27	●
Flowering spurge *(Euphorbia corollata)*	23	●
Mock pennyroyal *(Hedeoma hispida)*	23	●
Large-flowered beard tongue *(Penstemon grandiflorus)*	23	●
Erect, Smooth, or Illinois carrion-flower*	23	●
Tall cinquefoil *(Potentilla arguta)*	23	●
Stiff sunflower *(Helianthus pauciflorus)*	20	●●
Horsemint *(Monarda punctata)*	20	●●
Tall wormwood or Tarragon**	20	●
Silky prairie clover *(Dalea villosa)*	17	●

	freq%	cover
Grasses & Sedges		
Junegrass *(Koeleria pyramidata)*	80	●
Porcupine grass *(Stipa spartea)*	73	●●●
Little bluestem *(Schizachyrium scoparium)*	70	●●●
Big bluestem *(Andropogon gerardii)*	67	●●
Hay sedge *(Carex foenea)*	53	●●
Purple lovegrass *(Eragrostis spectabilis)*	53	●
Indian grass *(Sorghastrum nutans)*	40	●●●
Muhlenberg's sedge *(Carex muhlenbergia)*	37	●●
Pennsylvania sedge *(Carex pensylvanica* var. *pensylvanica)*	37	●●
Sand reed-grass *(Calamovilfa longifolia)*	37	●
Switchgrass *(Panicum virgatum)*	37	●
Prairie dropseed *(Sporobolus heterolepis)*	37	●●
Long-leaved panic grass *(Panicum perlongum)*	37	●
Scribner's panic grass *(Panicum oligosanthes)*	30	●●
Hairy grama *(Bouteloua hirsuta)*	30	●
Side-oats grama *(Bouteloua curtipendula)*	23	●●●
Fall witch grass *(Leptoloma cognatum)*	23	●
Woody Vines		
Virginia creeper *(Parthenocissus vitacea* or *P. quinquefolia)*	47	●
Semi-Shrubs		
Leadplant *(Amorpha canescens)*	53	●●
Prairie rose *(Rosa arkansana)*	43	●
Shrubs		
Chokecherry *(Prunus virginiana)*	50	●
American hazelnut *(Corylus americana)*	43	●
Smooth sumac *(Rhus glabra)*	40	●●
Low or Saskatoon juneberry *(Amelanchier humilis* or *A. alnifolia)*	37	●

Trees	Canopy		Shrub Layer	
	freq%	cover	freq%	cover
Bur oak	43	●●●	67	●
Northern pin oak	27	●●●	37	●
Black oak	23	●●●	23	●●
Jack Pine	17	●●●	17	●

*Erect, Smooth, or Illinois carrion-flower *(Smilax ecirrata*, *S. herbacea*, or *S. illinoensis)* **Tall wormwood or Tarragon *(Artemisia dracunculus* or *A. campestris)*

Appendix C: Potential Ecological Impacts

Disease

While there are multiple diseases that could impact the forest, the most significant are likely to be those that impact the oak trees, the dominant species at the site.

1. Oak Wilt

Oak wilt is a very serious fungal disease of oak trees that results in tree mortality. Once the oak wilt fungus becomes established in one tree, it can move through common root systems to adjacent trees of the same species—red oaks to other red oaks, and white oaks to other white oaks—thus the formation of an "infection center." Infection centers spread rapidly through red oaks and slowly through white oaks. Bur oaks are intermediate in spread rate.

Oak wilt can be controlled primarily through reducing and preventing the wounding of trees. When oak trees are wounded, they are more susceptible to oak wilt since beetles, which carry fungal spores on their bodies, are attracted to the scent of fresh wounds and become vectors of the disease. Storm damage can also result in potential infestations.

Overland spread of oak wilt by insects can be prevented by following these guidelines on when to prune and when to paint. During the high risk period, April, May and June, avoid wounding or pruning oaks. If trees are wounded or pruning is unavoidable, cover the wounds immediately or within minutes using one of the preferred materials such as water-based paint or shellac.

July through October is the low-risk period because the tree's vascular system begins shutting down and appears to be better able to prevent fungal growth. However, infections may rarely occur due to weather conditions and insect populations. Covering wounds is optional.

November through March is the safe period and the preferred time for pruning since the fungal pathogen and insect vectors are inactive.

If oak wilt is observed, the primary treatment method is to dig a double trench around the tree with a vibratory plow. This cuts through any root grafts with adjacent oak trees and prevents underground spread of the disease. A certified arborist would conduct this work.

