HARTLEY NATURAL AREA

NATIVE PLANT COMMUNITY MANAGEMENT PLAN

PREPARED FOR

CITY OF DULUTH

PREPARED BY

APPLIED ECOLOGICAL SERVICES, INC.

DRAFT - NOVEMBER 11, 2020

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Table of Contents

List of Figures

List of Tables

List of Appendices

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EXECUTIVE SUMMARY

The Hartley Natural Area (including most of Hartley Park) and Hartley Nature Center represent approximately 684 acres of forests and woodland, a pine grove, conifer plantations, various types of wetlands, and vernal pools. Tischer Creek flows through the site from the northwest to the east, and an impoundment creates Hartley Pond. Hartley Nature Center is one of the City of Duluth's most cherished parks in which the facilities, educational offerings, and various recreational uses are enjoyed by many residents, students, and visitors year round.

Prior to creation of the Hartley Natural Area, Hartley Park had already been formally dedicated by City Council to ecological restoration and environmental education in a manner and to an extent that is unique; this is clearly defined in the Hartley Park Master Plan (2014) and the City of Duluth's agreement with Hartley Nature Center. With this in mind, and through discussions with the City of Duluth and other stakeholders, the following goals have been established for the site's native plant communities:

- Protect and enhance the ecological function of native forests, woodlands, meadows, and wetlands through active restoration and management;
- Provide opportunities for public access to enjoy and engage in natural resource protection, restoration, and management;
- Per the Hartley Park Master Plan (2014), the project purpose is to help establish a framework for implementing improvements and managing resources within Hartley Park with natural resource goals that:
    - preserve and enhance the distinctive character of Hartley Park as a unique place both locally within Duluth and the greater region, and
    - restore natural ecological processes within the Park's diverse landscapes
- Per the Hartley Nature Center Park Stewardship Plan (2011), ensure future development projects do not:
    - increase the presence of invasive species,
    - decrease the diversity of native flora or fauna,
    - degrade the quality of established native plant communities, and
    - negatively affect the quality of nearby waterways.

This Hartley Native Plant Community Management Plan is a guide for vegetation management over the coming decade. The Plan describes the site's natural resources and existing ecological conditions, and lays out a framework, tasks, priority projects, estimated costs, and schedule for elevating the Park's native plant communities to a higher level of ecological health and resilience. Increased funding, monitoring, reporting, and long-term management will be critical to this Plan's success.

Well-trained City and HNC staff—assisted by volunteers, partners, and professional contractors—will work together to carry out elements of the Plan over the coming years. Results will be reported and evaluated at least every three years or as deemed necessary; the Plan will be updated in accordance with the reports and evaluations at least every five years. In this way, Hartley Natural Area will become

a more healthy and resilient complex of native ecosystems. The fruits of these efforts will be passed on to future generations for the enjoyment of all and the benefit of nature.

1. INTRODUCTION

1.1 Road Map to This Plan

The City of Duluth has committed to the ecological restoration and environmental education in Hartley Park well before the Hartley Natural Area was established under the Duluth Natural Areas Program. This is clearly defined in the Hartley Park Master Plan (2014) and the City of Duluth's agreement with Hartley Nature Center. The effective programmatic utilization of Hartley Park to educate people about ecological restoration is on a greater scale than anywhere else in the City because the City is achieving a double benefit often referred to by the Izaak Walton League as, "*Connect and Protect*". This means the City and its' funders are able to show a greater return on financial investment in restoring and managing Hartley for its' natural resources.

This Hartley Native Plant Community Management Plan (Plan) is a guide for vegetation management over the coming decade in Hartley Natural Area located in Duluth, Minnesota. The Introduction provides a brief overview of the site, the general setting, related plans, and management goals for the site's native plant communities. The Assessment describes the ecological setting of the area and summarizes some of the natural resources inventory findings from the recent *Management Plan for the Hartley Natural Area* (Minnesota Land Trust, 2019) which provided a foundation for the development of this Plan.

Considering the Hartley Natural Area project goals and assessment work to date, this Plan lays out a vision for what the site's native plant communities could become if properly restored and managed. The Implementation section presents restoration and management terminology, a general approach, and specific tasks to be conducted (e.g., removal of invasive species, planting of native vegetation). Management units are presented to help refine work areas, along with recent or ongoing management projects at the site. Priority projects are then described along with opinions of probable cost to implement the prioritized restoration and on-going management tasks. A phasing plan is included as a suggestion for implementation over a ten-year timeframe.

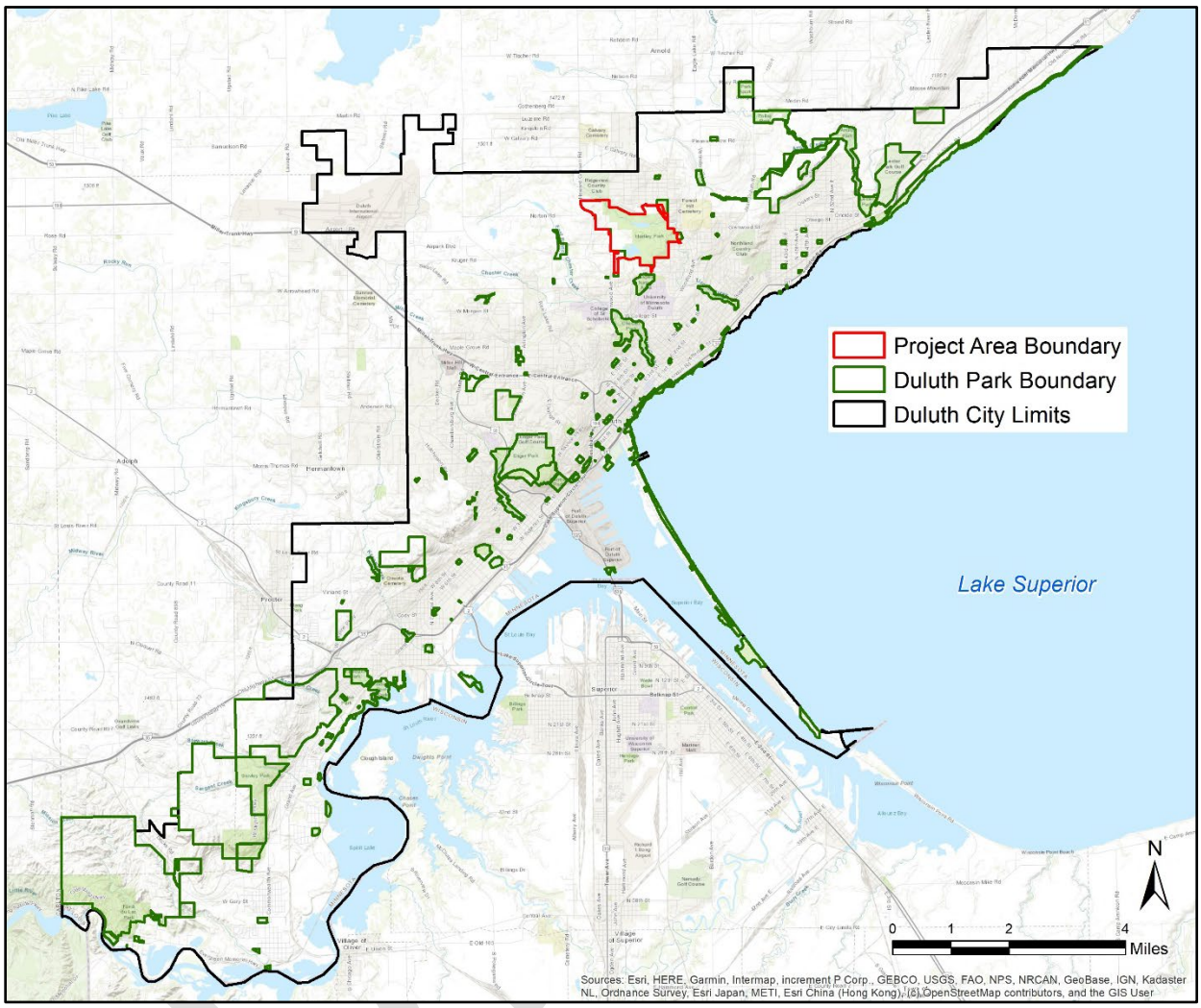
To assist with implementation, a prioritized list of recommended funding sources appropriate for restoration and management of the site's vegetation is provided along with monitoring and reporting recommendations to document change over time, gauge the success of management, and guide adaptations. Information is also provided on how the City and Hartley Nature Center have utilized volunteers to advance native vegetation goals, and how partnerships and ecological contractors can further assist in achieving those goals. The Plan should be reviewed and updated as often as necessary to provide direction and strategies into the future.

1.2 Site Overview

The Project Area is located in the north-central portion of the City of Duluth, St. Louis County, Minnesota (Figure 1). As one of City's premier natural areas, 620 acres have been recognized as the "Hartley Natural Area" (HNA) under the Duluth Natural Areas Program (DNAP). A portion of Woodland Recreation Area (on the northeast side of Woodland Avenue) is included within the HNA. The Project Area addressed by this Plan contains all of the HNA as well as adjacent parkland (including Hartley Nature Center). In this Plan, the Project Area is sometimes referred to simply as the HNA, but it includes

some areas outside the HNA where work has been completed in the past and for the protection of the HNA.

Figure 1. Location of Hartley Natural Area



The Project Area is characterized by:

- Over 620 acres, including forests and woodland, a pine grove, conifer plantations, various types of wetlands, and vernal pools
- Tischer Creek
- Hartley Pond (an impoundment in Tischer Creek)
- Hartley Nature Center
- Ten miles of multi-purpose trails

1.3 Related Planning Work & Information

The following plans and studies related to the HNA were compiled and reviewed for this project:

- City of Duluth Pine Thinning Project (City of Duluth, 2020)
- Management Plan for the Hartley Natural Area (Minnesota Land Trust, 2019)
- Plant Communities of Hartley Park (Reschke et al, 2019)
- Buckthorn and Restoration Management Plan for Hartley Park (Prairie Restorations, Inc., 2017)
- Duluth Traverse Mini Master Plan (City of Duluth, 2017)
- Duluth Cross Country Ski Trail Master Plan (Gary Larson Sports LLC, 2015)
- Evaluating Vital, Small Forested Wetlands (UMD-NRRI, 2015)
- Hartley Park Master Plan (SRF Consulting Group, Inc. et al, 2014)
- Tracking Buckthorn in Hartley Park (City of Duluth, 2014)
- Hartley Nature Center Park Stewardship Plan (Hartley Nature Center Park Stewardship Committee, 2011)

Several of these plans were developed using an inclusive public engagement process that provided valuable information about HNA stakeholders including how they use the park and feedback on potential changes related to restoration and park use. This Native Plant Community Management Plan is a technical, internal guidance document specific to City and HNC use to help manage vegetation with their partners; it is driven by the outcome of Hartley as a Duluth Natural Area. Therefore, public outreach was limited to an informational flyer about the project (posted on the City's and HNC's website and announced at several Natural Resource Commission meetings). On October 21, 2020, a stakeholder meeting was held via Zoom because of the Covid-19 pandemic. This public engagement, along with the Natural Resource Commission meetings, informed the public and stakeholders about this project and confirmed alignment with the Plan's direction.

1.4 Native Plant Community Management Goals

The HNA is a long-treasured area, valued by the community, and yet, greatly changed by anthropogenic forces over the last 150 years. Establishing native plant community goals for the site helps guide restoration and management planning. Through discussions with the City of Duluth and other stakeholders, the following goals have been established for the site's native plant communities:

- Protect and enhance the ecological function of native forests, woodlands, meadows, and wetlands through active restoration and management;
- Provide opportunities for public access to enjoy and engage in natural resource protection, restoration, and management; and
- Per the Hartley Park Master Plan (2014), the project purpose is to help establish a framework for implementing improvements and managing resources within Hartley Park with natural resource goals that:
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- Per the Hartley Nature Center Park Stewardship Plan (2011), ensure future development projects do not:
    - increase the presence of invasive species,
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2. ASSESSMENT

2.1 Landscape Context

A site's location provides insights into its natural resources—what they were, what they are today, and what they have the potential to become. Adjacent and nearby lands and waters can affect a site's vegetation, water, and wildlife, and may present opportunities to enlarge or better connect habitats.

2.1.1 Ecological Subsection

According to the Minnesota Department of Natural Resources' (MNDNR's) Ecological Classification System (MNDNR 2020a), Hartley Natural Area is located in the North Shore Highlands Ecological Subsection; this Subsection is within the Northern Superior Uplands Section, which lies within the Laurentian Mixed Forest Province. A description of the North Shore Highlands Ecological Subsection follows (adapted from MNDNR 2020a):

Overview

The boundary of this subsection follows the Highland Moraine along Lake Superior. In general, the boundary parallels the shore about 20 to 25 miles inland. This subsection occupies the area adjacent to Lake Superior. It is gently rolling to steep. Bedrock outcroppings are common and soils are commonly shallow. Soils are formed in red and brown glacial till and are very rocky. Lake Superior dominates this region. It moderates the climate throughout the year, acting as an air conditioner in summer and a heat source in winter. Presettlement vegetation was forest, consisting of white pine, red pine, jack pine, balsam fir, white spruce, and aspen-birch. Present land uses include recreation, tourism and forestry.

Landform

Ground moraine and end moraine of the Superior lobe cover much of the subsection (Hobbs and Goebel, 1982). Clay lake plain forms a broad band along the Lake Superior shoreline in the southern half of the subsection. The clay plain is flat to rolling, with steep, narrow ravines along many streams. There are also outwash deposits along the western edge of the subsection.

Bedrock geology

Glacial drift is thin over the entire subsection and bedrock is exposed or near the surface in large areas. The underlying bedrock consists of Upper Precambrian (Middle Proterozoic) basalt, rhyolite, gabbro, diabase, anorthosite, granite, sandstone, and shale (Morey 1976).

Soils

The soils are developed from rocky, red tills of the Superior Iobe. Textures range from sand to clay (Hobbs and Goebel 1982). Loams and sandy loams are the most common soil textures on the moraines, which occupy most of the subsection. The Highland Flutes, along the eastern edge of the subsection, have a predominance of thin soils over bedrock and clayey soils (Dept. of Soil Science, Univ. of Minnesota 1981b). The Nemadji-Duluth Lacustrine Plain has about 95% clayey soils. The

most common soils in the subsection are classified as Orthents, Ochrepts, and Boralfs (Anderson and Grigal 1984).

Climate

Total annual precipitation ranges from 28 to 30 inches, about 40% of which occurs during the growing season. The growing season ranges from approximately 121 to 135 days, with the longest growing season along the shore of Lake Superior. The growing season on Lake Superior is about 10 days longer than at the equivalent latitude 6 miles inland (Dept. of Soil Science, Univ. of Minnesota 1981b). Lake effect increases the amount of snowfall by about 10 inches within 5 miles of the Lake Superior shoreline, but a similar trend is not apparent in the annual precipitation data (Albert 1995).

Hydrology

Lakes make up about only two to three percent of the subsection. Numerous short streams, 10-15 miles long, lead directly from the highland to the shores of Lake Superior. Most of them have water falls near the shoreline (Wright 1972).

Presettlement vegetation

Marschner (1974) recorded aspen-birch forest, white pine-red pine forest, mixed hardwood-pine forest, and conifer bogs and swamps. White pine-red pine forest was most common on the clay lake plain and on thin soil over bedrock in the southern half of the subsection. Mixed hardwood-pine forest, with sugar maple, was concentrated on the ridges of the dissected clay lake plain and the Highland Flutes. In the northern half of the subsection, aspen-birch was dominant, with very little white pine-red pine forest or mixed hardwood-pine forest. Mixed hardwood-pine forest persisted on ridgetops in areas within 6-10 miles of the shoreline.

Present vegetation and land use

Almost the entire subsection remains forested, with forest management and recreation as the major land uses. Following logging, the extensive white pine-red pine forests have been replaced by forests of quaking aspen-paper birch. Tourism and mining are the other important land uses. There are no mines within the subsection, but ports were set up to get ore from the iron range to steel mills in Indiana and Ohio. The city of Duluth has a large port area and ships significant amounts of agricultural commodities, as well as iron ore.

Natural disturbance

Fire was an important disturbance. This is readily apparent in the northern half of the subsection, where there was a dominance of aspen-birch stands, which are pioneer species. Spruce budworm defoliation was and continues to be a significant disturbance to stands of balsam fir and spruce.

2.1.2 Adjacent Land Uses

Adjacent land uses have significant effects on natural areas. The majority of the land surrounding the HNA consists of suburban development, including a golf course (Ridgeview Country Club), which lies just north of the northwest portion of the HNA. These land uses can adversely affect natural areas by:

- Isolating a natural area from other nearby natural areas; this results in regional habitat fragmentation;
- Introducing invasive species and pests from the surrounding landscape;
- Acting as a source of predators, such as domestic cats, that kill native wildlife, especially birds and small mammals; and
- Contributing suburban stormwater runoff into Tischer Creek and other site drainageways, conveying pollution, sediment, and nutrients into site wetlands, Hartley Pond, and downstream water resources.

Woodland Avenue, a well-travelled road, separates Hartley Park (on the southwest) from adjacent Woodland Recreation Area (to the northeast). This roadway presents a threat to crossing wildlife and its noise can affect the nesting density of territorial songbirds.

These influences from outside the HNA are known to reduce the variety of species—biodiversity—in natural areas and reduce the overall level of ecosystem services generated at a site. Fortunately, low density residential development exists along most of the site's west edge, and a natural corridor extends northwest of the HNA. These low-intensity adjacent land uses have fewer negative "edge effects" that harm natural areas and they provide some degree of connectivity to other nearby natural lands.

2.2 Site Conditions

2.2.1 Plant Communities

Plant communities are an expression of many factors: climate, soils, hydrology, land use history, disturbance regimes, etc. Marschner's pre-European settlement mapping of Minnesota (1974) identified the HNA as "Mixed Hardwood and Pine (Maple, White Pine, Basswood, etc.)". Silt loam soils provided the substrate for these upland forests to thrive, while lower elevations and depressions (containing muck soils) likely harbored shrub swamps and wet meadows.

Plant communities are often divided into "native" plant communities (natural communities characterized by native plants and representative of historical vegetation assemblages) and "cultural" or "non-native" communities (typically dominated by non-native species and/or representative of a human-altered or -maintained landscape). The term "cultural" does not refer to areas of historical/cultural significance. The site's native plant communities are the focus of this management plan.

The following text and table were taken from the *Management Plan for the Hartley Natural Area* (Minnesota Land Trust, 2019):

> In the summer of 2019, researchers from University of Minnesota - Natural Resources Research Institute (UMD-NRRI) completed plant surveys for the entire natural area, using drone imagery and field surveys (Reschke et al 2019). This work built on the plant surveys conducted by Perry (2004).

A total of 23 native plant communities (NPCs) were identified in Hartley Natural Area according to Minnesota Department of Natural Resources' (MNDNR's) 2005 *Field Guide to Native Plant Communities of Minnesota* in 124 distinct polygons (Figure 2; Table 1).