2. Bur Oak Blight

Bur Oak Blight (BOB) is a relatively new fungal disease in Minnesota. This disease can kill trees, but moves much more slowly than does Oak Wilt. It only affects bur oaks. BOB seems to be influenced by the frequency of rainfall, with more rainfall resulting in conditions more suitable for the disease. Symptoms occur on leaves during July and August, with large, brown, wedge-shaped necrotic lesions forming. Sometimes leaf veins also turn brown. One of the best ways to diagnose the presence of this disease is by examining bur oaks during the winter. Normal bur oaks drop all their leaves during the winter. If the leaves are retained (even a few), this may indicate that the tree is infected with BOB. The disease overwinters in leaf petioles and spreads throughout the crown of the tree and potentially into other nearby trees over the span of several years. Mortality can result, but often trees that die are located next to ones that are

unaffected, so the rate of spread is relatively slow. There are injectable fungicide treatments that may help control of this disease. Periodic site-wide burning may also reduce the spore load, since many fallen leaves bear fungal spores.

Non-native and Over Populated Native Animals

A. Earthworms

No species of earthworms were native to the northern part of the U.S., since the last glaciation over 10,000 years ago. During the last century, "litter dwelling," "soil dwelling" and "deep burrowing" species of have been introduced - primarily as cast-off bait from anglers. Since then, they have become established and are very invasive in woodlands and forests. These species move into new areas in waves, one species following another, with ultimately the largest worms, night-crawlers, invading and becoming established. Earthworms have a very negative impact on native forest communities. As they tunneling into the top layers of soil they consume large amounts of leaf litter (duff). This results in soil compaction and a marked decrease in the duff layer, which is important for numerous plants and animals. Where there used to be several inches of the light, fluffy duff layer in native forests and woodlands, there is now only a trace or often none at all, with compacted, bare soil often prevalent. This situation results in increased erosion and nutrient runoff which is detrimental to lakes and streams. The lack of duff layer and soil compaction have negative ramifications on native forb populations, especially spring ephemerals which have evolved under conditions that required thick duff layers. The reduced duff also results in reduced populations of many native animals that rely on it, such as ovenbirds, salamanders and other species. In contrast, earthworm activity favors conditions for invasion by garlic mustard and common buckthorn.

B. White-tail Deer

Another factor of woodland decline is over-browsing/over-grazing. Areas that were pastured by cattle or sheep received heavy grazing pressure that was previously unknown. Native grazers (primarily bison and antelope) would move around and not concentrate in one area for long periods of time. This allowed for a very diverse forb layer to thrive. With the introduction of cattle in the last century and a half, that grazing pattern changed. Cattle will concentrate their grazing much longer and their impacts are much greater. Many of the native forbs simply cannot survive this new pressure.

Today, browsing by deer, not grazing, has a more significant negative impact on woodlands. Deer populations in the metropolitan area have greatly increased over the last century due to both direct and indirect causes. The conversion of native forest, woodland, savanna, and prairie first to agricultural land and then to more "suburbanized landscapes" have favored deer. Fragmentation of forests and managing for large gaps and residential lots with linear woodlands has greatly increased the suburban "edge effect." Deer prefer areas with large amounts of long, linear forest/woodland edge that can be used both as open areas to feed and wooded areas for cover. Active management for deer hunting by wildlife managers has also had a direct increase in deer abundance. Deer prefer to feed on many of the native forbs, shrubs, and tree seedlings. Although deer will eat buckthorn and honeysuckle, they do not prefer them if given the choice. This combination of factors greatly increases the browsing pressure on the few natives that can

survive earthworm and buckthorn. The lack of oak regeneration, typical of such woodlands, is one result of these conditions.

The synergistic effect of the three factors, fire suppression, earthworm infestation, buckthorn/honeysuckle invasion, and high deer browsing pressure has resulted in a situation of oak woodland decline. Although difficult to turn around, this decline can be ameliorated and possibly reversed, under appropriate management activities.

Climate Change

With the advent of global climate change, conditions for plant communities are changing. By the end of the century, scientists believe that much of the state of Minnesota will not be conducive for growth of boreal pine or boreal mixed forests. The climate of the Twin Cities will be more like that surrounding Sioux Falls, South Dakota, or that surrounding Oklahoma City. The state is expected to receive the same average amounts of precipitation or slightly more, but yearly distributions will be different. More rain is expected during the winter months and less rain during the summer months. The result will be a sort of "savannafication" of the region.