Figure 2. Native Plant Communities of Hartley Natural Area

(from *Management Plan for the Hartley Natural Area*, Minnesota Land Trust, 2019) *Note: Native Plant Communities that extend outside the HNA are subject to change due to development. This Plan is intended to address areas only within the HNA for preservation and protection.*

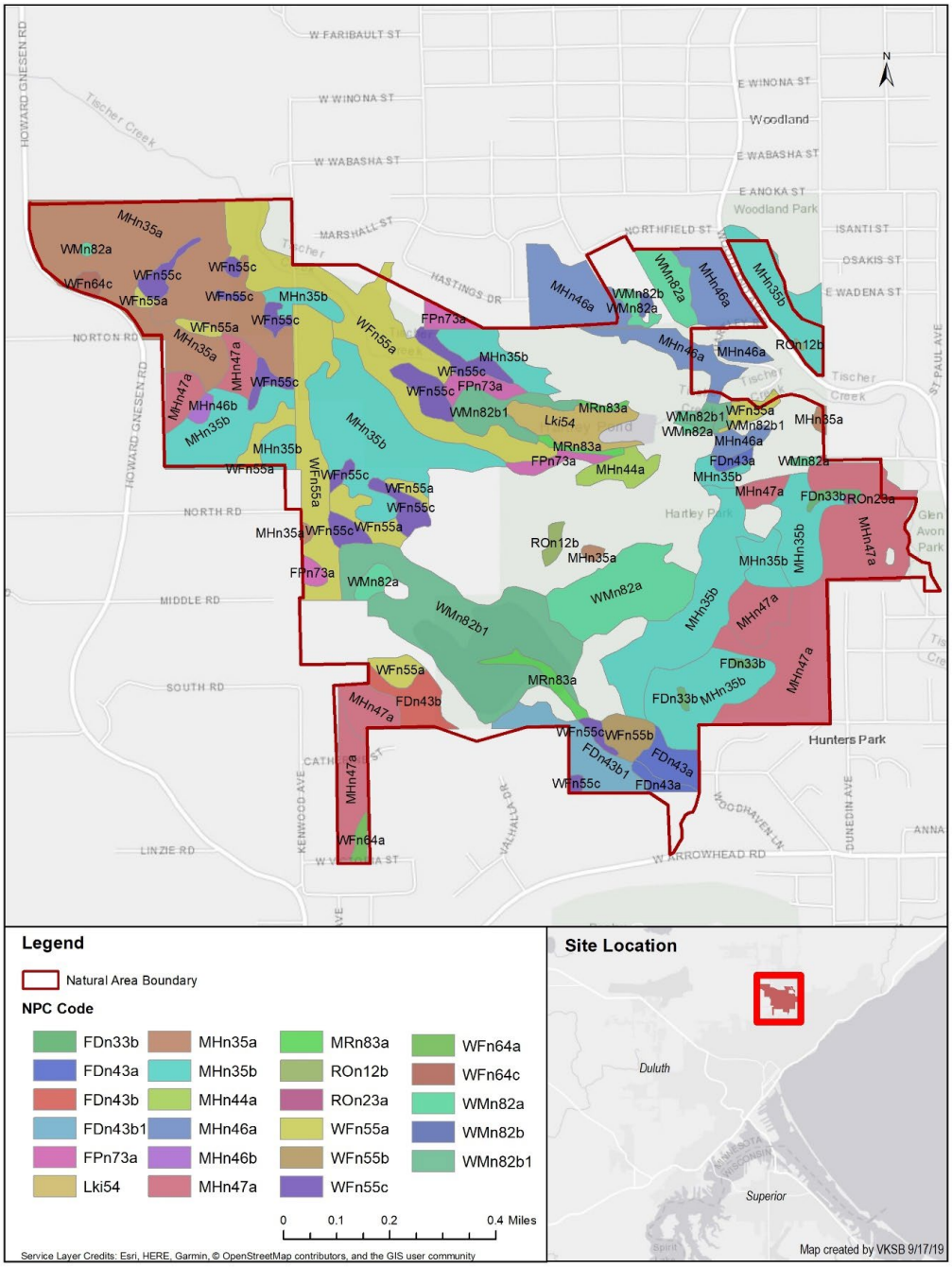


Table 1. Native Plant Communities in the Hartley Natural Area

(from *Management Plan for the Hartley Natural Area*, Minnesota Land Trust 2019)

System	Subtype Description	Subtype Code	S-Rank	Condition Rank (range)	Area (Acres)
Fire-Dependent Forest/Woodland	Aspen - Birch Woodland	FDn33b	S5	B-CD	1.9
	White Pine - Red Pine Forest	FDn43a	S2	C-CD	7.6
	Aspen – Birch Forest	FDn43b	S5	C	6.0
	Aspen - Birch Forest, Balsam Fir Subtype	FDn43b1	S5	C	10.3
Mesic Hardwood Forest	Aspen - Birch - Basswood Forest	MHn35a	S4	BC-D	60.2
	Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest	MHn35b	S4	BC-CD	128.7
	Aspen - Birch - Red Maple Forest	MHn44a	S4	D	4.4
	Aspen - Ash Forest	MHn46a	S4	D	34.8
	Black Ash - Basswood Forest	MHn46b	S4	C	1.1
	Sugar Maple - Basswood - (Bluebead Lily) Forest	MHn47a	S3	BC-CD	73.8
Rock Outcrop	Crystalline Bedrock Outcrop (Northern)	ROn12b	S4	C	1.5
	Bedrock Shrubland (Inland)	ROn23a	S3	D	0.3
Forested Rich Peatland	Alder Swamp	FPn73a	S5	C-D	8.6
Wet Forest	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	WFn55a	S4	C-D	65.7
	Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral)	WFn55b	S3	CD	4.1
	Black Ash - Mountain Maple Swamp	WFn55c	S4	BC-D	21.8
	Black Ash - Conifer Swamp	WFn64a	S4	C	1.3
	Black Ash - Alder Swamp (Northern)	WFn64c	S4	C	1.4
Marsh	Cattail - Sedge Marsh (Northern)	MRn83a	S2	C-D	4.5
Wet Meadow/Carr	Willow Dogwood Shrub Swamp	WMn82a	S5	B-C	30.9
	Sedge Meadow	WMn82b	S4 or S5	D	0.6
	Sedge Meadow, Bluejoint Subtype	WMn82b1	S5	B-D	51.8
Lakeshore System	Inland Lake Clay/Mud Shore	Lki54	S4	C	8.6

Excerpt from *Management Plan for the Hartley Natural Area* (Minnesota Land Trust 2019) continued:

Condition ranks were assigned to each polygon according to the ranking specific to each community. In general, the condition ranks can be characterized as follows:

A = Outstanding
B = Very high quality; only slight disturbance
BC = High quality; significant signs of human disturbance
C = Altered, but with appropriate management, recovery within 50-100 years is expected
CD = Between C and D
D = Severely degraded; recovery will require active restoration

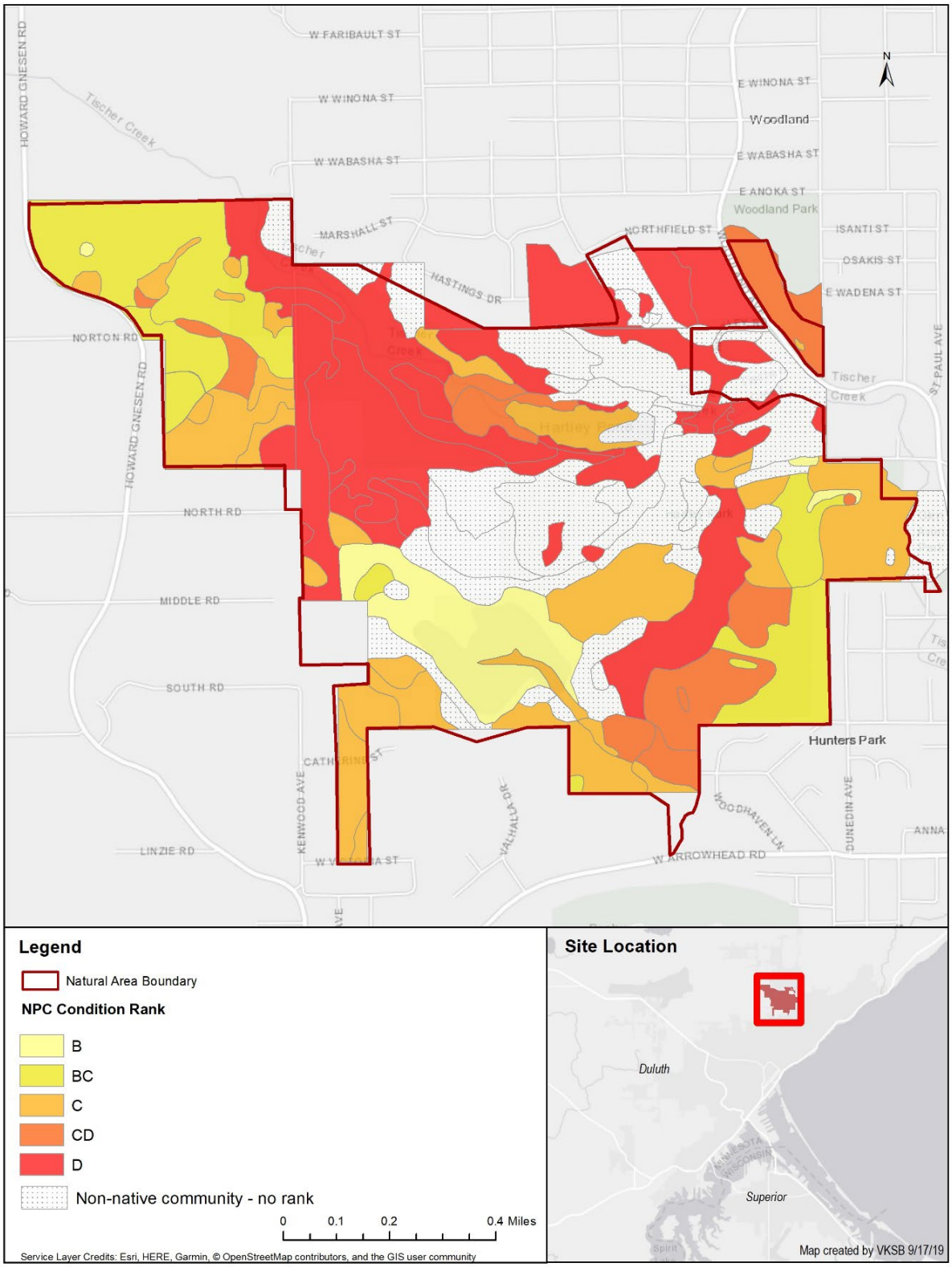
Condition ranks for the NPCs are shown in Figure [3], with the range of conditions seen across the natural area for each NPC provided in Table 1. In most instances, NPCs identified as severely degraded (condition rank D) had an abundance of non-native species present (Reschke et al, 2019).

NPC types and subtypes have been assigned conservation status ranks (S-ranks) that reflect the risk of elimination of the community from Minnesota (MNDNR, 2009). The five ranks are:

S1 = critically imperiled
S2 = imperiled
S3 = vulnerable to extirpation
S4 = apparently secure; uncommon but not rare
S5 = secure, common, widespread, and abundant

The S-ranks for the 23 NPCs found in Hartley Natural Area are given in Table 1. The majority of NPCs in the natural area rank as apparently secure (S4) or secure (S5). Two communities, White Pine – Red Pine Forest (FDn43a) and Cattail – Sedge Marsh (Northern) (MRn83a), rank as imperiled, while three communities rank as vulnerable to extirpation (Sugar Maple – Basswood (Bluebead Lily) Forest, MHn47a; Bedrock Shrubland (Inland), ROn23a; and Black Ash – Yellow Birch – Red Maple – Basswood Swamp (Eastcentral), WFn55b).

Figure 3. Condition Ranks of Native Plant Communities in the Hartley Natural Area
(from *Management Plan for the Hartley Natural Area*, Minnesota Land Trust 2019)



Cultural or Non-Native Plant Community Types

The following text was adapted from the *Management Plan for the Hartley Natural Area* (Minnesota Land Trust, 2019):

> The 2019 survey defined five cultural or non-native plant community types: conifer plantation (red pine or jack pine), non-native forest/woodland (European mountain ash), non-native shrubland (wet, wet mesic, and upland), non-native grassland, and non-native other (ball park, buildings, pavement, dam, and gravel). These community types cover 167.9 acres of the surveyed area [see white and gray areas in Figure 2]. Descriptions of the vegetated non-native plant community types are as follows (Reschke, 2019):
>
> *Conifer Plantation - 51.5 acres*
> In Hartley the conifer plantations are forests dominated by either red pine or jack pine, with the pines planted in rows, often close together. Common shrubs in the understory include glossy buckthorn, European mountain ash, beaked hazelnut, dwarf raspberry, and red raspberry.
>
> *European Mountain-ash Forest - 1.3 acres*
> This one polygon is a forest dominated by European Mountain-ash, with a few yellow birch. Understory shrubs include glossy buckthorn, red raspberry, choke cherry, and beaked hazelnut.
>
> *Non-native Grassland - 10.4 acres*
> These polygons are grassy meadows or old fields often dominated by reed canary grass, with tansy, Canada thistle, valerian, glossy buckthorn, and buckthorn mixed in.
>
> *Upland Non-native Shrubland - 53.2 acres*
> These polygons are upland shrublands dominated by glossy buckthorn and buckthorn. This type has been split into two subtypes based on soil moisture: Mesic Non-native Shrubland (C4a) and Wet-mesic Non-native Shrubland (C4b).
>
> *Wetland Non-native Shrubland - 33.1 acres*
> These polygons are wetlands dominated by glossy buckthorn and buckthorn, with some speckled alder and sapling black ash present. Reed canary grass is often present.

2.2.2 Water Resources

Surface waters provide habitat for many species of fish, amphibians, reptiles, birds, clams, and aquatic insects. They include rivers, lakes, streams, ponds, and wetlands. Natural water features within the HNA include Tischer Creek and its tributaries, lowland forests and swamps, wet meadows and shrub carrs, and numerous vernal pools. Water resources are not the focus of this Native Plant Community Management Plan, but lowland and wetland plant communities are addressed. Additional information regarding the site's water resources can be found in the *Management Plan for the Hartley Natural Area* (Minnesota Land Trust 2019).

2.2.3 Invasive Plants

Invasive plants often establish and thrive in disturbed habitat, usually crowding out native plants and altering the habitat in damaging ways. Removing these aggressive species is a major management activity of natural resources programs. Primary plants of concern at the HNA include invasive Glossy buckthorn (*Frangula alnus*), Common buckthorn (*Rhamnus cathartica*), invasive Honeysuckles (*Lonicera* spp), Tansy (*Tanacetum vulgare*), Wild Parsnip (*Pastinaca sativa*), Garlic Mustard (*Alliaria petiolata*), Japanese Knotweed (*Fallopia Japonica* var. *japonica*), and Purple Loosestrife (*Lythrum salicaria*). Reschke et al (2019) identified a total of 44 invasive species present in the HNA (Table 2).

Table 2. Invasive Plant Species Found in Hartley Natural Area (Reschke et al, 2019)

Scientific name	Common name	# polygons
Frangula alnus	glossy buckthorn	80
Valeriana officinalis	valerian	72
Rhamnus cathartica	common buckthorn	69
Taraxacum officinale	common dandelion	66
Tanacetum vulgare	tansy	58
Plantago major	common plantain	54
Hieracium aurantiacum	orange hawkweed	47
Cirsium arvense	Canada thistle	41
Phalaris arundinacea	reed canary grass	41
Lonicera sp., alien	Eurasian honeysuckle	25
Leucanthemum vulgare	ox-eye daisy	23
Lotus corniculatus	bird's-foot trefoil	13
Arctium sp.	burdock	12
Cirsium vulgare	bull thistle	12
Syringa x prestoniae	Preston's lilac	12
Stellaria sp.	stichwort or chickweed	11
Convallaria majalis	lily-of-the-valley	8
Hesperis matronalis	dame's rocket	8
Hieracium sp. (yellow)	hawkweed	8
Lonicera caerulea ssp. edulis	honeyberry	8
Lupinus polyphyllus	large-leaved lupine	8
Campanula cervicaria	bristly bluebells	6
Fallopia japonica var. *japonica* (= *Polygonum cuspidatum)*	Japanese knotweed	5
Acer ginnala	Amur maple	4
Campanula rapunculoides	European bellflower	4
Glechoma hederacea	creeping charlie	4
Aegopodium podograria	goutweed	3
Bromus inermis	smooth brome	3
Galeopsis tetrahit	hemp nettle	3
Medicago sativa	alfalfa	3
Sorbus aucuparia	European mountain ash	3
Syringa cf. vulgaris	common lilac	3
Typha sp. (alien?)	cattail	3
Berberis thunbergii	Japanese barberry	2
Lythrum salicaria	purple loosestrife	2
Matricaria discoidea	pineapple weed	2
Medicago lupulina	black medick	2
Sonchus sp.	sow thistle	2
Typha sp. - alien	narrowleaf cattail	2
Verbascum thapsis	common mullein	2
Acer platanoides	Norway maple	1
Hemerocallis fulva	orange daylily	1
Sorbaria sorbifolia	false spiraea	1
Syringa reticulata	Amur lilac	1

Ecological restoration and management activities may accidentally introduce or spread invasive species. To avoid this, see guidelines developed by the MNDNR (Appendix A).

2.2.4 Invasive Wildlife, Pests & Diseases

Invasive wildlife, pests, and diseases can also harm natural areas by eliminating native wildlife and degrading habitat. Emerald ash borer (EAB, a non-native, invasive beetle), is eliminating street trees and natural ash stands throughout the eastern United States. This is just the most recent of many devastating pests inadvertently or purposefully introduced to North America. As long as global commerce exists, new invasive wildlife species and pests will have to be dealt with.

Emerald Ash Borer

EAB has already killed some of the site's green ash and black ash trees, and it is likely they will continue to die over the coming decade. Chemical treatment of individual trees can provide effective protection against EAB, but it is often not feasible to treat and protect ash trees throughout a large area such as the HNA.

Oak Wilt

Oak wilt (a deadly, invasive fungus) occurs in the region and likely has affected oaks on the site. Seasonal guidelines for cutting, pruning, and care of wounds of oak trees should be followed strictly to prevent the spread of this destructive disease. If present and not managed, oak wilt has the potential to kill trees in the red oak group in the near term, and trees in the white oak group in the long term.

Butternut Canker

The state-endangered Butternut (*Juglans cinerea*) exists on the site. This native tree species was listed by MNDNR as Special Concern in 1996 due to a lethal fungal disease called butternut canker (*Sirococcus clavigignenti-juglandacearum*). With the canker decimating this species across the state, Butternut was listed as state-endangered in 2013. Healthy (presumably resistant) trees have been found growing adjacent to diseased trees in Minnesota. These trees, if they are truly resistant, could be extremely valuable in efforts to preserve the species, and they must not be cut down. Cuttings and seeds taken from disease resistant trees and propagated in tree plantations could potentially provide stock for landscaping purposes and possibly for reestablishing wild populations. It is also advisable to consider augmenting existing populations by direct planting of seeds taken from healthy trees.

The MNDNR refers to USDA recommendations for protecting and retaining butternut trees (USDA 1996):

> Vigor of individual trees in managed woodlots, urban, or other high-value landscape settings may be increased by proper pruning and tree care. If management objectives include conserving potentially resistant trees, the following guidelines will be helpful in retaining trees for seed and nut production and in selecting trees for breeding:
>
> 1. Retain trees with more than 70 percent live crown and with less than 20 percent of the combined circumference of the stem and root flares affected by cankers.
> 2. Harvest dead or declining trees to salvage the quality and value of the wood or maintain the trees in the forest for their wildlife value.

3. Retain trees free of cankers with at least 50 percent live crown and growing among diseased trees. These trees may be resistant and have value for propagation by grafting or for future breeding. Efforts are underway to locate potentially resistant trees in native forest stands. Contact the USDA Forest Service North Central Forest Experiment Station in St. Paul, MN, for further information if you find a healthy butternut.

White Pine Blister Rust

Blister rust is a fungal disease that creates cankers by killing areas of bark and outer wood. The HNA has a stand of Eastern white pine (*Pinus strobus*) trees that have a genetic history of natural resistance to white pine blister rust. According to the *Management Plan for the Hartley Natural Area* (Minnesota Land Trust 2019), cuttings collected by the University of Minnesota Cloquet Forestry Center and the USDA Forest Service from several trees in this stand were grafted for research to enhance propagation of blister rust resistance into Minnesota forests. This stand of trees is a unique historic resource, as it provides the opportunity to re-establish this ecologically important species; therefore, the HNA's blister rust-resistant Eastern white pines should continue to be protected.

2.2.5 Rare Natural Features

Federally-Tracked Natural Features

The U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) website is used to identify federally-tracked species in a project area. A query of IPaC (USFWS 2020a, Appendix B) indicated that five federally-listed species may potentially be affected by activities at or near the HNA.

- Piping plover (*Charadrius melodus*), Federally-endangered
- Northern long-eared bat (*Myotis septentrionalis*), Federally-threatened
- Canada lynx (*Lynx canadensis*), Federally-threatened
- Gray wolf (*Canis lupus*), Federally-threatened
- Red knot (*Calidris canutus rufa*), Federally-threatened

A brief description of each species follows, including potential conservation measures that can be taken at the HNA.

Piping plover. This Federally-endangered bird is a small, sand-colored, shoreline bird that uses wide, flat, open, sand beach with sparse vegetation. Their nesting territories can include small creeks or wetlands; however, these habitats need to be adjacent to shorelines and beaches of large waterbodies. Because the HNA is over 1.5 miles inland from Lake Superior, it is very unlikely this species uses the site.

Northern long-eared bat. This Federally-threatened mammal is a medium-sized bat with long ears that uses forested areas for summer roosting. Its range includes the entire Upper Midwest, including Minnesota. This bat species overwinters in caves and mines with constant temperatures, high humidity, and no air currents. This species may travel over 100 miles between summer and winter habitat, but journeys of 50 miles are more common. Northern Long-eared bat has shown a preference for upland forests but also may use lowland forests with mid-sized streams. The HNA provides these habitats; therefore, this species may use the site.

Survey techniques to determine the presence or absence of Northern Long-eared bat should follow the USFWS survey guidance for Indiana bat (USFWS 2019). USFWS management guidelines (USFWS 2016) recommend that tree-cutting in suitable habitat should not occur from April 1 through September 30. It is critical to not clear during pup-rearing season, from June 1 through July 31, especially in the white-nose syndrome zone, discussed below. Tree clearing at the site, even for ecological restoration, should occur from early October through March. Fortunately, this is the typical period for tree removal in ecological restoration projects, and this timing also avoids harming nesting migratory birds.

Impacts and threats to Northern Long-eared bat (and other bat species) are:

- White-nose syndrome, an immediate threat to all cave-hibernating bat species. White-nose syndrome is a fungus that has spread rapidly across the U.S. since its discovery in New York state in 2006. It is a major concern for bat conservation because it kills all or nearly all bats using overwintering caves, mines, and other "hibernacula." White-nose syndrome is present in St. Louis County (USFWS 2020c).
- Impacts to overwintering hibernacula: changes to access, microclimate changes, and human disturbances.
- Loss or degradation of summer forest habitat and/or roost trees.
- Wind farm operations (turbines can kill bats).

Northern Long-eared bat can be protected by:

- Not removing potential roost trees
- Not removing trees within 150 feet of a known roost tree when young bats are with mothers at the roost; this "non-volant pup" phase is June 1 through July 31
- Not removing forest cover from within ¼ mile of a known hibernaculum.

Canada lynx. This Federally-threatened mammal is a mid-sized, boreal forest carnivore that occurs across most of northern North America including northern Minnesota and the Duluth region. Their preferred habitat is moist, cool, boreal spruce-fir forests with high snowshoe hare densities. Snow also influences lynx distribution, and populations typically occur where continuous snow cover lasts four months or longer (Interagency Lynx Biology Team 2013). While Duluth does not offer ideal habitat for this species, reported sightings (https://www.dnr.state.mn.us/nhnrp/lynx_sightings.html) suggest Canada lynx may use the HNA.

Impacts and threats to Canada lynx are:

- Trapping and timber harvests that removed, changed and fragmented habitat.
- Snow, space, hares, and habitat connectivity, all required by lynx, are all threatened by climate change and various human activities including development, recreation, agriculture, mining and forestry management practices.

Canada lynx can be protected by:

- Use fire and mechanical vegetation treatments as tools to maintain a mosaic of lynx habitat, in varying successional stages.

- When designing fuel reduction projects, where possible retain patches of untreated areas of dense horizontal cover within treated areas.
- Vegetation management should be designed to provide for winter snowshoe hare habitat as forest stands develop successionally over time.
- Retain mature multi-story conifer stands that have the capability to provide dense horizontal cover.

Gray wolf. This Federally-threatened mammal is found in nine U.S. states including Minnesota. Their territories range in size from less than 50 square miles to more than 1,000 square miles, depending on habitat and seasonal movements of available prey. Recent surveys by the MNDNR (https://files.dnr.state.mn.us/wildlife/wolves/2019/survey-wolf.pdf) suggest Gray wolf may use the HNA.

Impacts and threats to Gray wolf are:

- Habitat reduction due to human encroachment.
- Deaths from hunting and vehicle collisions.

Gray wolf can be protected by:

- Minimizing conflicts with livestock and the lethal backlash against wolves.
- Avoiding development that results in habitat fragmentation.

Red knot. This Federally-threatened shorebird is a medium-sized, rare, low-density migrant annually recorded in Minnesota (most frequently at Park Point, Duluth). This species is also observed along the State's 110 larger inland lakeshores, such as Upper Red Lake, Leech Lake, Mille Lacs, and Lake of the Woods. Occasionally, this species appears at sewage treatment plants in the southern third of the State and at other wetlands in the prairie region (USFWS 2014). Given its habitat preferences, it is not likely that Red knot uses the HNA.

Impacts and threats to Red knot are:

- Sea level rise; coastal development; shoreline stabilization; dredging; reduced food availability at stopover areas; disturbance by vehicles, people, dogs, aircraft, and boats; and climate change.

Red knot can be protected by:

- Reducing development and disturbance at known stopover locations.

Other Rare Species and Habitats

In addition to Federally-tracked listed species, the USFWS also tracks critical habitats, migratory bird species of conservation concern, National Wildlife Refuges, Fish Hatcheries, and wetlands in the National Wetlands Inventory. The IPaC report states that the HNA lies within critical habitat for the Canada lynx. Forests along migration corridors are important stopover destinations for migratory birds, and the report identified 22 migratory bird species of conservation concern that may use the site (see Appendix B for list). No refuge lands or fish hatcheries were identified at the HNA, and a variety of wetlands have been mapped at the site.

State-Tracked Natural Features

The MNDNR's Natural Heritage Information System (NHIS) uses Biotics, a spatial database, to track records of high quality and rare natural communities as well as rare plant and animal species, including those that are endangered, threatened, or special concern. A review of NHIS data (MNDNR 2020b) for the HNA and a 1-mile buffer around the site identified four rare natural feature records.

- Blanding's turtle (*Emydoidea blandingii*), State-threatened
- Narrow triangle moonwort (*Botrychium lanceolatum ssp. angustisegmentum*), State-threatened
- Northern goshawk (*Accipiter gentilis*), State Special Concern
- Least moonwort (*Botrychium simplex var. simplex*), State Special Concern

Blanding's turtle. This State-threatened reptile requires both wetland (pond, marsh, shrub swamp, bog, slow-moving ditch/stream) and upland (open, grassy or brushy, sandy) habitats to complete their life cycle. This species was last observed near the site (not on site) in 2007; however, the presence of Hartley Pond and numerous vernal pools and other wetlands suggests this species may use Hartley Natural Area. Impacts and threats to Blanding's turtle are:

- Loss of wetland habitat through drainage or flooding (converting wetlands into ponds or lakes)
- Loss of upland habitat through development or conversion to agriculture
- Human disturbance, including collection for the pet trade and road kills during seasonal movements
- Increase in predator populations (skunks, raccoons, etc.) which prey on nests and young

Blanding's turtle can be protected by following the following MNDNR recommendations.

General

- A flyer with an illustration of a Blanding's turtle should be given to all contractors working in the area (http://files.dnr.state.mn.us/natural_resources/animals/reptiles_amphibians/turtles/blandings_turtle/flyer.pdf).
- Turtles which are in imminent danger should be moved, by hand, out of harm's way. Turtles which are not in imminent danger shall be left undisturbed.
- If a Blanding's turtle nest is in a proposed project area, the nest should not be disturbed.
- Silt fencing should be set up to keep turtles out of construction areas. Silt fencing shall be removed after the area has been revegetated.

Wetlands

- Wetlands should not be impacted.

- Wetlands (including littoral/lakeshore wetlands) should be protected from pollution; use of fertilizers and pesticides shall be avoided, and run-off from lawns and streets shall be controlled. Erosion shall be prevented to keep sediment from reaching wetlands and Hartley Pond.

Utilities

- Utility access and maintenance roads should be kept to a minimum to reduce road-kill potential.
- Because trenches can trap turtles, trenches should be checked for turtles prior to being backfilled, and the areas will be returned to original grade where possible.

Landscaping and Vegetative Management

- Terrain should be left with as much natural contour as possible.
- When feasible, disturbed areas should be revegetated with native vegetation (some non-natives form dense patches through which it is difficult for turtles to travel).
- Vegetation management in infrequently mowed areas - such as in ditches, along utility access roads, and under power lines - should be done mechanically when feasible (chemicals should be avoided). When feasible, vegetation management shall occur fall through spring (after October 1st and before June 1st).
- Erosion control blankets should be made of wildlife-friendly (e.g., all natural fiber) materials so as not to endanger turtles or other wildlife susceptible to entanglement (https://files.dnr.state.mn.us/eco/nongame/wildlife-friendly-erosion-control.pdf).

Narrow triangle moonwort. This State-threatened plant prefers moist, shady, mature northern hardwood forests, particularly in low areas. This species was last observed near the site (not on site) in 1998; however, the presence of these habitats suggests this species may exist at the HNA. Narrow triangle moonwort appears to be very sensitive to disturbance. The MNDNR identifies the following impacts and threats to this species are:

- Loss of the humus layer caused by non-native earthworms.
- Damage caused by timber harvesting, the effects of road building, and land use changes that affect drainage.
- Any activity that results in the creation of significant gaps in the overstory canopy. Timber management, even selective harvesting, can increase solar energy reaching the forest floor, thereby warming and drying the soil.

Conservation strategies to protect this species include:

- Protect native forest soils. This includes preventing the introduction or spread of non-native earthworms by following MNDNR guidelines (Appendix A) and general sediment and erosion control measures.
- Minimize significant loss of tree canopy.

Northern goshawk. This State Special Concern species is the largest forest raptor in Minnesota, with long, broad, and rounded wings, a long, rounded tail, and stout legs and feet. Because it has been observed within the HNA as recently as 2018, the following management approaches should be followed.

- Maintaining contiguous forested areas with high amounts of canopy closure to provide adequate resources (Bruggeman et al. 2011).
- Retain and manage for abundant woody debris to provide habitat for prey populations.
- Avoid destruction of alternate nests that may exist within ¼ mile of the active nest (MNDNR 2003a).

Least moonwort. This State Special Concern plant occurs primarily in open sites, including prairies, wetlands, and abandoned mine sites. It was last observed near the site (not on site) in 1943. Because Least moonwort has not been documented at the HNA over the past 80 years, it is unlikely that it exists at the site. The MNDNR does not identify any special management considerations for this species. However, all species of the genus *Botrychium* are believed to rely on a symbiotic relationship with soil fungi; therefore, the health and condition of the soil fungal community may have a greater role in maintaining populations of *Botrychium* species than factors occurring above ground.

2.2.6 Climate

According to Minnesota's Wildlife Action Plan 2015-2025 (MNDNR 2016), we are already experiencing the early effects of climate change in Minnesota – including higher temperatures (especially during the winter and overnight) and more severe precipitation events. These changes are likely to influence species and ecosystems by altering fundamental interactions with other species and the physical environment, potentially creating a cascade of impacts throughout ecosystems (Staudinger et al., 2012).

More specific to the Duluth region (located within the Laurentian Mixed Forest Province), the Northwoods Climate Change Response Framework project (Handler et al., 2014) predicts warmer temperatures or drier conditions that reduce available moisture, more intense storm events, and shifts in the timing or amount of precipitation. Native plant community-specific predictions provided by the Framework (Handler et al., 2014) follow:

> **Fire-Dependent Forest System.** This system is vulnerable to increased drought and warming that increases moisture stress. Major system stressors include fire suppression, insect pests and diseases, understory hazel competition, and deer herbivory.
>
> **Mesic Hardwood Forest System.** This system *[the dominant native plant community in the HNA]* is vulnerable to increased droughts that could produce moisture stress and increase the occurrence of wildfires. This system generally contains a larger number of plant species than some forest systems, which may increase its adaptive capacity. Species diversity along with warming temperatures may allow this system to expand into previously unsuitable areas. However, stands with few species and reduced structural diversity may have lower adaptive capacity. Major system stressors include earthworms, invasive plants, insect pests and diseases, freeze-thaw cycles, drought, and deer herbivory.
>
> **Floodplain Forest System.** This system is vulnerable to the timing and intensity of precipitation events resulting in changes in the timing or volume of stream flows. Major system stressors include changes in flood regime, increase of invasive species (buckthorn, garlic mustard, and reed canary grass), drought, and deer herbivory.

Wet Forest System. This system is vulnerable to shifts in the timing or amount of precipitation that could disrupt system functions. Management knowledge and history are lacking for these systems; thus, less is known about how these systems function and respond to disturbance. Because these forests often exist as large complexes of a single species or few species, they have lower adaptive capacity in areas where they exist as isolated pockets on the landscape that may limit migration and gene flow. Major stressors include changes in soil moisture, ongoing ash decline, invasive species such as reed canary grass, insect pests (emerald ash borer), and drought.

Managed Aspen System. This system is vulnerable to increased moisture stress during the growing season, which could result in greater mortality. Warmer growing-season temperatures could result in more suckering after harvests. Increased wildfires could help maintain aspen; however, frequent disturbances from herbivory, drought, and more intensive management could result in aspen becoming a less successful competitor. Major system stressors include forest tent caterpillar and gypsy moth, drought, deer herbivory, hypoxylon canker, and earthworms.

Managed Red Pine System. This system is vulnerable to seasonal shifts in precipitation patterns, which may decrease the survival of planted seedlings, particularly if the trend is for wetter springs and drier summers. Red pine plantations typically have very little genetic, structural, and species diversity, which may result in low resilience to future disturbance or changing conditions. Major stressors include armillaria fungi disease, red pine shoot blight, understory hazel competition, deer herbivory, bark beetles, and drought stress in dense stands.

These climate projections warrant consideration in the management of natural areas. Due to the many unknowns surrounding climate change (magnitude, rate, interactions, responses, etc.), adaptation strategies are generally broad. Over time, climate adaptation strategies can be refined for specific geographies and situations. The following general adaptation strategies are based on the National Fish, Wildlife and Plants Climate Adaptation Strategy (National Fish, Wildlife and Plants Climate Adaptation Partnership 2012):

1. Conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate.
2. Manage species and habitats to protect ecosystem functions and provide sustainable cultural, subsistence, recreational, and commercial use in a changing climate.
3. Enhance capacity for effective management in a changing climate.
4. Support adaptive management in a changing climate through integrated observation and monitoring and use of decision support tools.
5. Increase knowledge and information on impacts and responses of fish, wildlife, and plants to a changing climate.
6. Increase awareness and motivate action to safeguard fish, wildlife, and plants in a changing climate.
7. Reduce non-climate stressors (e.g., control invasive species) to help fish, wildlife, plants and ecosystems adapt to a changing climate.

Some of these strategies are already being practiced at the HNA: invasive plants are being managed and areas are being restored to more healthy, diverse native plant communities. These practices will provide greater ecological resilience in the face of environmental change. Continued attention to

ongoing climate research and monitoring the response of the HNA's native plant communities to management will continue to guide site-specific management practices over time.

2.3 Summary of Findings

- The HNA represents one of the City of Duluth's largest natural area land holdings, which is one reason why it was enrolled in the Duluth Natural Areas Program (DNAP).
- The HNA is located within the Minnesota DNR's "North Shore Highlands Ecological Subsection", which is characterized by a relatively cold and moist climate, thin soils over often shallow bedrock, and uplands dominated by silt loams and lowlands dominated by muck soils.
- Prior to European settlement, the HNA was dominated by Mixed Hardwood and Pine forests (containing Maple, White Pine, Basswood, etc.).
- The HNA contains high quality remnant native plant communities as well as significantly disturbed landscapes. The most disturbed areas are centrally located in the HNA, while the less disturbed areas lie generally towards the site's perimeter. This suggests controlling edge effects around the site's perimeter is an important conservation action to take.
- Invasive vegetation is a major issue and threat to the HNA. Many of the site's forests and woodlands have been degraded by glossy and common buckthorn, and influences such as Emerald ash borer and climate change will continue to alter the site's plant communities.
- Adjacent lands are dominated by suburban development, partially isolating the HNA from other natural areas.
- Several rare plant and animal species have been recorded on or near the HNA.
- Restoration and management planning should consider the effects of climate change, particularly in regard to appropriate target plant communities and native species selection.

Introducing or mimicking the processes that historically maintained the site's ecosystems, controlling edge effects, shifting vegetation composition towards dominance by appropriate native species (considering the effects of climate change), and restoring appropriate vegetative structure will improve the health and resilience of the HNA's native plant communities and associated wildlife populations over time.

3 IMPLEMENTATION

The preceding Assessment section of this plan describes the HNA's existing natural resources, laying the foundation for management planning. This section describes how native plant communities will be restored and managed at the site.