By facilitating the movement of plants from more southerly and westerly regions of Minnesota, degradation of natural areas may be able to be mitigated or averted. By promoting healthy oak woodland and oak savanna ecosystems, the potential negative shift from unsustainable land management expectations and serious loss of diversity can occur by focusing on strategies emphasizing resistance and resilience. Appropriate actions could "mimic," assist, or enable ongoing natural adaptive processes such as species dispersal and migration, population mortality and colonization, changes in species dominance and community composition, and changing disturbance regimes.

According to the DNR Wildlife Action Plan 2015-2025:

Climate change impacts anticipated for forested areas include: "Insect damage, larger blowdown areas, droughts, and fire are expected to interact, resulting in many forests, particularly ones on marginal soils, becoming savannas. Invasive species, including earthworms, may limit the establishment and growth of native tree seedlings and other understory plants (Galatowitsch et al. 2009).

Deciduous forests within the prairie-forest border are severely fragmented by agriculture and urban/ suburban sprawl. Should fragmentation increase, thereby creating smaller forest patches and increasing edge habitat, the ability of some plant and animal species to adapt to climate change could become progressively limited. Reasons for this include increased predation on wildlife, the spread of invasive species, and competition from other native species that prefer forest edge."

Appendix D: List of Noxious and Invasive Plants

Numerous annual, biennial or perennial plants have been designated by the Minnesota Commissioner of Agriculture as being injurious to public health and the environment. A few of the most common species are listed below. Bolded species have been found at Riverside Park. The site should be monitored regularly for any other species and control measures taken immediately if any are detected.

- Oriental Bittersweet: a fast-growing vine that overwhelms other plant communities.
- **Common or European Buckthorn**
- Glossy Buckthorn: a great threat to wetlands, where it can form dense stands that cause the growth of other species to be suppressed. It is also an alternative host to fungi that infects oats.
- **Tartarian Honeysuckle**: displace native plants in grassland, savanna, forest edges and open woodland.
- Multi-flora Rose: forms small to large infestations often climbing into trees, invades forest and forest margins.
- **Garlic Mustard:** significant negative impact on forest understory.

Additional specially regulated plants that have the potential to cause harm in non-controlled environments include:

- Giant Knotweed: forms dense stands where it can crowd out native vegetation.
- Japanese Knotweed: forms dense thickets that exclude native vegetation and greatly alters ecosystems.

The DNR also maintains a list of additional invasive, terrestrial plants, below. Bolded species were found at Riverside. All of these species are considered detrimental to native plant communities and should be managed, with the possible exception of creeping Charlie. Unless in a very localized area, this species is too pervasive to be able to control it. However, it does not tend to completely impede native species. Additional species that should also be managed, and were found at Riverside are: white mulberry, burdock, curly dock, and Kentucky bluegrass.

amur maple
amur silver grass
birdsfoot trefoil
black locust
black swallowwort
British yellowhead
bull thistle
butter and eggs
Canada thistle
common tansy
common teasel
cow vetch
creeping Charlie
crown vetch
cut-leaved teasel
dalmation toadflax
giant hogweed
Grecian foxglove
hairy vetch
hoary alyssum
Japanese barberry
Japanese hedge-parsley
Japanese hops
leafy spurge
meadow knapweed
musk thistle
narrowleaf bittercress
phragmites
Norway maple
orange hawkweed
oxeye daisy
perennial sow thistle
poison hemlock
purple loosestrife
Queen Ann's Lace
reed canary grass
Russian olive
Siberian elm
Siberian pea shrub
smooth brome grass
spotted knapweed
tree of heaven
white sweet clover
yellow sweet clover
wild parsnip
yellow iris
yellow star thistle

Appendix E: Methods for Controlling Non-native Invasive Woody Plant Species

Common Buckthorn, Tartarian Honeysuckle, Siberian Elm, and Black Locust are some of the most common woody species likely to invade native woodlands or prairies in Minnesota. Buckthorn and honeysuckle are European species that escaped urban landscapes and invaded woodlands in many parts of the country. They are exceedingly aggressive and, lacking natural disease and predators, can out-compete native species. Invasions result in a dense, impenetrable brush thicket that reduces native species diversity.