3.1 Restoration & Management Approach

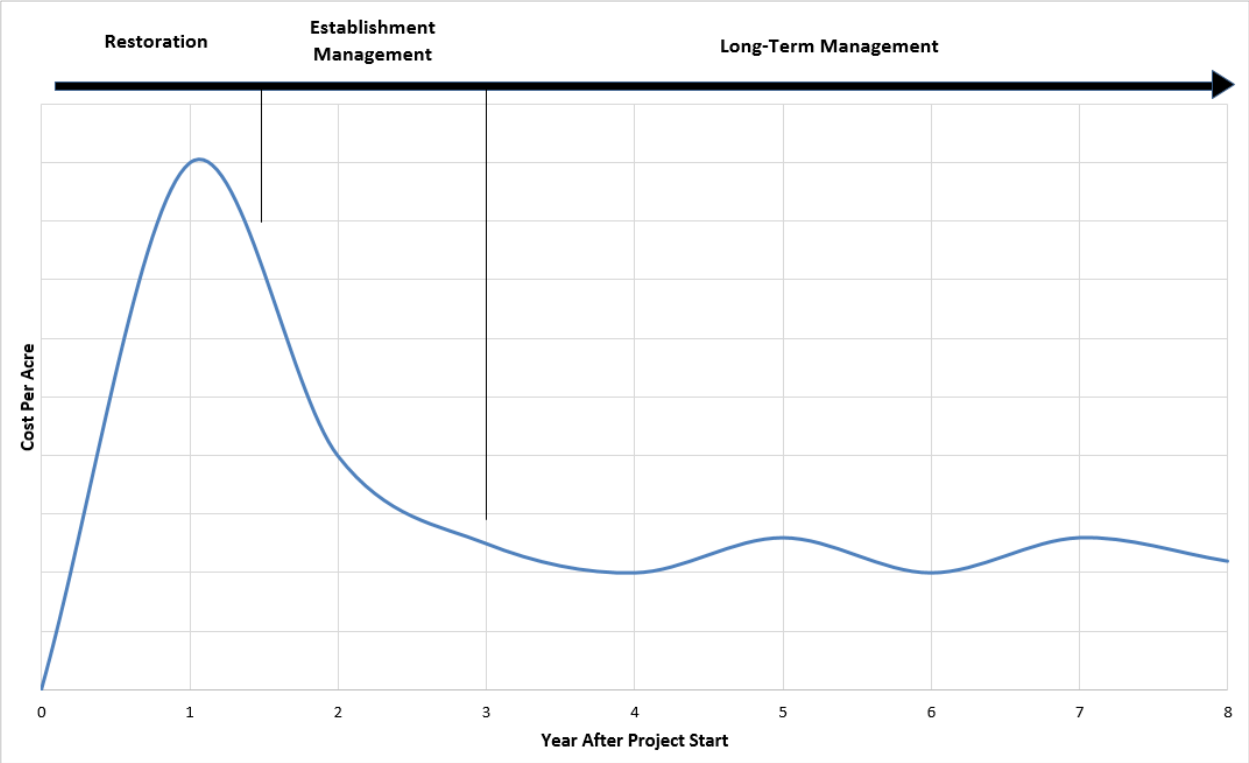
Ecological restoration creates healthy and sustainable ecosystems, often in developed or disturbed landscapes. The composition, structure, and function of restored ecosystems aim to be like those of original ecosystems, but of course cannot in a few years (or perhaps ever) fully replicate those original ecosystems that persisted for thousands of years. Like the original ecosystems, restored ecosystems have a greater variety of native plant and animal species, higher levels of natural functions like infiltration and carbon storage, and greater resilience in the face of environmental change compared to turf, cropland, and other cultural ecosystems.

Restored ecosystems need to be managed to keep them in good working order, just as cultural land covers must be. The ecosystems of 150 years ago also were "managed" by fire, grazing and burrowing animals, flooding, and other natural disturbances on the landscape. Changes in the larger landscape and in local conditions often prevent the full re-creation of natural conditions that prevailed 150 years ago. Historical conditions give us insights into what natural conditions are possible at a given site, but no more. More importantly, the goals of a restoration project will dictate the level of effort and resulting conditions.

3.1.1 Restoration & Establishment Phase

Ecological restoration has short- and long-term management phases. The initial restoration and short-term (i.e., "establishment") phase is typically more labor-intensive and costly. The initial effort usually lasts about three years and requires a significant investment to prepare for and begin establishing the proposed native plant communities. Tasks often include: re-introducing natural disturbances (e.g., fire); re-establishing natural hydrological cycles in aquatic systems; using biocontrol, physical methods, and chemicals (e.g., herbicides) to control invasive plant species; and seeding and planting of native vegetation. The length of time before transitioning to long-term management depends on the site's initial quality, weather conditions, how the site responds to restoration activities, the size of the site, and factors unique to the site. Figure 4 shows the relatively high cost of initial restoration work, the somewhat reduced cost during establishment management, and the lowest annual cost during long-term management.

Figure 4. Generalized Cost of Restoration and Management Over Time



Establishing a new forest or wetland from a cultural or severely degraded site is referred to as "restoration," whereas "enhancement" is used to describe activities where minimal-to-moderate effort and cost is required to improve an existing native plant community. Restoration might entail converting an old field to a native forest. Enhancement might entail removing invasive shrubs and overseeding native plants in an existing native forest.

3.1.2 Long-term Management Phase

After the restoration and establishment phase, the process shifts to a lower-cost, but equally important, long-term management phase. Without a commitment to long-term management, short-term restoration and enhancement investments may be wasted. Scheduling and budgeting long-term monitoring and management every year protects restoration and/or enhancement investments and ensures that the plant community and ecosystems continue on a trajectory toward greater ecological health.

Typical long-term management tasks include selective removal or treatment of invasive plants (e.g., spot spraying herbicide, pulling, cutting), re-seeding disturbed or poorly developing areas, re-planting woody plants that have died, and maintaining the disturbances that perpetuate a diverse and resilient plant community. Most ecosystems need some type of disturbance that removes dead plant material, regenerates many plant species, and opens up new habitat for plants and animals to perpetuate themselves. Controlled burns (prescribed fires) are a common tool used to mimic former fire regimes in prairies, savannas, wetlands, and some forests and woodlands. In areas where burning is not feasible, harvesting hay from prairies, which loosely mimics grazing, can also be effective. One-hundred fifty

years ago, the Duluth region experienced intermittent fires, large browsing mammals (e.g., moose and caribou), and significant beaver activity; the region's plants and animals were adapted to those conditions.

3.1.3 Adaptive Management

Restoration and management plans need to be flexible. Restoration programs are often not implemented exactly according to a plan because the timing of funding may not align with field operations, the response of ecosystems to restoration may dictate adjustments in techniques, and the basic management needs of an ecosystem may change in response to new threats and conditions. New scientific findings and insights also may change restoration plans and management practices. For these reasons, restoration and management plans should be viewed as a starting point in a process of restoring biodiversity and natural processes in natural areas, subject to amendment as conditions and information change.

The most successful restoration programs include regular monitoring and reporting as feedback on the program's effectiveness. Monitoring also generates information to justify changes in the restoration and management program. "Adaptive management" is a cycle of implementation, monitoring, evaluation, adjustment, and further implementation. Adaptive management is used in the best restoration programs, begins with the initial restoration work, and continues indefinitely as natural areas are managed over time.

3.2 Restoration & Management Approach and Tasks

Successful ecological restoration and management requires the correct execution of a series of tasks, each of which should be customized to the site's unique environmental conditions to meet project goals. The *Management Plan for the Hartley Natural* Area (Minnesota Land Trust 2019) provides general management recommendations for different types of native plant communities; however site-specific restoration and management prescriptions require an understanding of site-specific goals, resources, budget, and other factors.

For restoration and management planning, an "ecological approach" entails first using less expensive, more natural methods to restore natural processes and appropriate vegetation structure and composition to an ecosystem. This often consists of replacing dominant invasive vegetation with dominant native species in the selected target plant community. Prescribed fire and physical removal of undesirable vegetation typically follows. This is then followed by other tasks, such as targeted use of herbicides and other interventions to set the plant community on a trajectory toward greater ecological health and resilience.

The variability of existing plant communities (including their species composition, structure, land use history, soils, etc.) and the variability of restoration and management goals present a complex challenge for natural resource managers. The following framework can facilitate development of efficient, effective, and appropriate restoration and management prescriptions for discrete areas.

1. **Understand the starting ecosystem.** It is rarely an intact natural community, and is more commonly a degraded natural community, a cultural landscape (e.g., cropland, pasture, turf), or a novel ecosystem—that is, a cultural landscape that appears stable or slow-changing, such as an old field or a forest dominated by non-native trees.
2. **Define conservation and restoration goals** for the given tract of land or plant community, including the target plant communities. The goals should lead to self-perpetuation and limited human management of ecosystems, and long-term resilience despite environmental change and unexpected stressors.
    a. Consider the type and level of **ecosystem services** being restored in light of expected land use, species and habitats targeted for protection, and other desired outcomes.
    b. Consider the **achievable ecological quality.** Is it realistic to expect an A-quality plant community, or is BC-quality acceptable?
    c. Consider **short-term and long-term costs.** For instance, though generally cheaper than most management techniques, is it cost-effective (and appropriate) to manage a particular site with fire given its natural disturbance regime and constraints?
    d. Consider **schedule and milestones.** Define the period of time over which the goals will be realized, and define steps along the way that represent significant interim accomplishments.
3. **Assemble the appropriate tasks and sequence** to set the ecosystems and target plant communities on a trajectory towards ecological health, integrity, and resilience.
    a. Begin by **restoring processes** that can be used cheaply and extensively to restore vegetation structures, such as flood regimes, fire, canopy closure, other processes (grazing, burrowing), the addition of legacy materials, etc.
    b. **Restore vegetation structure** by using or mimicking natural processes or adding biocontrol agents—use spot herbicide application sparingly and broadcast herbiciding as a last resort—with the goal of restoring dominance by native plants suited to local climate, soil, and setting.
    c. **Introduce plant species diversity** as necessary to support restoration of native dominance and ecological functions (e.g., provide pollinators with resilience against climate change by introducing southern plant species projected to advance over northern species projected to be stressed. Include a wide range of species across the spectrum and monitor their ability to survive and reproduce. Native seeding and live-planting are typically required if the native seed bank is exhausted.
4. **Ensure adequate resources** to implement the restoration work and perpetual management thereafter.
5. **Accept long time frames** to implement monitoring, reporting, and adaptation.

Typical ecological restoration and establishment management tasks are described below. Some of these practices are also appropriate during long-term management (addressed later in this Plan).

A Note About Herbicides

Restored native species dominance in all vegetation layers of a plant community often requires herbicide use. If native dominance can be restored without herbicides, spot-treatment may still be appropriate to eliminate colonies of the most problematic species. Some can be managed with mowing or hand-pulling, but in many cases targeted herbicide treatment is the most cost-effective means of control.

The public is increasingly concerned about herbicides and other pesticides used on public land. City staff may be contacted for information in response to restoration and management involving herbicides. A consistent message should be conveyed to the public by City staff who receive inquiries about herbicides:

1. The City minimizes herbicide use by taking an ecosystem approach and following Integrated Pest Management (IPM) practices. When deemed necessary, the City allows use of herbicides with the lowest toxicity to achieve restoration goals.
2. Herbicide application on City-managed lands is applied at the lowest effective concentration by licensed applicators following manufacturer's instructions.
3. Recommended safety precautions are followed by herbicide applicators, and signage is installed as appropriate to inform the public of herbicide use and appropriate exclusion intervals following application.

The amount of herbicide applied for ecological restoration and management is at levels far below that used in agricultural fields. Moreover, the herbicide is often precisely applied to small areas, such as a cut stump or individual thistle clump. Preference is given to low-pressure nozzle and wick-application to minimize drift and spillage. Restoration professionals prefer to use broadcast herbicide application as a tool of last resort, in order to remove a dominant invasive plant in a vegetation layer that is resistant to other approaches.

3.2.1 Hydrological Restoration

Natural Hydrology. In natural settings of the Midwest and Great Lakes Region, wetlands and associated streams, ponds, and lakes experienced predictable (often gradual) rises and falls in water level after large storms and spring snowmelt. Small storms rarely caused surface and groundwater levels to rise significantly; however, the Duluth region's shallow bedrock, clayey soils, and steep slopes contributed to more flashy hydrology than other regions. Evapotranspiration from the land and vegetation gradually drew down water and groundwater levels from early summer into fall. (The groundwater table that is visible in wetlands, streams, ponds and many lakes rises and falls even more slowing than surface water levels.)

Altered Hydrology and Vegetation Effects. Native plants and animals were well-adapted to the formerly gradual changes in water and groundwater level. Ditching, tiling, and other drainage systems, as well as land clearing and impervious surfaces, have deranged the natural hydrological regime in the majority of wetlands, streams, ponds, and lakes of the region. Damming and road-building also alter hydrology by impounding water uphill and drying the downhill landscape. These changes in hydrology alter the plant and animal communities of hydrologically-dependent ecosystems by favoring certain species well-adapted to either a static hydrological regime (such as above dams) or artificially dynamic hydrological regime, such as below drained agricultural and developed landscapes. Dominance by a few species often results, with the loss of plant and insect biodiversity, and shifts in the abundance of bird, amphibian, and small mammal densities.

Restoring Hydrology. In hydrologically-deranged wetland and related systems, the first restoration task is to identify where ditches, tiles, undersized road culverts, berms and dikes exist on a site in order to remove them and restore a more natural hydrological regime. A second task is to identify locations outside the site which have a disproportional effect on the hydrology of the site. The first task is a normal part of restoration, while the second requires taking a watershed approach that often involves multiple parties, considerable expense, and long time frames. Specific to the HNA, work is underway to restore cooler water temperatures to Tischer Creek and improved fish passage culverts below the dam.

3.2.2 Prescribed Burning

Fire-Dependent Ecosystems. Prescribed burning is an important and cost-effective ecological restoration and management tool – and one that is appropriate for fire-dependent communities such as: pine, pine-oak, and oak forests; oak and oak-pine savanna; prairie; wet meadow; and marsh. The HNA contains fire-dependent forests, woodlands and other native plant communities that benefit from infrequent fire. These plant communities are often most cost-effectively managed with well-planned

and -executed prescribed burns. The many benefits of fire in these communities has been well documented.

Burning Grasslands and Meadows. The HNA's Pollinator Meadows and other prairie-like habitats should be burned approximately every three years, but this depends on the rate of woody plant invasion and the accumulation rate of fine fuel. More frequent burning may be needed to control woody plant growth, or less frequent if the litter layer accumulates slowly. Creating two or three burn units, each capturing the landscape's heterogeneity, preserves refugia for wildlife negatively affected by fire. For instance, invertebrates are protected by not burning an entire plant community at once, usually recolonizing the burned patch from refugia in the next year or two. The USDA/NRCS recommends that most prescribed burning be done in the early spring before grassland birds nest; however, late-summer and fall burns also avoid the prime nesting season (USDA/NRCS 1999).

Burning Forests and Woodlands. Fire-dependent forests and woodlands may have sufficient oak or pine leaf litter to carry a low-intensity surface fire, generally with flame lengths only up to two to three feet. These surface fires help remove excess leaf litter and organic duff, control invasive plants not adapted to fire, and stimulate the growth of a diverse assemblage of native plants. (The fire research in Itasca State Park demonstrate this clearly for pine forests.)

The HNA's fire-dependent forests and woodlands should be burned every five to ten years, depending on their species composition, available fuel, ecological quality, and restoration and management needs. However, burning these areas can be challenging if fine fuel is sparse. Legacy materials (downed woody debris and snags) must be addressed before or after a burn. In closed-canopied forests, especially with a woody understory, dense shade often suppresses invasive plants, making prescribed burning less important as a management tool.

Challenges of Using Prescribed Fire. Prescribed burning can be challenging in a developed setting. Park users, neighboring residences and businesses, traffic on roads, and air quality all need to be considered when developing a thorough and safe burn plan. Prior to burning, the City of Duluth or its appointed contractor should secure the necessary permissions, notify the community, and take appropriate precautions to protect infrastructure or vegetation that is not intended to be burned. Due to fixed costs associated with mowing fire breaks, notifications, mobilization, and burn coordination and execution, small burns of less than dozen or so acres are much more expensive on a per-acre basis than larger ones.

3.2.3 Biocontrol

Biocontrol is the use of natural enemies to reduce invasive species populations. There are several approved biocontrol agents available for controlling invasive species in Minnesota; however, the HNA's most problematic invasive plants (e.g., glossy and common buckthorn) lack approved biocontrol agents. Table 3 presents some invasive plant species that can be controlled with approved biocontrol agents.

Table 3. Potential Biocontrol Options for the Hartley Natural Area

Plant Community	Invasive Plant Species	Biocontrol Agent	Mechanism	Application to Site	References
Forests & Woodlands	Garlic mustard (*Alliaria petiolata*)	A root-crown mining weevil (*Ceutorhychus scrobicollis*)	Adult Stage: Herbivory of foliage. Larval Stage: Mine petioles and root crowns throughout the winter and early spring.	Biocontrol agent currently not available in the United States but undergoing further testing.	Becker et al. 2020
Upland Grasslands	Leafy spurge (*Euphorbia esula*)	Leafy spurge beetle (*Aphthona lacertosa*)	Adult Stage: Herbivory of foliage and lay their eggs at the base of spurge plants. Larval Stage: The eggs hatch and larvae feed on the roots over the winter until they pupate and emerge as adults the following summer.	Leafy spurge is not known to exist at HNA. If detected, experimental releases may be recommended.	Chandler et al. 2012
		Black dot Leafy spurge flea Beetle (*Aphthona nigriscutis*)			
	Spotted knapweed (*Centaurea stoebe*)	Seedhead weevils (*Larinus minutus* and *L. obtusus*)	Adult stage: Herbivory of foliage. Larval stage: Consume the developing spotted knapweed seed.	Spotted knapweed is not known to exist at HNA. If detected, experimental releases may be recommended.	Chandler 2020
		A root-boring weevil (*Cyphocleonus achates*)	Larval Stage: Develop in the roots consuming plant resources and physically damaging the roots.		
Wetlands	Purple loosestrife (*Lythrum salicaria, L. virgatum*)	Black-margined loosestrife beetle (*Galerucella calmariensis*)	Adult Stage: Herbivory of foliage. Larval Stage: First instar larvae feed concealed within leaf or flower buds; later instars feed openly on all aboveground plant parts.	Purple loosestrife is known to exist at HNA. Experimental releases are recommended.	MNDNR 2020
		Purple Loosestrife Leaf Beetle (*Galerucella pusilla*)			
		Loosestrife root weevil *(Hylobius transversovittatus)*	Adult Stage: Herbivory of fliage. Larval Stage: Feed within the roots		

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3.2.4 Invasive Tree & Shrub Removal

As part of an ecosystem approach, removing invasive woody vegetation often dramatically accelerates the ecological restoration process. Glossy buckthorn (*Frangula alnus*), Common buckthorn (*Rhamnus cathartica*), and Asian honeysuckles (e.g., *Lonicera tatarica*) are primary targets in the HNA since they can dominate forest understories. Some native trees and shrubs, however—Boxelder (*Acer negundo*), Green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), Common hackberry (*Celtis occidentalis*), Eastern red cedar (*Juniperus virginiana*), Chokecherry (*Prunus virginiana*)—behave as invasive species in native plant communities damaged by past poor management. In these cases, selectively or completely removing them from a forest understory also accelerates the restoration process. Once these species are under control, native trees and shrubs can be planted to compete with the invasives. Planting nut- and berry-producing trees and shrubs should be a priority as these important source of wildlife food are usually missing or scarce in damaged forest ecosystems.

If resources are limited, invasive vegetation management should focus on removing invasives from the highest quality areas or areas with the rarest natural features since areas experiencing early invasions are easier to control than dense infestations.

Removing invasive woody vegetation typically includes the following tasks.

- **Native Plant Protection.** Protect desirable native woody and herbaceous vegetation by various means: no forestry mowing, no goats, no heavy equipment, no broadcast herbiciding.
- **Slope Protection and Safety.** Steep slopes may make mechanized woody plant removal very difficult. Hand cutting with workers in safety harnesses is a better choice. Goats may be effective on steep slopes, but have disadvantages discussed below.
- **Soil Protection.** Woody plant removal should be done when the ground is frozen to minimize rutting and damage to plant roots.
- **Hand-Pulling.** Where feasible on relatively flat, stable soils, hand-pull seedlings and young invasive shrubs of up to 3" diameter near the base. This can be done with a Weed Wrench or similar tool. If control can be executed over several years, buckthorn may be removed from sites with sandy, mucky, or other loose soil by cutting the stem at a height of 3 feet. These stems may "sucker" or re-sprout but can then be extracted through leverage or tools after a year or two, avoiding the use of chemicals.
- **Hand-Cutting.** When other methods are not feasible, invasive woody plants should be cut and stump-treated with an approved contact herbicide. This is a commonly used technique as it accommodates most situations, but disposing of material can add significant costs (see below). If a less expensive method is desired, invasive woody plants can receive a basal bark application

of herbicide and left standing after dying. Herbicides should be appropriate to the task and methods should be used that minimize damage to native vegetation or soil biota.

- **Goat Browsing.** Goats have been used at some restoration sites to browse and reduce invasive woody vegetation. Goats defoliate and stress small shrubs and trees, woody plant seedlings, and the low-hanging branches of taller plants, but cannot control mature shrubs. Moreover, browsing may not kill the browsed plant, allowing it to regrow. Because mature invasive shrubs are found in many of the HNA's forests, goats are not a suitable tool. Other disadvantages are that goats browse native woody species and require the installation and management of electric fencing and other infrastructure. For these reasons, goats should be used only at appropriate sites, under close supervision, and with other brush control methods.
- **Forestry Mowing.** Mechanized forestry mowing is often used for large areas of invasive woody plants, but may have the disadvantages of removing and damaging desirable native vegetation, causing soil erosion, and compacting soil. Forestry mowing also leaves uneven/shredded stump-cuts, making herbicide application challenging. For this reason, re-sprouts are common, requiring foliar application of herbicide (see below). For large areas dominated by invasive woody plants and lacking native woody plants, mechanical forestry may be appropriate.
- **Understory Thinning.** Where past poor management has allowed early-successional trees to dominate the forest understory, a deep shade develops. Selective thinning of these trees can accelerate the restoration process. A continuous forest canopy should be maintained in most forests, as this reduces the invasion and growth of buckthorn and honeysuckle. Thinning the understory and creating canopy gaps, however, allows more sunlight to reach the ground, helps the growth of mid- to late-seral species (e.g., yellow birch, hemlock, red oak), and stimulates the spread of native groundlayer plants.
- **Woody Material Disposal.** Cut material is typically hauled off site, chipped and thin-spread on the site, or stacked into brush piles for wildlife habitat or burning (in approved locations). Care should be taken to not spread invasive plant seeds and berries during removal. Handling and transporting cut material should follow all state and federal recommendations to prevent the movement of pests, such as Emerald ash borer and Gypsy moth. If many large trees are being cut, those should be moved out of the way to maintain travel routes for material disposal. Where there are fewer large trees being removed, the boles can be bucked, chopped and thin-spread, and the trunks left on the ground as wildlife habitat. If generating a commercial product such as biomass for energy or stream bioengineering material, understory thinning can be done with lower material removal costs.
- **Treating Re-sprouts and Seedlings.** Treat invasive woody vegetation seedlings and re-sprouts with approved foliar herbicide in the growing season following cutting, preferably late in the summer or early fall to avoid collateral damage to native groundlayer vegetation. Due to the seedbank that accumulates in well-established stands of buckthorn and honeysuckle, treatment of these invasive seedlings may be needed for up to seven years after the initial removal.

3.2.5 Invasive Herbaceous Vegetation Control

- **Competition by Native Plants.** As invasive plants create a seedbank which produces seedlings for years, expanding the cover of native vegetation is the most effective way in the long term to compete with and suppress the germination and growth of invasive plant seedlings.
- **Native Plant Protection.** Protect desirable native vegetation by avoiding native plants with equipment and herbicides. Select the right herbicide and apply at the proper time with the proper method to minimize drift and drip. Properly use prescribed burning. Use a broadleaf-specific herbicide when protecting native grasses, sedges, and graminoids, and a grass-specific herbicide when protecting native forbs.
- **Multi-Pronged Approach.** Employ an Integrated Pest Management (IPM) approach by combining manual pulling where erosion is not a concern, spot-application of herbicide, spot-mowing, and prescribed burning (see Section 3.3.5)—the combination determined by the life history vulnerabilities of the invasive plants being controlled.
- **Broadcast Herbicide Treatment.** Two or three herbicide treatments are usually required to control certain perennial weeds; e.g., Smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), and Canada thistle (*Cirsium arvense*). Spot-herbicide treatment after initial removal is usually needed in these situations. Broadcast herbicide applications should be used as a last resort.

3.2.6 Herbaceous Vegetation Installation

- **Native Seedbank Assessment.** Following initial removal of invasive woody and herbaceous species, the native seedbank should be allowed to express itself. If in the first year it does not respond sufficiently in variety or coverage, native seeding should be initiated.
- **Native Seeding.** Seeding is less expensive than installing live plants, but requires more time to establish, often up to three years. Always use native seed of the local ecotype, originating within 150-200 miles of the site. Seeding a native grassy cover crop will rapidly stabilize soils and create a competitive environment for invasive seedlings emerging from the seedbank. A native grass seeding also provides fine fuel to carry a prescribed burn, if that is a restoration and management action. Diversity can be increased by seeding forb species after the graminoids are established, usually by drilling seed after a burn or mowing. Volunteers can collect native seed and hand sow it in sparse or low diversity areas. The ground layer vegetation will help stabilize soils, prevent new invasion by invasive and weedy plants, and restore the ecological composition, structure, and function of the area being restored.
- **Live Plugs.** Live plant plugs ("plugging") produces an immediate effect but is relatively expensive. An intermediate approach is to add plugs to a native seeding area, either to increase diversity of species that do not establish well from seed, or to create an impressive floral display, such as in high visibility areas.

3.2.7 Tree & Shrub Installation

- **Planting Trees and Shrubs.** Native woody plantings are used to replace or compete with invasive or early-seral native woody plants, setting the plant community on a trajectory to a more resilient condition. In restoration projects, plant material typically consists of whips, bare root stock or small saplings. Using smaller material is lower cost than larger material and usually results in better establishment over time. As guided by restoration goals and plant community targets, install ecologically appropriate and local ecotype native trees and shrubs. Protection from deer and rodent browsing may be necessary. Appropriate native species can be selected from the MNDNR species list (MNDNR 2003b, Appendix C) for each target plant community; however, climate change should also be taken into consideration. The Climate Change Atlas (https://www.fs.fed.us/nrs/atlas/) provides lists of tree species predicted to be resilient to climate change in northern Minnesota. Tree species that should be considered for planting in the HNA's forests include:

  - Bur oak (*Quercus macrocarpa*)
  - Northern pin oak (*Q. ellipsoidalis*)
  - Northern red oak (*Q. rubra*)
  - White oak (*Q. alba*)
  - Blackjack oak (*Q. marilandica*)
  - Chestnut oak (*Q. prinus*)
  - Post oak (*Q. stellata*)
  - Eastern hophornbeam/Ironwood (Ostrya virginiana)
  - Hackberry (*Celtis occidentalis*)
  - Mockernut hickory (*Carya alba*)
  - Mountain maple (*Acer spicatum*)
  - Red maple (*A. rubrum*)
  - Silver maple (*A. saccharinum*)
  - Sugar maple (*A. saccharum*)
  - Yellow/Tulip poplar (*Liriodendron tulipifera*)

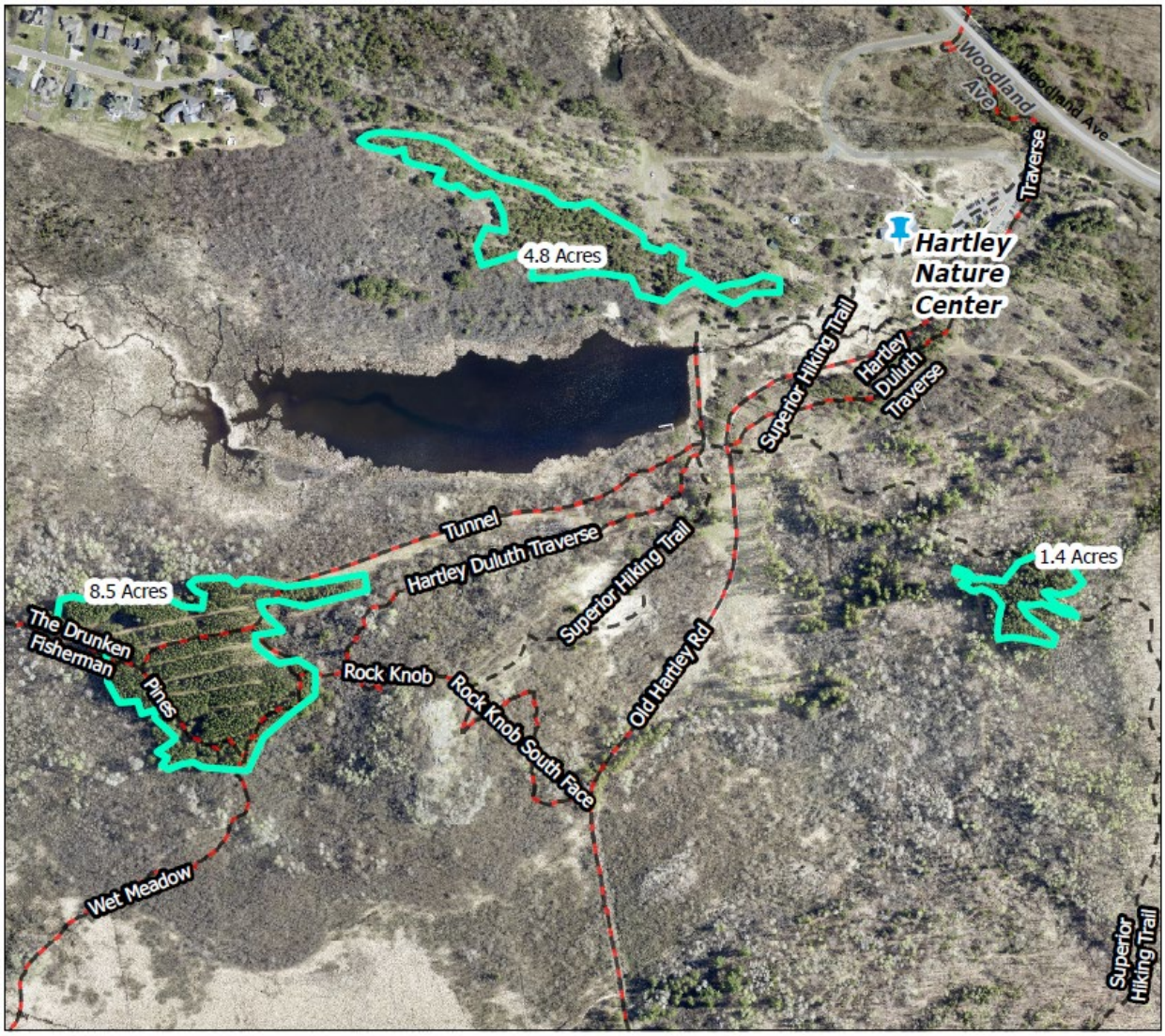
- **Direct Seeding.** Direct seeding of harvested acorns, walnuts, hickory nuts, butternut, and seeds of elm and maple is a low-cost but slow method to establish woody plants; however, it may be effective in certain areas.

- **Timing of Planting.** It is often best to not install woody vegetation in the first year or two of restoration and management due to the extensive invasive plant removal occurring. Native trees and shrubs can be added after invasive management is completed.

3.2.8 Conifer Plantation Thinning and Restoration

The HNA contains about 51 acres mapped as Conifer Plantation. While dominated by native Red pine (*Pinus resinosa*) and Jack pine *(Pinus banksiana*), these represent significantly altered plants communities. Over the past several years, the City of Duluth has been implementing a conifer plantation thinning project, which includes approximately 15 acres in the HNA (Figure 5). A significant proportion of planted pines were removed from the site in 2016 (including trees knocked over by the 2016 blowdown), and continued thinning is proposed to occur over the coming years.

Figure 5. Pine Stands within City Thinning Plan in Hartley Natural Area (Source: City of Duluth)



The City's conifer plantation thinning plan includes replanting with a diversity of conifer seedlings: White pine (*Pinus strobus*), Balsam fir (*Abies balsamea*), White spruce (*Picea glauca*), and White cedar (*Thuja occidentalis*). In addition to conifer seedlings, the City intends to also direct seed other appropriate native species such as Paper birch (*Betula papyrifera*), Red oak (*Quercus rubra*), Bur oak (*Quercus macrocarpa*), Yellow birch (*Betula alleghaniensis*), and Red and Sugar maple (*Acer rubrum*, *A. saccharum*). Restoration plantings will also include native shrubs and herbaceous plants. Local conditions will dictate which species are most appropriate for a particular location. All tree plantings will require browse protection from White-tailed deer.

3.2.9 Turf to Native Vegetation Conversion

Small portions of the HNA contain turf lawn; most of these are actively used, justifying this vegetation cover. To increase habitat (for pollinators and other native species), to improve other ecosystem services, and to reduce long-term maintenance costs, underutilized turf areas could be converted to

native prairie or savanna groundlayer vegetation. The conversion of herbaceous vegetation from turf grass to prairie/savanna grasses, sedges, and wildflowers involves the following.

- **Native Plant Protection.** Protect desirable vegetation, especially mature native trees, by marking a perimeter around them in which turf removal methods are carefully applied.
- **Turf Removal without Herbicide.** Black plastic laid on the turf in summer will kill turf. However, this process requires large amounts of plastic sheeting, the plastic must be installed to not cause runoff and erosion problems, it may require several months for turf to die, and soil-dwelling biota will also be killed. Sod-cutting is another turf removal method; however, this procedure also removes topsoil from the site, which requires transport and disposal and may leave site soils less conducive to revegetation.
- **Turf Removal with Herbicide.** Use approved broadcast herbicide to kill existing lawn and other undesired vegetation. A minimum of two herbicide treatments is often required to control turf species and achieve performance standards. Mowing prior to or in between treatments may improve the kill of the turf.
- **Native Seeding.** Once turf species are removed satisfactorily, seed with local ecotype native seed. Seeding is less expensive than installing live plant plugs, however seeding requires more time for establishment, and some prairie and savanna species are slow to develop.
- **Live Plugs.** Some species are best installed as live plants. If rapid establishment and additional species diversity is desired, enhancement plugging can be conducted in select areas, such as along roads and paths, or near buildings, signage, and other site amenities.

Unit costs (see Table 5) can be used for estimating the price of these conversions at the level of individual sites.

3.2.10 Ecological Monitoring & Reporting

Monitor natural areas response to restoration/enhancement activities so management activities are adjusted accordingly. Monitoring the restoration and management activities at a site will help define the best management schedule and techniques. Monitoring can range from rapid and simple assessments to quantitative surveys with detailed reporting. A detailed discussion of ecological monitoring and reporting is in Section 3.4.

Management Considerations When Working In or Near Vernal Pools

A number of vernal pools have been identified at Hartley Nature Area, and many other pools may exist at the site. These important habitats support a diversity of native reptiles (including the State-threatened Blanding's turtle), amphibians (including several salamanders and frogs), and aquatic insects (including fairy shrimp). Given the sensitivity of these habitats and the species they support, special care should be taken during execution of ecological restoration and management tasks. Precautions include:

- Prevent the introduction or spread of non-native earthworms by following MNDNR guidelines (Appendix A).
- Avoid activities that could result in rutting, compaction, erosion, or sedimentation impacts. When possible, conduct work when soils are frozen or very dry to avoid soil disturbance.
- Avoid use of herbicides. If used, herbicides should be aquatic-approved and applied with the appropriate equipment for precision application and to minimize the amount of chemical used.
- Avoid changes to the adjacent or overhanging tree canopy, as this can change the pool's hydrology and water temperature, potentially adversely affecting vegetation and wildlife.

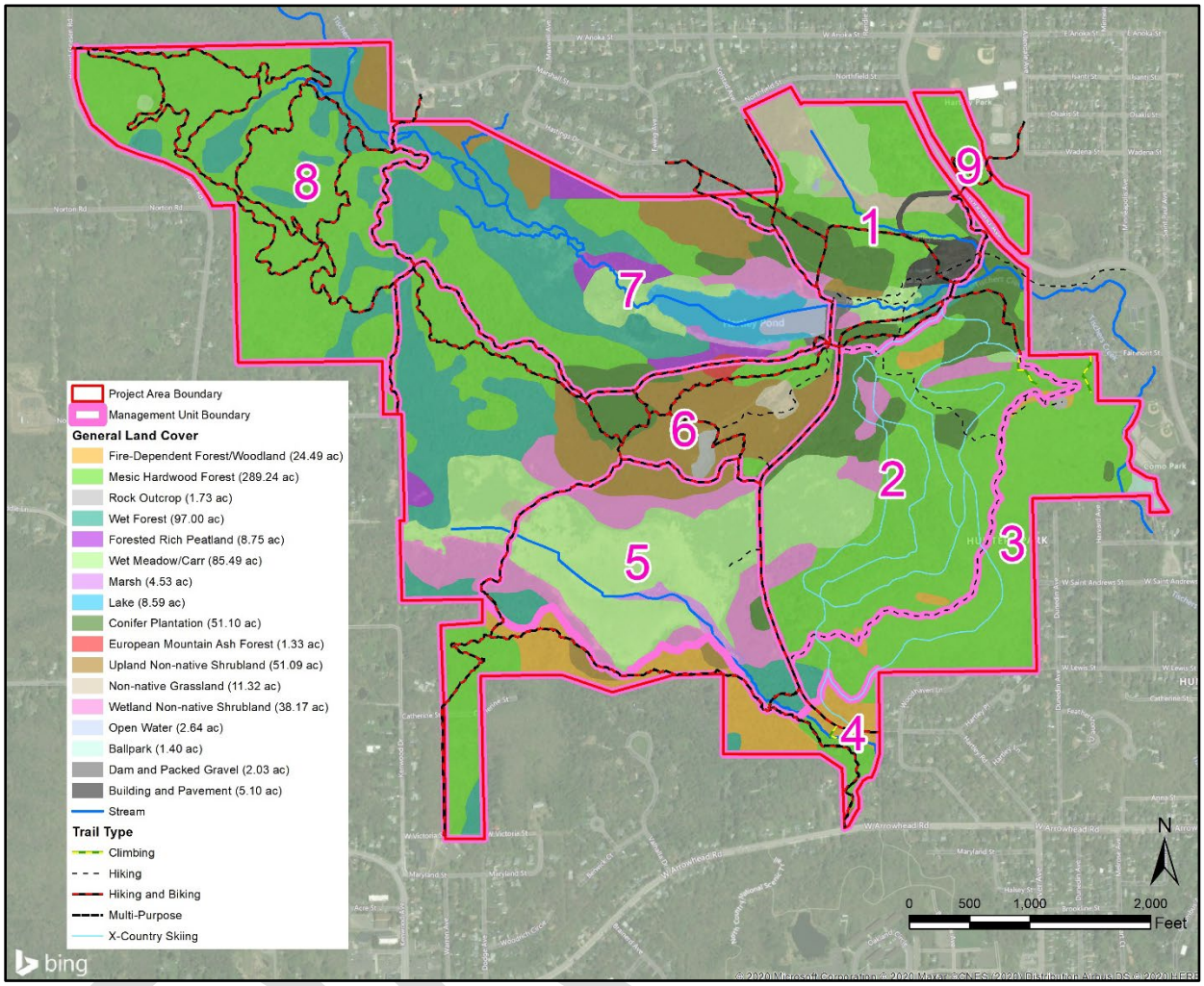
3.3 Native Vegetation Restoration & Management Program

3.3.1 Generalized Land Cover and Management Units

Ecological restoration, enhancement, and management are often conducted in a given area or "management unit." Small sites may be treated as a single management unit, but larger sites are often subdivided to facilitate implementation of restoration/management tasks in areas with similar management needs and proposed uses. Management units are also used to phase projects over time, often necessitated by annual budgets, or to provide refuges for invertebrates during and after prescribed fires. Management units may consist of a single plant community type (e.g., forest), but they often contain a variety of plant communities. Management unit boundaries are typically delineated along existing roads/trails, plant community edges, watercourses, or topographic breaks.