Siberian elm, native to eastern Asia, grows readily, especially in disturbed and low-nutrient soils with low moisture. Seed germination is high and seedlings establish quickly in sparse vegetation. It can invade and dominate disturbed areas in just a few years. Black locust is native to the southeastern United States and the very southeastern corner of Minnesota. It has been planted outside its natural range, and readily invades disturbed areas. It reproduces vigorously by root suckering and can form a monotypic stand.

Chemical Control

The most efficient way to remove woody plants that are 1/2 inch or more in diameter is to cut the stems close to the ground and treat the cut stumps with herbicide immediately after they are cut, when the stumps are fresh and the chemicals are most readily absorbed. Failure to treat the stumps will result in resprouting, creating much greater removal difficulty.

In non-freezing temperatures, a triclopyr herbicide such as Vastlan or Garlon 3a, or a glyphosate herbicide (e.g Roundup) can be used for most woody species, **except** legumes such as black locust. It is best to add a marker dye to make treated stumps more visible. In winter months, Garlon 4 is typically used, mixed with a penetrating oil. Diesel fuel should never be use as it is more toxic in the environment and for humans. Garlon 4 will cause a "kill-ring" and should only be used at very degraded sites. Garlon 4 should NOT be use at Riverside Park due to the sensitivity of the groundwater to contamination and the potential for high quality herbaceous plants. For plants in the pea family, such as black locust, an herbicide with the active ingredient clopyralid can be more effective than glyphosate. Common brand names for clopyralid herbicides are Transline, Stinger, and Reclaim.

FMR recommends using foam or dauber type applicators to apply herbicide. These methods eliminates overspray, reduces chemical use, and increases the chemical efficacy as more chemical goes into the plant.

Ideal weather conditions for herbicide work are during the growing season (when the plants are biologically active) and especially when soil moisture levels are low. Some studies have shown that when soil moisture is high, herbicide is more likely to move out of the roots of the treated plant into the soil, potentially having lethal effects on nearby plants and simultaneously sub-lethal effects on the treated plant (Dornbos & Pruim 2012). Fall is typically the best time for buckthorn removal work because they retain their leaves longer than any other woody plant so it is very easy to locate them. Fall is also a good time for most other woody plant control as it is easier to move through the woods, native plants are dormant so impacts to them are minimal.

Most material will be cut with brush cutters and chainsaws, used only by properly trained professionals.

In the year following initial cutting and stump treatment, there will be a flush of new seedlings as well as resprouting from some of the cut plants. A foliar application of herbicide is a common treatment approach, typically done in fall, when desirable native plants are dormant and when the plant is pulling resources from the leaves down into the roots. However, this method will affect native herbaceous plants and may cause significant mortality. It should **NOT** be used in high quality locations unless specific methodology is approved, such as foam application on very dense stands or use of a wick applicator. Krenite (active ingredient – fosamine ammonium) is an herbicide used in fall to prevents bud formation in the spring. This herbicide can be effective, but results are highly variable. Glyphosate or a triclopyr herbicide such as Garlon can also be used. Glyphosate is non-specific and will kill anything green and should not be used for foliar treatment if there are any desirable native plants. Triclopyr targets broadleaf plants and does not harm graminoids. However, it can have negative impacts on native plants even when applied during dormancy. All herbicides should be applied by licensed applicators and should not be applied on windy days. Care should be taken to avoid application to other plants.

Large, undesirable trees and shrubs can also be destroyed without cutting them down. Girdling is a method suitable when there are small numbers of large trees. Bark is removed in a band around the tree, just to the outside of the wood. If girdled too deeply, the tree will respond by resprouting from the roots. Alternatively, two girdle rings are cut around a tree, the herbicide is applied. Girdled trees die slowly over the course of one to two years. Girdling should be done in late spring to mid-summer when sap is flowing and the bark easily peels away from the sapwood.

Basal bark herbicide treatment is another effective control method. A triclopyr herbicide such as 10% Garlon 4, mixed with a penetrating oil, is applied all around the base of the tree or shrub, taking care to minimize overspray or run off. This method typically causes a significant “kill ring” and should NOT be used at Riverside.

Mechanical Control

Mechanical methods for woody plant removal include hand-pulling, weed wrenching, forestry mowing, repeated cutting and browsing.