For the Hartley Natural Area, existing land cover data (Reschke et al 2019) was used to classify the site into major landforms and plant communities. This included consideration of natural communities at the MNDNR "System" level as well as cultural land cover types. Plant communities typically reflect local soils, moisture, slope, and aspect conditions, and this was confirmed for much of the site through comparison of land cover mapping with soils mapping, topographic data, wetland mapping, and aerial imagery. In addition, road and trail alignments, previously managed areas, and ecological quality ranks were also considered to develop draft management units for the site. Draft management units were reviewed by and discussed with City staff, HNC staff, and the Technical Team, leading to the development of nine management units shown in Figure 6.

Figure 6. Generalized Land Cover and Management Units of Hartley Natural Area



3.3.2 Recent or Ongoing Projects by Others

Several entities separate from the City of Duluth and Hartley Nature Center (HNC) are leading ecological restoration and management projects in Hartley Natural Area. These are discussed briefly below.

Hartley Park Northwest Hills Restoration Plan

The Nature Conservancy (TNC) is actively working in MU-8 and the northwest portion of MU-7 under a project titled the "Hartley Park Northwest Hills Restoration Plan." In response to the July 2016 blowdown that severely impacted this portion of the Park, TNC is conducting brushing activities and native tree planting in 36 canopy gaps, totaling approximately 12 acres. TNC plans to conduct initial brushing, tree planting, and browse protection efforts with their contracted crew during late 2020, but there will be future opportunities for volunteers to add trees and browse protection in Spring 2021 and subsequent maintenance opportunities over the coming decade. More detailed information regarding TNC's restoration plan is provided in Appendix D.

Tischer Tributary Channel Restoration Project

The South St. Louis County SWCD has recently completed a channel restoration project along Tischer Creek as it flows southeast through MU-1. The project entailed re-grading the channel, armoring the banks, and installing toe wood, cobble riffles, and grade control structures.

Tischer Creek Channel Re-Route

The Minnesota DNR Is working with the City and partners in the area to explore a watershed level roadmap for Tischer Creek. This will include looking at alternatives to restore the health of Tischer Creek in and around Hartley Pond and its' associated dam.

Other Ongoing Projects

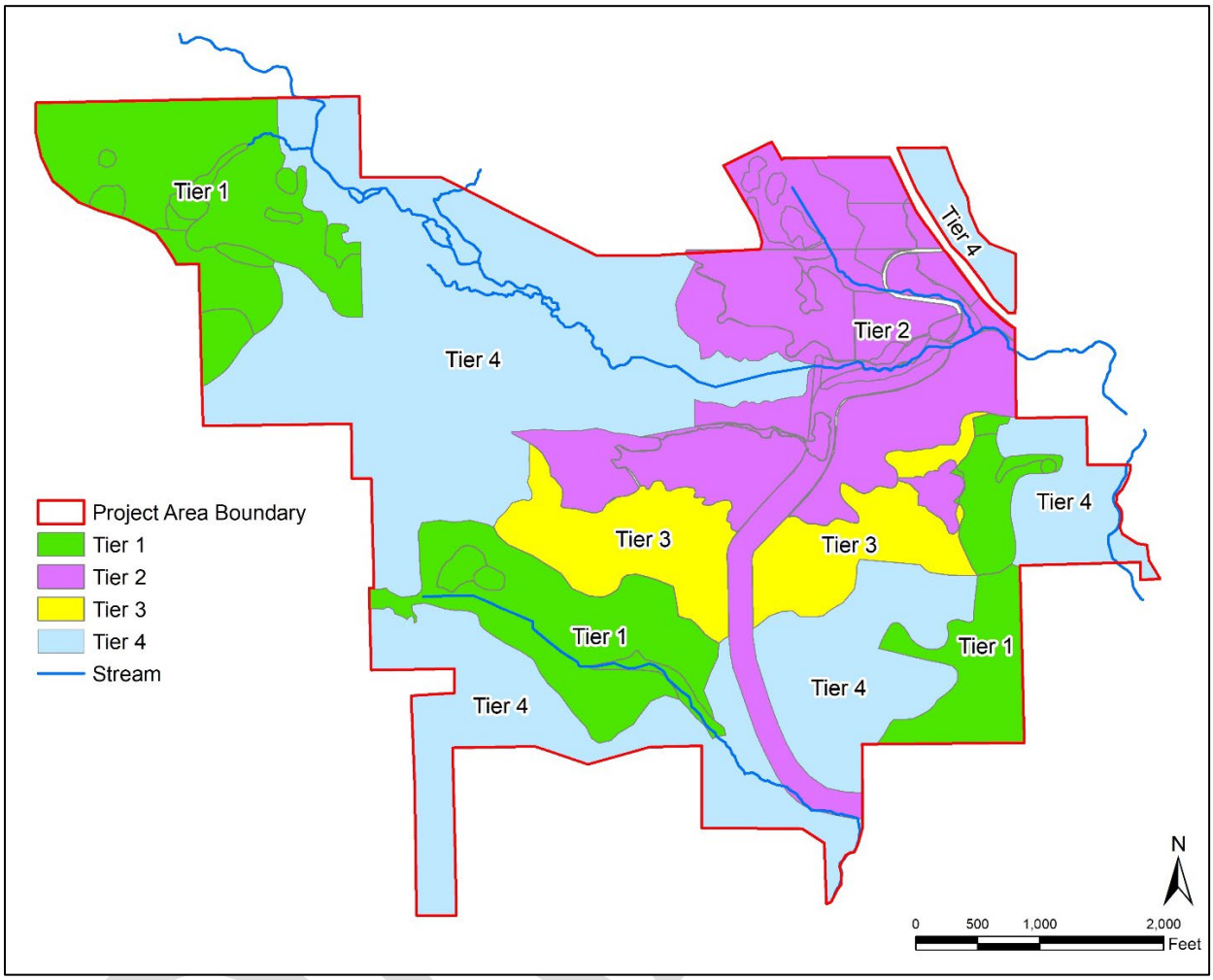
The City and HNC also have several restoration, enhancement, and management projects underway within the Natural Area. These ongoing projects, along with newly proposed projects, are addressed in the following section.

3.3.3 Project Prioritization

Plant community mapping and assignment of quality ranks helps identify native plant communities appropriate for restoration and enhancement at the site. Proposed native plant communities are those largely self-sustaining ecological combinations of species that are expected to develop at a site following the implementation of ecological restoration and management activities. Most of the HNA's plant communities are native, generally warranting enhancement to a higher level of ecological integrity. Others plant communities are cultural, such as the old pine plantation stands; these can be restored and managed in a variety of ways, depending on short- and long-term goals for the area. Other cultural landscapes, such as turf lawns and native landscapes and gardens near HNC, are not proposed for restoration and management.

Working closely with City staff, HNC staff, and the Technical Team, a tiered prioritization scheme was developed. Priorities were arrived at considering a variety of criteria, including location considerations (e.g., protection of high-quality plant communities, managing areas of previous investment), cultural considerations (e.g., safety issues, educational programs and opportunities), and specific actions (e.g., control of noxious invasive species). Tier 1 represents the highest priority areas for vegetation restoration and management to occur, followed by Tiers 2 through 4 (Figure 7). A description of each Tier follows.

Figure 7. Tiered Approach to Priority Vegetation Projects at Hartley Natural Area



Tier 1 (153 acres)

Highest quality natural areas. By focusing on these relatively intact portions of the site, the site's most valuable plant communities will be protected with limited effort and resources. Of particular importance is controlling early invasions by aggressive plant species before they get a foothold and degrade ecological health.

Tier 2 (153 acres)

Areas where past or ongoing vegetation restoration management has occurred. By addressing these areas, the City is safeguarding past investments of time and money, ensuring restoration areas do not "backslide" into their former, degraded condition.

Tier 3 (60 acres)

Provides better connectivity between Tier 1 and Tier 2 areas. By coalescing restored natural areas, the amount of disturbed "edge" habitat is reduced, thereby reducing adverse edge effects such as encroachment by invasive plant species.

Tier 4 (316 acres)

Completes the restoration and management of the HNA. Following Tiers 1 through 3 (and with a better understanding of incorporating adaptive management techniques at the site), a phasing plan will be developed to address the restoration and management needs of remaining natural and semi-natural areas.

This Plan looks out about ten years focusing on Tiers 1 and 2, with the understanding that future Plan updates will advance work into Tiers 3 and 4 until all of the HNA is under management. Discrete projects within Tiers 3 and 4 will be defined and prioritized in a manner similar to that used in establishing Tier 1 and 2 priorities. Tier 3 and 4 prioritization considerations may be influenced by progress within Tier 1 and 2 areas, other types of project work (e.g., the Tischer Creek riparian corridor may rise as a priority as stream restoration gets underway), results of monitoring data, future partnerships, and/or other factors. The general restoration and management tasks and costs provided in this Plan will be comparable for similar plant communities of similar quality as detailed under Tier 1 and 2 projects below.

Following our tiered approach, more specific priority projects are defined for Tiers 1 and 2 (Figure 8 and Table 4) since this work is anticipated to be a major component over the next ten years. Should the nature of funding, staffing, and partnerships improve, the work may take less time than this Plan anticipates and the Plan should be updated to advance the work accordingly. Table 4 provides project name, acreage, and restoration and management needs and goals for each priority project.

Figure 8. Priority Projects at Hartley Natural Area

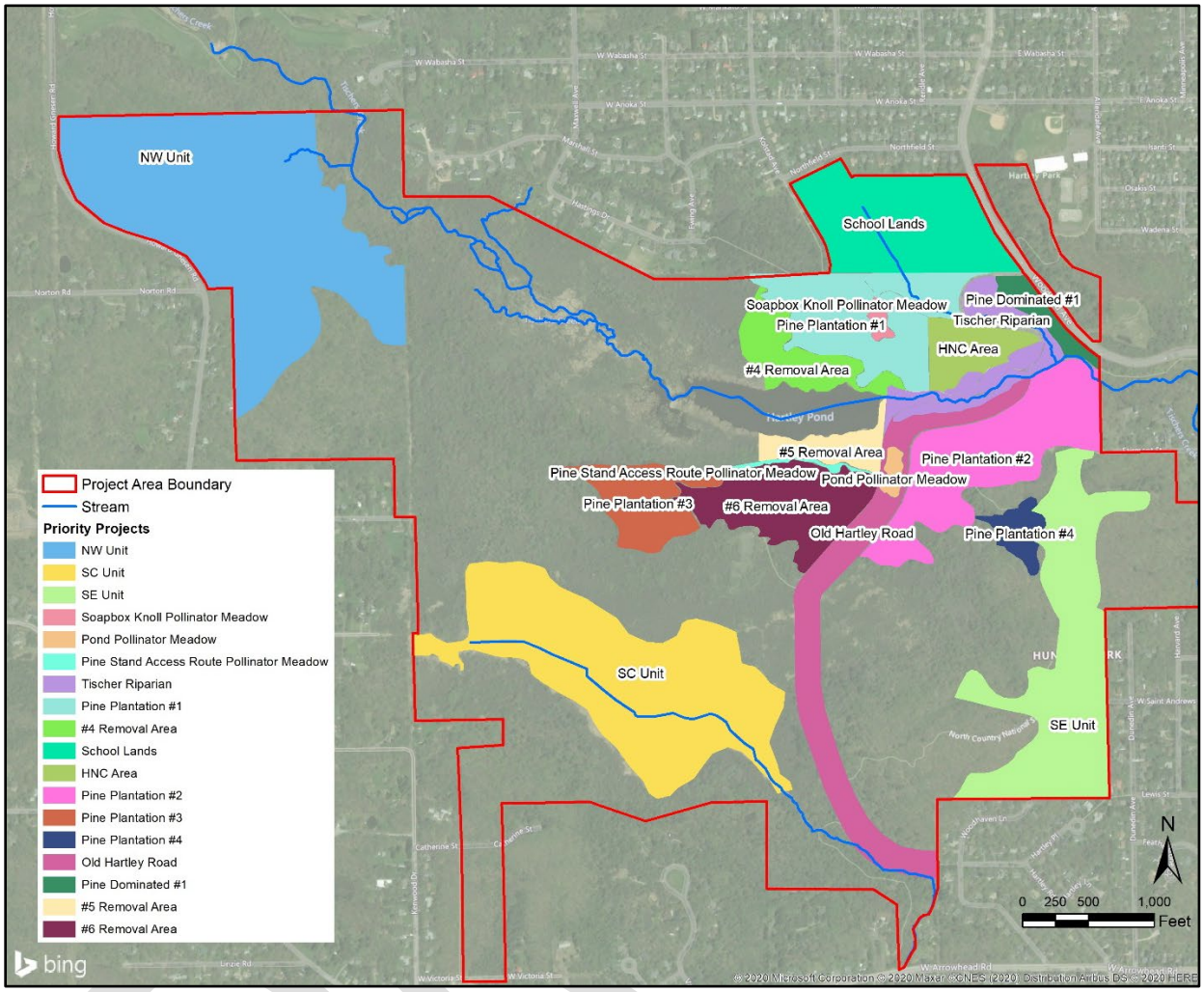


Table 4. Priority Vegetation Management Projects at Hartley Natural Area

Project Name	Area (acres)	Existing Community/Condition	Target Community	Required Tasks	Comments
Tier 1					
NW Unit	69.1 (7.8 ac needs management)	Good quality upland forests (BC), with blowdown damage	Enhanced (and diversified) native forests; min. quality BC	Brush buckthorn (limited cover); interplant canopy gaps with native, long-lived conifers & other species	TNC currently implementing, but focusing on only 36 canopy gaps (~12 ac)
SC Unit	50.5 (5 ac needs management)	Wet Meadow/Carr (BC)	Enhanced Wet Meadow/Carr; min. quality B	Manage reed canary grass and invasive cattail (in patches)	Old farmstead "island" (0.85 ac) source of invasives
SE Unit	33.6 (5 ac needs management)	Good quality upland forest and woodland (B-BC)	Enhanced forest and woodland; min. quality B	Brush buckthorn	Private trails & associated impacts not explicitly addressed
Tier 2					
(3) Pollinator Meadows (Soapbox Knoll, Pond, and Pine Stand Access Route)	2.7	Restored prairies/meadows; under long-term management	Enhanced prairies/meadows; min. quality BC	Spot spraying; weed pulling	Already under long-term management
Tischer Riparian	9.4 (not all needs all management)	Mostly Wet Forest/Meadow/ Carr; some Mesic Hardwood Forest (D-NN)	Forest and wetland communities; min. quality C	Brush buckthorn; manage reed canary grass	
Pine Plantation #1	19.8 (8 ac needs management)	Conifer Plantation and upland forest, shrubland, and non-native grassland (mostly NN)	Mesic Hardwood Forest; min. quality CD	Continued brushing & follow-up management; tree planting; pine thinning in 2-3 yrs; replant with native trees	Brandon 2020 focus; accommodate future feller-buncher access
#4 Removal Area	8.6 (4 ac needs management)	Upland and lowland shrubland; Conifer Plantation (NN)	Mesic Hardwood Forest and Wet Meadow/Carr; min. quality CD	Continued brushing & follow-up management; tree planting	Brandon 2020 focus; coordinate resto & mgmt. with Creek re-route project
School Lands (#7,8,9,10,11,14 Removal Areas and Pine Dominated #2)	23.6 (12 ac needs management)	Upland forest, Wet Meadow/Carr, and non-native grassland (mostly D, some NN)	Mesic Hardwood Forest and enhanced Wet Meadow/Carr; min. quality CD	Continued brushing & follow-up management; tree planting	Brandon 2020 focus
Hartley Nature Center Area	5	Upland forest, woodland and grassland (mostly NN)	Enhanced communities; min. quality BC	Continued brushing & follow-up management; spot spraying; weed pulling	High visibility area; Brandon/contractors do cutting/herbicide;

Project Name	Area (acres)	Existing Community/Condition	Target Community	Required Tasks	Comments
					volunteers pull weeds, maintain weed mats, water new plantings
Pine Plantation #2	24.9 (8 ac needs management)	Conifer Plantation, upland forests, and lowland shrubland (C to NN)	Mesic Hardwood Forest, enhanced Wet Meadow/Carr, and Enhanced Fire-Dependent Forest/Woodland; min. quality CD	Continued brushing & follow-up management; tree planting	Thinning complete; remaining mgmt. required on far E
Pine Plantation #3	9.7	Conifer Plantation (NN)	Mesic Hardwood Forest; min. quality CD	Continued brushing & follow-up management; tree planting; pine thinning in 2-3 yrs	Accommodate future feller-buncher access
Pine Plantation #4	3.3	Conifer Plantation and Mesic Hardwood Forest (mostly NN)	Mesic Hardwood Forest; min. quality CD	Continued brushing & follow-up management; tree planting; pine thinning in 2-3 yrs	Accommodate future feller-buncher access
Old Hartley Road	20.4	Various upland and lowland communities; invasives along trail corridor (C to NN)	Enhanced communities; min. quality BC	Continued brushing & follow-up management; spot spraying; weed pulling	High visibility corridor; needs heavy lifting before volunteer work
Pine Dominated #1	3.6	Conifer Plantation and non-native grassland (NN)	Mesic Hardwood Forest; min. quality CD	Brush buckthorn & follow-up management; spot spraying; weed pulling	Keep dense to visually screen out the road from the nature center
#5 Removal Area	4.8	European Mtn. Ash Forest, Forested Peatland, Marsh, and Mesic Hardwood Forest (D-NN)	Enhanced communities; min. quality CD	Brush buckthorn & follow-up management; spot spraying; weed pulling	
#6 Removal Area	15.6	Upland shrubland, non-native grassland, Mesic Hardwood Forest, and European Mt Ash Forest (D to NN)	Mesic Hardwood Forest; min. quality CD	Continued brushing & follow-up management; tree planting	

3.3.4 Opinions of Probable Cost

Ecological restoration and management requires an investment. Natural areas planning can help focus limited resources by presenting real unit costs, such as dollars per acre to carry out invasive brush removal in a forest. Many variables influence unit costs. The size of an area being restored, the existing site conditions, access and slope issues all affect cost. For planning purposes, it is useful to understand generalized unit costs (Table 5). Some of these costs apply to long-term management, too, as discussed in Section 3.3.5. These costs assume a professional natural resource contracting firm does the work.

Table 5. Generalized Professional Contractor Unit Costs for Ecological Services

Task	Unit	Unit Cost Range
Brushing (cut and stump treat)	acre	$1,500-$3,500
Brushing (forestry mower)	acre	$1,000-$2,500
Foliar spray young woody brush	acre	$200-400
Broadcast herbicide	acre/trip	$175-300
Spot herbicide	acre/trip	$200-400
Mowing	acre/trip	$150-350
Prescribed burn (min. 3 ac)	acre	$300-700
Tilling	acre	$150-350
Native seed (material only)	acre	$200-$1,100
Native seeding (no-till drill, labor only)	acre	$200-500
Native seeding (hand-broadcast, labor only)	acre	$300-600
Straw mulch (spread and crimp)	acre	$600-900
Installed live herbaceous plant plug	each	$3-7
Installed shrub (2-gallon pot)	each	$25-40
Installed shrub (5-gallon pot)	each	$45-60
Installed tree (10-gallon pot or 2” ball & burlap)	each	$150-250, $300-600

To better understand the cost of implementing priority projects, opinions of probable cost (OPCs) were developed for Tiers 1 and 2 using the project area acreage (Table 4), defining the restoration and management tasks (Section 3.2) needed in each plant community (considering each area’s ecological condition), and assigning average unit costs for each task (similar to those found in Table 5, but adjusted based on City of Duluth’s anticipated approach). OPCs address the costs of initial restoration as well as “establishment management”, which generally covers the first three years of a project. The following table summarizes OPCs for carrying out the necessary initial restoration and establishment management tasks to improve the ecological health of all Tier 1 and Tier 2 priority projects at the HNA.

Table 6. Opinions of Probable Cost1 for Initial Restoration & Management at the HNA Priority Projects

Priority Project	Natural Area Investments (ac)	Estimated Initial Restoration & Management Cost
NW Unit	7.8	$ 44,350
SC Unit	5.0	$ 22,550
SE Unit	5.0	$ 27,360
(3) Pollinator Meadows	2.7	$ 5,940
Tischer Riparian	5.0	$ 57,380
Pine Plantation #1	8.0	$ 57,160
#4 Removal Area	4.0	$ 37,780
School Lands	12.0	$ 134,320
Hartley Nature Center Area	5.0	$ 43,000
Pine Plantation #2	8.0	$ 65,380
Pine Plantation #3	9.7	$ 76,145
Pine Plantation #4	3.3	$ 22,605
Old Hartley Road	20.4	$ 72,420
Pine Dominated #1	3.6	$ 25,020
#5 Removal Area	4.8	$ 53,760
#6 Removal Area	15.6	$ 173,160
Totals	***119.9***	***$ 918,330***

[1] Assumes initial restoration and establishment management (usually first 3 years) conducted by a combination of professional ecological contractors, City staff, and volunteers; costs do not address long-term management.

The City of Duluth and the HNC's existing natural resource restoration and management budgets, staff, and equipment limit what can be practically done in a given year. Therefore, to implement restoration at the level of the anticipated costs, it is necessary to phase in projects over several years. Project implementation and phasing is discussed under Section 3.3.6.

3.3.5 Long-term Management

Long-term management (sometimes called perpetual management) is needed to maintain the composition, structure, and function of healthy native ecosystems. Long-term management begins after the initial restoration work and establishment management are completed, usually around the fourth year. The tasks required for long-term management, and the frequency at which they are implemented, vary depending on the type of plant community, the management needs, and site-specific goals. The primary long-term management tasks are weed control and prescribed burning.

Weed Control

Control invasive, non-native, or other aggressive vegetation, primarily with appropriate spot pulling, spot mowing, and/or spot herbicide applications. Annual weeds can be controlled by mowing them prior to setting seed. Deck-mounted equipment, string trimmers, and other methods can be used to accomplish mowing. Cutting and foliar spraying of invasive woody vegetation may also be necessary in areas with ongoing woody invasion.

Prescribed Burning

Prescribed burning is a very cost-effective management tool for many native plant communities, including not only prairies but also some woodlands, forests, and wetlands. Generally, long-term management burns are conducted on a rotational basis (which provides refugia for wildlife), beginning with the fall or spring following the third full year of growth after a new seeding in a fire-dependent community (e.g., prairie). Burns should be designed, timed, and executed to minimize negative impacts to upland grassland birds and invertebrates. In order to mimic natural fire regimes, burns should extend across habitat gradients (e.g., burning from prairies into adjacent wetlands or forests) when feasible. Patchy burns are effective at maintaining heterogeneous habitats and providing refugia for invertebrates and other small animals during and after fire. If prescribed burning is not employed in prairie areas, haying, mowing, and/or grazing should be used to remove accumulating plant material and to control woody seedlings. Appropriate equipment and timing should be used to prevent rutting of wetland soils.

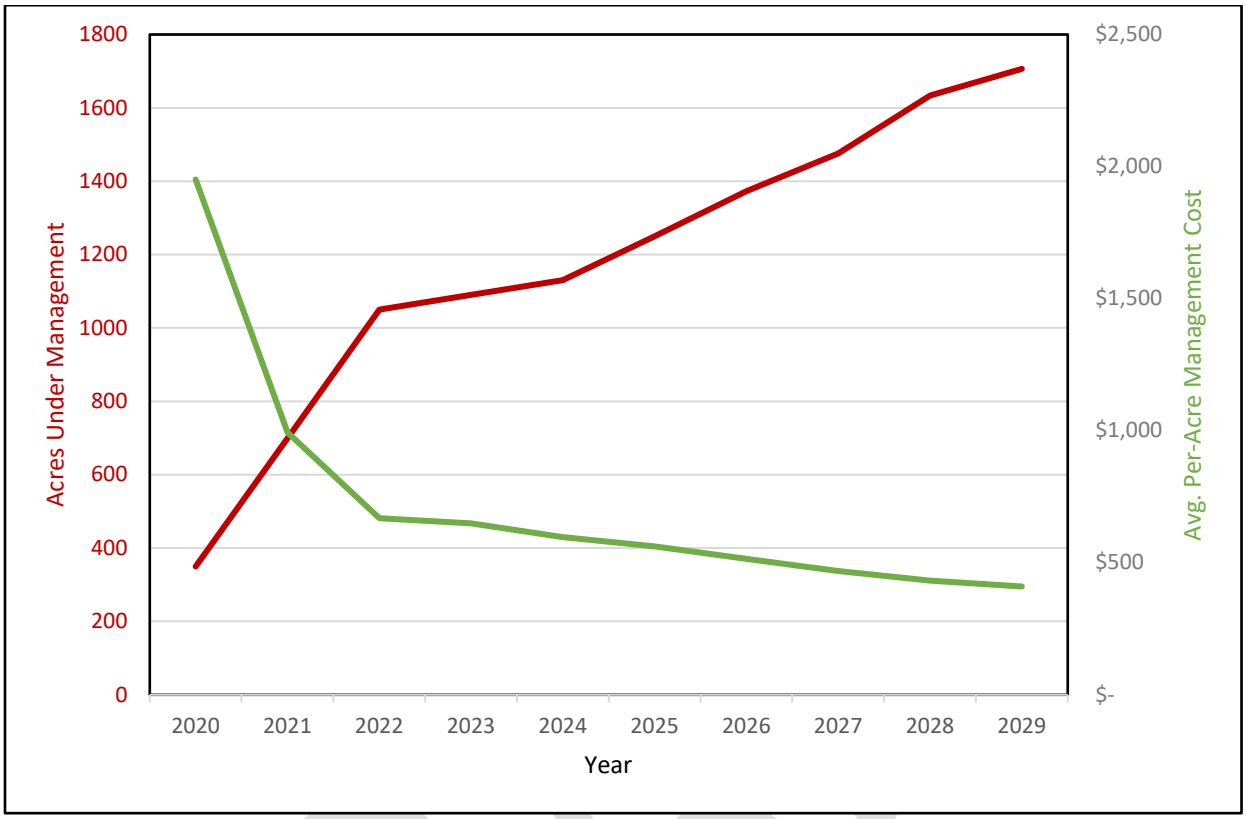
Annual costs for long-term management typically range from $150-$500 per acre, depending on a variety of factors, and should be considered as part of the budget when deciding the type and size project being undertaken.

3.3.6 Implementation Schedule

The City of Duluth and the HNC are responsible for implementing this Plan and will need to decide how internal resources (e.g., staffing, expertise, City funding) and external resources (e.g., grant funds, partners, volunteers) will be leveraged and how aggressively to implement ecological restoration and management at the HNA. As discussed above, most restoration efforts require more substantial up-front costs (e.g., woody invasive species removal, native plant materials installation). This is then followed by two or three years of "establishment management" with relatively regular and intense management practices to ensure the restoration remains on a trajectory for success. Over time, the initial costly restoration and establishment phase will require less effort/resources, decreasing annual costs (Figure 4). This typically frees up funding and allows additional acreage to come under restoration and management; however, it is important that all restored natural areas be perpetually managed (but at a relatively low cost).

Figure 9 shows a hypothetical restoration and management program where at the beginning (2020), per-acre costs are high and the area managed is small. Several years later, though, per-acre costs have fallen dramatically and the number of acres under management has risen substantially. At the end of the decade, annual per-acre management costs will average around $375, which is typical for long-term management costs.

Figure 9. Hypothetical Project Acres Managed & Per-Acre Cost



At this time, the City and the HNC do not have a projected budget for the HNA; this Plan is intended to provide information for the City and HNC to set future budget goals with their partners. Based on project prioritization and OPCs developed above, Table 7 presents an implementation schedule for native plant community vegetation restoration and management over the coming decade. This scenario assumes annual expenditures of approximately $90,000 to $100,000 for each of the next ten years. While available funding and resources are not known at this time, it is the City's goal – along with the HNC as their partner – to initiate or continue restoration and management efforts in all Tier 1 and Tier 2 areas over the coming decade. Tier 3 and 4 projects will then be defined, prioritized, and phased in as funding and other resources allow. Should the nature of funding, staffing, and partnerships improve, the work may take less time than indicated in Table 7 and the Plan should be updated to advance the work accordingly.

Table 7. Ten-year Implementation Schedule for Priority Projects at Hartley Natural Area

Hartley Natural Area Native Plant Community Management Plan (20-0133)
Prioritization, Phasing & Opinions of Probable Cost
Scenario: budget $50K-$100K/yr; 2% annual inflation

= Initial Restoration
= Establishment Management (avg. $300/ac/yr)
= Long-term Management (avg. $150/ac/yr)

			Year										
Prioritized Terrestrial Restoration & Management Projects	**Natural Area Investments (ac)**	**Estimated Initial Resto & Mgmt Costs for Project**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total Cost**
NW Unit	7.8	$ 44,350	$ 14,769	$ 15,064	$ 15,365	$ 2,483	$ 2,533	$ 1,292	$ 1,318	$ 1,344	$ 1,371	$ 1,398	**$ 56,936**
SC Unit	5.0	$ 22,550	$ 7,509	$ 7,659	$ 7,813	$ 1,592	$ 1,624	$ 828	$ 845	$ 862	$ 879	$ 896	**$ 30,506**
SE Unit	5.0	$ 27,360	$ 9,111	$ 9,293	$ 9,479	$ 1,592	$ 1,624	$ 828	$ 845	$ 862	$ 879	$ 896	**$ 35,408**
(3) Pollinator Meadows	2.7	$ 5,940	$ 1,978	$ 2,018	$ 2,058	$ 860	$ 877	$ 447	$ 456	$ 465	$ 475	$ 484	**$ 10,117**
Tischer Riparian	5.0	$ 57,380	$ 19,108	$ 19,490	$ 19,879	$ 1,592	$ 1,624	$ 828	$ 845	$ 862	$ 879	$ 896	**$ 66,001**
Pine Plantation #1	8.0	$ 57,160	$ 19,034	$ 19,415	$ 19,803	$ 2,547	$ 2,598	$ 1,325	$ 1,351	$ 1,378	$ 1,406	$ 1,434	**$ 70,292**
#4 Removal Area	4.0	$ 37,780	$ 12,581	$ 12,832	$ 13,089	$ 1,273	$ 1,299	$ 662	$ 676	$ 689	$ 703	$ 717	**$ 44,522**
School Lands	12.0	$ 134,320	$ 13,432	$ 13,701	$ 13,975	$ 85,525	$ 14,539	$ 4,054	$ 4,135	$ 2,068	$ 2,109	$ 2,151	**$ 155,689**
Hartley Nature Center Area	5.0	$ 43,000					$ 15,499	$ 15,809	$ 16,126	$ 1,757	$ 1,793	$ 896	**$ 51,881**
Pine Plantation #2	8.0	$ 65,380					$ 23,566	$ 24,038	$ 24,518	$ 2,812	$ 2,868	$ 1,434	**$ 79,236**
Pine Plantation #3	9.7	$ 76,145					$ 27,446	$ 27,995	$ 28,555	$ 3,410	$ 3,478	$ 1,739	**$ 92,623**
Pine Plantation #4	3.3	$ 22,605						$ 8,311	$ 8,477	$ 8,647	$ 1,183	$ 1,207	**$ 27,825**
Old Hartley Road	20.4	$ 72,420						$ 7,996	$ 8,156	$ 66,550	$ 7,314	$ 7,460	**$ 97,476**
Pine Dominated #1	3.6	$ 25,020								$ 5,748	$ 23,921	$ 1,317	**$ 30,986**
#5 Removal Area	4.8	$ 53,760									$ 44,974	$ 19,660	**$ 64,634**
#6 Removal Area	15.6	$ 173,160										$ 52,770	**$ 52,770**
Totals	***119.9***	***$ 918,330***	***$ 97,521***	***$ 99,472***	***$ 101,461***	***$ 97,463***	***$ 93,229***	***$ 94,414***	***$ 96,302***	***$ 97,453***	***$ 94,230***	***$ 95,357***	***$ 966,901***

Note: this 10-year projection assumed an annual budget of $100,000 per year, and therefore, the additional costs to work into Tier 3 and 4 are not projected. If funding becomes available at a greater scale, more may be able to be accomplished in this time period.

3.3.7 Funding Sources

The completion of this Plan better positions the City of Duluth, the HNC, and/or their partners to pursue and secure grant funding for native plant community projects at Hartley Natural Area. Based on a review of available conservation and natural resource grants, we compiled the following list of potential funding sources appropriate for native plant community restoration and management at Hartley Natural Area. Recommended priority grant opportunities have been underlined.

Federal Programs

- **Great Lakes Restoration Initiative (GLRI).** The U.S. EPA and its partner agencies agree on program and project priorities to implement the GLRI Action Plan. The money is appropriated to EPA, which provides funding to other federal government agencies. In turn, those agencies (and EPA, too) use that money to fund restoration projects. Projects must support one of the GLRI focus areas, which include invasive species, habitat and species, education, monitoring, evaluation, communication, and partnerships.
  More information is available at: https://www.glri.us/funding
- **National Fish and Wildlife Foundation (NFWF) (Federal Public-Private Partnerships)**
  - **Five Star and Urban Waters Restoration Grant**. A partnership grant to develop community stewardship of local natural resources—preserving them for future generations and enhancing wildlife habitat. Also addresses water quality in designated priority watersheds. All projects must have on-the-ground measurable activities, community partners, integrated education and outreach. Request for proposals annually, April.
    More information: https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program
  - **Monarch Butterfly and Pollinators Conservation Fund**. A program to advance pollinator education by protecting, conserving, and increasing habitat for monarchs and other pollinators. Priority will be given to projects within the monarch's eastern migratory flyway that includes 16 states (Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas and Wisconsin. Uses measurable metrics to rank (primarily acres restored/created). Restoration work to focus on federal, state, and tribal lands; rights-of-way for rail, transmission/pipeline, and roadside; and agricultural lands. 1:1 Match.
    More information: https://www.nfwf.org/programs/monarch-butterfly-and-pollinators-conservation-fund/monarch-butterfly-and-pollinators
  - **Resilient Communities Program.** Designed to enhance community capacity to plan and implement resiliency projects and improve the protections afforded by natural ecosystems by investing in *green infrastructure* and other measures. Emphasis on floods and droughts in the Midwest. States and communities associated with Wells Fargo Operations. Request for proposals annually, April.
    More information: https://www.nfwf.org/programs/resilient-communities-program

State and County Programs

- **Natural Resources Block Grant**. The Natural Resources Block Grant (NRBG) is a state grant available to counties to help them implement programs designed to protect and improve water resources. This Plan focuses on restoration and management of native plant communities, so vegetation projects that benefit water resources may be eligible under this grant. St Louis County utilizes its Comprehensive Water Management Plan to assist this implementation.
  More information is available at: https://www.stlouiscountymn.gov/departments-a-z/planning-development/land-use/plans-grants#5230597-natural-resources-block-grant-nrbg
- **Outdoor Heritage Fund**. Thirty-three percent of the sales tax revenue from the Clean Water, Land and Legacy amendment is distributed to the Outdoor Heritage Fund. Those funds "may be spent only to restore, protect, and enhance wetlands, prairies, forest and habitat for fish, game, and wildlife." Includes **Conservation Partners Legacy** (CPL) grant program.
  More information is available at: https://www.legacy.mn.gov/outdoor-heritage-fund
- **Minnesota's Lake Superior Coastal Program**. Every year the DNR offers grants to help communities, agencies, and organizations balance protection of Lake Superior coastal resources with providing places for people to live, work, and play.
  More information is available at:
  https://www.dnr.state.mn.us/waters/lakesuperior/grants.html
- **Clean Water Fund.** Thirty-three percent of the sales tax revenue from the Legacy amendment is allocated to the Clean Water Fund. Those funds may only be spent to protect, enhance, and restore water quality in lakes, rivers, and streams and to protect groundwater from degradation. At least five percent of the clean water fund must be spent to protect drinking water sources.
  More information: https://www.legacy.mn.gov/clean-water-fund
- **Environment & Natural Resource Trust Fund**. The Environment and Natural Resources Trust Fund (ENRTF) was established following voter approval of a constitutional amendment in 1988. The money in the Trust Fund is generated by the Minnesota State Lottery. The Trust Fund holds assets that can be appropriated, "for the public purpose of protection, conservation, preservation, and enhancement of the state's air, water, land, fish, wildlife, and other natural resources."
  More information is available at: https://www.legacy.mn.gov/environment-natural-resources-trust-fund

Local Programs

- **Hartley Memorials**. Special, usually one-time donations given to Hartley Nature Center to recognize a loved one.

3.4 Monitoring & Reporting

3.4.1 Monitoring

The most successful natural resource restoration and management programs collect pre- and post-management data to establish a baseline and measure subsequent positive, negative, and neutral trends in natural resources. The data collected should be simple to gather, easy to analyze, and straight-forward to present. Monitoring data are typically collected in the following ways:

- **Field Data Forms**. Designed to easily record information necessary for evaluating metrics and performance standards.
- **Field Photography**. Photography is a very efficient and useful monitoring tool. Field photography techniques include:
    - *Ground Photography* – Photos taken of landscapes (with the camera held horizontally) are useful for documenting general appearance, structure, and possibly species diversity. Photos taken at roughly a 45^{o} angle looking downward provide better documentation of actual vegetation species and ground conditions (useful for estimating percent cover, documenting fine fuel available for prescribed burning, and recording small erosion features). Techniques that maximize the utility of ground photography include:
        - Georeferenced Photographs – documents photo location for reference in GIS; the smart phone or tablet application "Collector for ArcGIS" can be used to georeference photos.
        - Repeat Photography – Photos taken at a marked and/or fixed location over time to document conditions and track progress/trends; usually a photo is taken in each of the four cardinal directions.
    - *Aerial Photography* – With the increased availability of unmanned aerial vehicles (UAVs, or drones), it is relatively easy to collect site-specific aerial photography or other remote sensing data (e.g., elevation contours). As with ground photography, aerial photography has greater utility when georeferenced and used for repeat photography.
- **Geographic Data**. Developing and updating maps or other geographic data can be an important monitoring tool. GIS is a commonly used and powerful platform for collecting and managing spatial data as well as the attributes associated with mapped features. ArcGIS Online and Collector for ArcGIS are powerful tools that provide cloud-based mapping services and can greatly facilitate field data collection.