Weed-wrenching and hand-pulling are similar, except hand-pulling requires no tools (optional use of a pliers) and is suitable for seedlings or very small saplings (less than 3 ft tall), whereas weed wrenches involve use of a weed extracting tool and is used on larger plants, up to about 2-inches diameter. Both methods can be done any time when the soil is moist and not frozen. Disadvantages to both methods they are time-consuming and require that the dirt be shaken off each plant that is pulled. They also, especially weed wrenching, create a great deal of soil disturbance and should not be used on steep slopes or anywhere that desirable native forbs are growing. The soil disturbance also creates opportunities for weed germination. This method is best used in areas that have very little desirable native plant cover. It could be used at Riverside as a good volunteer activity to remove seedling plants in disturbed areas.

Forestry mowers are large machines that essentially grind everything in their path. The mower can be set at different heights, and can cut at or just below the surface of the soil. It is important to mow as LOW as possible because it destroys the root collar where resprouting occurs. But even at slightly high cutting heights, the mower tends to shatter the stems and can be a very effective tool for significantly reducing buckthorn levels. The mulch from mowing also serves to suppress new buckthorn seedlings and can dramatically reduce the seedling "carpet" that typically happens after large plants are removed. The mower is best used on frozen soils to reduce impacts. At Riverside, a mower would be most effective in areas where buckthorn is small (e.g. less than ½-inch diameter at the base). A typical approach is to hand-cut and treat larger stems, then forestry mow smaller stems. Use of the mower typically requires follow-up foliar application, which can have negative impacts on native plants.

Repeated cutting is another potential control method. It consists of cutting the plants (by hand or with a brush cutter) at critical stages in the growth cycle. Cutting in mid spring (late May) intercepts the flow of nutrients from the roots to the leaves. Re-cutting in fall (about late September) intercepts the flow of nutrients from the leaves to the roots. Depending on the size of the stem and other factors such as weather conditions and the amount of available light, many plants may die within a few years, with two cuttings per year. However, this method is costly and requires diligence in precise timing.

Using of browsing animals, especially goats, is another means of control. This is best used on small stems – 4 ft or less. Goats primarily defoliate the stems, weakening the plant. If the plants are small and this is done repeatedly (ideally twice a year), this method can significantly reduce the invasive plant over time. However, there are several limitations to the use of goats, including the fact that they do not discriminate between desirable native plants and undesirable non-native plants; they eat everything in sight. It is also a costly method as many years of browsing are needed and results are variable. For these reasons, we do not recommend this method at Riverside.

Stems, Seedlings and Re-sprouts

Prescribed burning is the most efficient, cost effective, and least harmful way to control very small stems, seedlings, and resprouts of all woody plants. It also restores an important natural process to fire-dependant natural communities (oak forests, for example). Burning can only be accomplished if adequate fuel (leaf litter) is present and can be done in late fall or early spring, depending site conditions. Burning will primarily kill small seedling – first year plants. It will top-kill larger plants, but also weakens them, making them easier to control with other methods, such as follow-up mow or foliar herbicide.

Torching can also be used as an alternative to prescribed burning. While effective, it is not cost effective for sites with dense buckthorn.

If burning is not feasible, critical cutting and/or foliar application are alternatives. Or do nothing and re-cut/treat new growth in 3-5 years.

Disposal

Stack and burn: One of the easiest and most cost-effective method to handle large amounts of brush is usually to stack it and burn it in winter.

Cut and let lie: In areas where brush is not dense, it can be cut up into smaller pieces and left on the ground where it will decompose in one to three years. This method is especially useful on slopes to reduce erosion potential. As Riverside is a very visible public park we would recommend generally avoiding this method.

Rot piles: Small brush piles (e.g. 8 ft tall or less, similar length & width) can also be left in the woods as wildlife cover. This should be used as a supplement to other methods, and there should not be more than a 2-3 piles per acre. Again, with the public use at Riverside, we recommend minimal rot piles, but it may be cost effective for some of the fringe areas of the park.

Biofuels: At some sites where there is an abundance of tree removal and good access, cut trees may be hauled and chipped and used for mulch or as a biofuel. This method is not suitable for Riverside.

Haul and chip: Brush can be hauled off the site and either chipped on-site or off-site. If chipped on-site it can be blown back into the woods as long as the chip is spread around so it's not more than 2 inches thick. This allows native plants to push through, but is also effective as suppressing buckthorn seedlings from germinating. Brush can also be chipped (on or off-site) and disposed of at a compost facility. The latter is an excellent option at Riverside.