The type and frequency of monitoring can vary depending on the stage of the project. Typically, monitoring is more frequent and comprehensive during the initial stages of the restoration (referred to as "Construction Oversight Monitoring" below). Hiring a qualified professional ecological contractor typically reduces the amount of construction oversight monitoring required. After the initial restoration has been completed, monitoring during long-term management (referred to as "General Natural Areas Monitoring" below) may decrease in frequency and/or focus on different restoration goals.

1. **Construction Oversight Monitoring (during initial restoration and establishment management)**
    a. *Site Preparation Inspection.* Before installing native seed and plants, a qualified ecologist should inspect the entire project area to confirm site preparation was done properly. This includes removal of invasive vegetation and preparation of seedbed or soil for planting.
    b. *Restoration Management.* During restoration activities, a qualified ecologist should oversee contractors, City staff, and volunteers at a frequency required by the skill level of workers and tasks being implemented.
    c. *Assess Attainment of Performance Standards.* After restoration work is completed, a qualified ecologist should assess objective and measurable performance standards and identify any required warranty planting and seeding (e.g., replacement of dead plantings, overseeding if native cover goal not achieved).
2. **General Natural Areas Monitoring (typically during long-term management)**
    a. *Conduct Walkabout Survey.* Walk the site and complete a qualitative assessment to document general ecological conditions, the presence of invasives, and other environmental concerns as time and resources allow.
    b. *Collect Data on Monitoring Metrics.* Using established metrics for the project (e.g., percent cover by native vegetation, percent of cut stumps re-sprouting at any given time), assess attainment of desired trends and performance standards.
    c. *Report Issues to City.* Promptly determine and schedule needed interventions. For instance, a new invasive plant population may be identified, warranting control.

Data collection and analysis can be supported by enlisting "citizen scientists", students, and teachers. Any restoration project can become a "living lab" for both research and public education. However, some monitoring (e.g., most plant and insect studies) requires a higher level of expertise, training, or oversight.

Bioblitz

Many communities have collected valuable field data by sponsoring a bioblitz, a 24-hour period when professionals and volunteers document all living species in a given area, such as a public park. A bioblitz gathers data on plants and animals in an area as people discover the natural world there and learn from experts. Holding a bioblitz at the HNA could be an effective way to engage the nearby colleges and universities, HNC members, and the local community to collect baseline or ongoing monitoring field data for comparison with previous and/or subsequent bioblitzes and monitoring.

3.4.2 Reporting

After monitoring data is collected, it is typically summarized and analyzed in a written report and/or database. The frequency of this reporting can vary; some projects require reporting after every site visit, while others choose to receive a compilation of information once a year. Reporting allows stakeholders to review available information on vegetation, wildlife, and erosion to determine if project goals are being achieved and whether adjustments to management practices may be needed. This "adaptive management" sets in motion a cycle of evaluation, adjustment, and refinement to make

maintenance activities most effective. A simple written report, cumulative spreadsheets, and/or data assimilated into a GIS platform provides a means of collecting, archiving, updating, assessing, and tracking monitoring data to ensure performance standards are met and adaptive management is practiced.

Advances in technology have provided several new options for collecting and reporting monitoring data. Collector for ArcGIS allows information to be shared rapidly between people and departments (e.g., field inspectors and land managers). When monitoring reveals conditions that pose a threat to public safety (hazard trees, erosion issues, etc.), photos taken with Collector can quickly and easily provide georeferenced imagery that documents the location and scope of the issue to City staff. Additionally, select data can be made available to the public so they can be kept informed about projects in their neighborhood as new information is collected. Information sharing should be reviewed to ensure it follows the most current City of Duluth policies.

3.5 Volunteer Engagement

Volunteers can be an important element in a natural resources restoration and management program. Some volunteer tasks may be one-time events, and other tasks may be repeated over time by dedicated volunteer stewards. Volunteers can be particularly effective at some long-term management and monitoring tasks. Volunteer efforts may involve physical labor (e.g., planting trees, removing invasive species) or monitoring/research (e.g., field observations, data collection, and data analysis). Many volunteer activities require oversight by trained volunteers, staff, or partners. Staffing investments are often necessary to operate a safe, effective, and sustainable volunteer program.

Many benefits can arise from engaging volunteers in a specialized natural resource management volunteer program:

- The public learns about natural resources, increasing their awareness and appreciation of natural areas and the natural world.
- Valuable data can be collected for baseline and trend monitoring.
- Cost-savings can be achieved through volunteer labor and in-kind match for grants.
- Builds community and appreciation of parks and natural resource programs.

The following table summarizes natural resource management tasks for which volunteers can provide assistance, as well as what tasks are appropriate for City/HNC staff or professional restoration contractors (discussed below).

Table 8. Using City/HNC Staff, Volunteers & Private Contractors for Ecological Tasks

Ecological Task	City/HNC Staff	Volunteer Role			Restoration Contractor
		Generally Appropriate	Appropriate with Training & Oversight	Generally Not Appropriate	
Native seed collection & sowing		X			
Installation of live trees, shrubs, herbaceous plugs	X	X			X
Hand-pulling invasive plants	X	X			
Dragging cut brush		X			
Cutting brush			X		X
Simple ecological monitoring	X		X		
Herbicide application	X			X	X
Prescribed burning	X				X
Slope stabilization	X		X		X
Management mowing	X			X	X
Technical ecological monitoring	X			X	X

Although assistance by volunteers has no direct cost, the staff time or contracted time for organizing, training, equipping, and supervising volunteer events is a cost, as are materials (e.g., tools, safety equipment, food and beverage). Thoughtfully planned and executed volunteer programs will help reach the desired audience of potential volunteers, engage them in safe and productive work, and have them return to volunteer again.

3.5.1 Existing Volunteer Program

City of Duluth

Duluth Invaders is a service initiative coordinated by the City of Duluth's Park Maintenance Division. Duluth Invaders works to educate the community on the harmful impacts of invasive plants, as well as to eradicate invasive plants and restore public lands to ensure healthy, native ecosystems. Volunteers serve with Duluth Invaders through coordinated one-time volunteer events that are traditionally focused on invasive removal. Through the Duluth Invaders R2ED Team (Rapid Response and Early Detection Team), individuals are invited to serve in an ongoing capacity. R2ED Team members are assigned priority locations and are provided the necessary tools and support to remove and dispose of targeted invasive plants within their designated areas.

Volunteering at Hartley Nature Center

Hartley Nature Center has a long history of engaging volunteers. Hartley volunteers assist with a wide variety of projects and programs, including volunteering as an office assistant, education assistant, event helper, or as a stewardship assistant. Stewardship assistants make up a significant portion of all Hartley volunteers. These assistants help with invasive species management, trail maintenance, trimming,

mowing, citizen science projects, and gardening. A large portion of these volunteers help with one-time group projects, mostly focused on invasive species management and/or restoration work. However, the HNC volunteer program also has a handful of individual volunteers that help with projects on a more regular basis. Most volunteer efforts are focused on stewardship of the HNC outdoor campus, pollinator garden, and programming sites; however, the City of Duluth has partnered with the HNC and other nonprofits (e.g., Cyclists of Gitche Gumee Shores, Duluth Cross Country, Duluth CISMA, The Superior Hiking Trail Association) on projects throughout Hartley Park to help manage the City's lands.

3.5.2 Volunteer Program Considerations/Recommendations

Because both the City of Duluth and HNC host mature volunteer programs, there is already a cohort of dedicated and experienced people to assist with restoration and management projects. Considering an individual project and the specific tasks needed to execute it (potentially including site preparation, soil preparation, seeding, planting, weeding, watering, and other long-term maintenance) will help determine which tasks might be most cost-effective using volunteers (see Table 8).

3.6 Partnerships

As with volunteers, partnerships provide opportunities for cost-savings and deeper relationships with partner organizations; however, developing and sustaining partnerships often requires dedicated staff time. The City of Duluth and/or HNC have existing partnerships with the following groups:

- Minnesota Department of Natural Resources
- Duluth Colleges and Universities
- Natural Resources Research Institute
- Minnesota Land Trust
- The Nature Conservancy
- South St. Louis Soil and Water Conservation District
- Stewardship Network Duluth Cooperative Invasive Species Management Area
- Cyclists of Gitche Gumee Shores
- Duluth Cross Country Ski Club
- Superior Hiking Trail Association

New partnership opportunities include:

- Conservation Corps of Minnesota and Iowa
- Duluth Audubon Society
- Master Gardeners
- Master Naturalists

It is recommended the City and/or HNC establish agreements or contracts with partner organizations to help implement ecological restoration and management projects, especially long-term management. This is what is being done with The Nature Conservancy's Hartley Park Northwest Hills Restoration Plan.

3.7 Ecological Contractors

Private, professional ecological contractors have staff, equipment, and experience to efficiently implement natural resource restoration and management projects. Unlike non-profits and government, however, their overhead costs must be included in their prices in order to remain viable businesses. When used, qualified ecological contractors should meet the following criteria:

- Firm has local project experience in the past five years providing the specific ecological restoration and management tasks required for the project.
- On-site field supervisor(s) overseeing project implementation are fluent in English and present on site or available at all times during work. Field supervisor(s) should have a minimum of five years experience conducting ecological restoration and vegetation management in the region.
- Proper training and certifications for restoration and management activities with inherent risks, such as use of heavy equipment, herbicides, chainsaws, and prescribed fire.
- Positive references from past clients.
- Sufficient bonding for the work being performed.

While professional contractors are typically more expensive than using in-house resources and volunteers, qualified contractors complete high-quality work efficiently and meet performance standards under their guarantee. Bidding documents and specifications should state required qualifications for contractors (such as those listed above), project schedules, and performance standards that ensure the City's goals are met. Solicitation, assessment, and selection of bids, as well as contractor oversight and contract administration takes expertise and time.

4 NEXT STEPS

The City of Duluth has recognized the ecological significance of Hartley Natural Area through its entry into the Duluth Natural Areas Program. Residents cherish Hartley Park's natural areas, which also support the City with ecosystem services. On the other hand, historical land uses and colonization by invasive species have compromised the functions and value of the HNA's natural resources. Building on past and on-going management activities, the information in this Native Plant Community Management Plan will help the City and the Hartley Nature Center better plan and execute projects to best achieve the HNA's conservation goals.

The next steps needed to implement this Native Plant Community Management Plan are:

Generate External Support

- Continue with community outreach to inform the public of the Plan and volunteer needs
- Host a bioblitz at HNA
- Continue to collaborate with partner organizations and volunteers to advance priority projects
- Celebrate milestones, such as completion of a major restoration project or initiation of a new endeavor

Secure Resources

- Develop funding/grant applications (e.g., Outdoor Heritage Fund, Environment & Natural Resource Trust Fund, Monarch Butterfly and Pollinators Conservation Fund)
- Explore new partnership opportunities and commitments
- Review Capital Improvement Plan funding (to ensure adequate funds to achieve the City's natural resources goals)
- Explore expanding the use of volunteers to assist with appropriate restoration and long-term management tasks (e.g., seed collection and sowing, planting, hand-pulling weeds, simple monitoring)

Measure Progress & Adaptively Manage

- Document field conditions (e.g., georeferenced photographs, pre-restoration conditions), coordinate management, and monitor progress.
- Evaluate project performance through monitoring; adjust subsequent management plans and contracts as warranted
- Prepare annual written reports (conducted at the end of each year, summarizing work completed in active project areas, management needs, and recommended actions the following year)

Well-trained City and HNC staff—assisted by volunteers, partners, and professional contractors—will work to carry out elements of the Plan over the coming years. Results will be reported and evaluated at least every three years or as deemed necessary; the Plan will be updated in accordance with the reports and evaluations at least every five years. In this way, HNA will become a more healthy and resilient

complex of native ecosystems. The fruits of these efforts will be passed on to future generations for the enjoyment of all and the benefit of nature.

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Appendix A. Practices to Avoid Introducing & Moving Invasive Species (MN Dept. Nat. Resources)

It is the MNDNR's policy to limit the introduction of invasive species onto MNDNR managed lands and waters, limit their rate of geographical spread, and reduce their impact on high value resources.

The movement of equipment, organisms, and organic and inorganic material are potential pathways for the introduction or spread of invasive species. Each of these pathways should be considered and addressed to reduce risk associated with invasive species movement.

General Procedures for Intentional Movement of Equipment

1. Before arriving at a work site, inspect for and remove all visible plants, seeds, mud, soil, and animals from equipment.
2. Before leaving a work site, inspect for and remove all visible plants, seeds, mud, soil and animals from equipment.
3. After working on infested waters or waters known to harbor pathogens of concern, clean and dry equipment prior to using in locations not known to be infested with species or pathogens present at the last location visited.

Specific Procedures: Vehicles and Heavy Equipment

1. When possible maintain separate equipment to use on uninfested sites.
2. If working on multiple sites, work in uninfested sites before infested sites and clean equipment after use.
3. When working within a site with invasive species work in uninfested areas before infested areas and clean equipment after use.
4. Avoid entering site under wet conditions to minimize rutting and other soil disturbances.
5. Minimize area of soil disturbance with equipment.
6. Minimize number of access points to site.
7. When creating roads and trails minimize area of vegetation and soil disturbance.
8. Survey site before management treatment and treat or avoid moving equipment through existing patches of invasive species.
9. Conduct post management treatment monitoring and treat any responding invasive species.
10. Inspect all gear and remove vegetation, soil, and organisms prior to arriving and leaving site.
11. On sites that are known to be infested with species such as garlic mustard, spotted knapweed, leafy spurge, etc. (species with small seed that can collect on cloth material) wash clothing after work is complete.
12. Carry boot brush in or on all vehicles and clean boots and clothing (in a controlled area) when leaving any site.
13. Use brush to clean gear and equipment such as chainsaws to remove loose soil and plant materials.
14. Avoid parking in patches of invasive species. When unavoidable, clean vehicle of all visible evidence of soil and vegetation when leaving site.
15. Brush off (hand remove) plants, seeds, mud, soil and animals from vehicles, including wheel wells, tracks, hums, blades, grills, etc.
16. Power spray equipment after hand removal, if necessary, to remove aquatic plant remnants (particularly curly-leaf pondweed, Eurasian watermilfoil, flowering rush, and purple loosestrife) and earthworms.

General Procedures for Intentional Movement of Organisms, Organic and Inorganic Material (including water, fish, plants, mulch, soil, gravel, rock)

1. Do not plant or introduce prohibited or regulated invasive species or other listed invasive species.
2. Do not transport water from infested waters, except by permit. When you must use water from an infested waters, do not drain this water or water that has come in contact with organisms from the infested waters, where it can run into another basin, river, or drain system that does not go to a treatment facility.

3. Use only mulch, soil, gravel, etc. that is invasive species-free or has a very low likelihood of having invasive species.
4. Do not transplant organisms or plant material from any waters with known populations of invasive aquatic invertebrates
5. Do not move soil, dredge material, or raw wood projects that may harbor invasive species from infested sites.

Specific Procedures: Re-vegetation (Aquatic and Terrestrial Plants)

1. Do not plant or introduce prohibited or regulated invasive species or other listed invasive species.
2. Inspect transplanted vegetation for signs of invasive species that may be attached to the vegetation and remove (i.e., other plant material and animals, etc.)
3. Re-vegetate with native species.
4. Preserve existing native vegetation. Peel topsoil that contains natives away from the work zone, stockpile and then replace it at the end of construction. This can help re-establish native species quickly.
5. If stockpiled invasive free topsoil isn't adequate for post-construction landscaping, and black dirt, sand or gravel must be purchased, purchase invasive species (i.e., worm) free material.
6. Purchase certified weed-free mulch.
7. Inspect outside of storage containers and materials for visible presence of invasive species.
8. If possible, use seeding material, plants, fill, straw, gravel, and mulch that are certified as uninfested.
9. Monitor areas where materials are added for evidence of invasive species germination.
10. When possible minimize the use of outside materials.

Procedures to Minimize the Risk of Increasing the Dominance of Invasive Species on Site

1. Survey site before burning and treat or avoid moving through patches of invasive species before burn is conducted.
2. Avoid entering site under wet conditions to minimize rutting and other soil disturbances.
3. Conduct post-treatment monitoring and treat any invasive species (such as resprouts and germination).

Site Planning and Management

Construction activities that disturb the soil surface can expose dormant invasive species seed banks and create a growth medium that favors invasive plants. Landscaping can also introduce invasive plant species, as can maintenance activities such as mowing, grading, and stormwater pond maintenance.

Exercise site-level management to minimize the introduction, spread, and impact of invasive species. Site-level management shall include planning, implementation and evaluation procedures that reduce the risk of introduction, spread, and impact of invasive species. Procedures include identification of invasive species, monitoring for invasive species, developing strategies and actions to minimize spread and impact, implementing management actions, and evaluating success.

References

Minnesota Department of Natural Resources Operational Order #113, Invasive Species, May 31, 2007.
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Appendix B. Information for Planning and Consultation (IPaC) Report for Hartley Natural Area (USFWS)

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

St. Louis County, Minnesota

Local office

Minnesota-Wisconsin Ecological Services Field Office

(952) 252-0092
(952) 646-2873

MAILING ADDRESS

4101 American Blvd E
Bloomington, MN 55425-1665

PHYSICAL ADDRESS

4101 American Blvd E

-

Bloomington, MN 55425-1665

http://www.fws.gov/midwest/Endangered/section7/s7process/step1.html

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS

Canada Lynx Lynx canadensis There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened
Gray Wolf Canis lupus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/4488	Threatened
Northern Long-eared Bat Myotis septentrionalis No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	Threatened

Birds

NAME	STATUS
Piping Plover Charadrius melodus There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/6039	Endangered
Red Knot Calidris canutus rufa No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1864	Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Canada Lynx Lynx canadensis https://ecos.fws.gov/ecp/species/3652#crithab	Final

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
American Bittern Botaurus lentiginosus This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/6582	Breeds Apr 1 to Aug 31

Bald Eagle Haliaeetus leucocephalus — Breeds Dec 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1626

Black-billed Cuckoo Coccyzus erythropthalmus — Breeds May 15 to Oct 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9399

Bobolink Dolichonyx oryzivorus — Breeds May 20 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Canada Warbler Cardellina canadensis — Breeds May 20 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Cape May Warbler Setophaga tigrina — Breeds Jun 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Connecticut Warbler Oporornis agilis — Breeds Jun 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Dunlin Calidris alpina arcticola — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Evening Grosbeak Coccothraustes vespertinus — Breeds May 15 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Golden Eagle Aquila chrysaetos — Breeds Jan 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1680

Golden-winged Warbler Vermivora chrysoptera — Breeds May 1 to Jul 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8745

Harris's Sparrow Zonotrichia querula — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Lesser Yellowlegs Tringa flavipes — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9679

Long-eared Owl asio otus — Breeds Mar 1 to Jul 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3631

Marbled Godwit Limosa fedoa — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Olive-sided Flycatcher Contopus cooperi — Breeds May 20 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3914

Red-headed Woodpecker Melanerpes erythrocephalus — Breeds May 10 to Sep 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Ruddy Turnstone Arenaria interpres morinella — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Rusty Blackbird Euphagus carolinus — Breeds May 10 to Jul 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Semipalmated Sandpiper Calidris pusilla — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Whimbrel Numenius phaeopus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9483

Wood Thrush Hylocichla mustelina — Breeds May 10 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

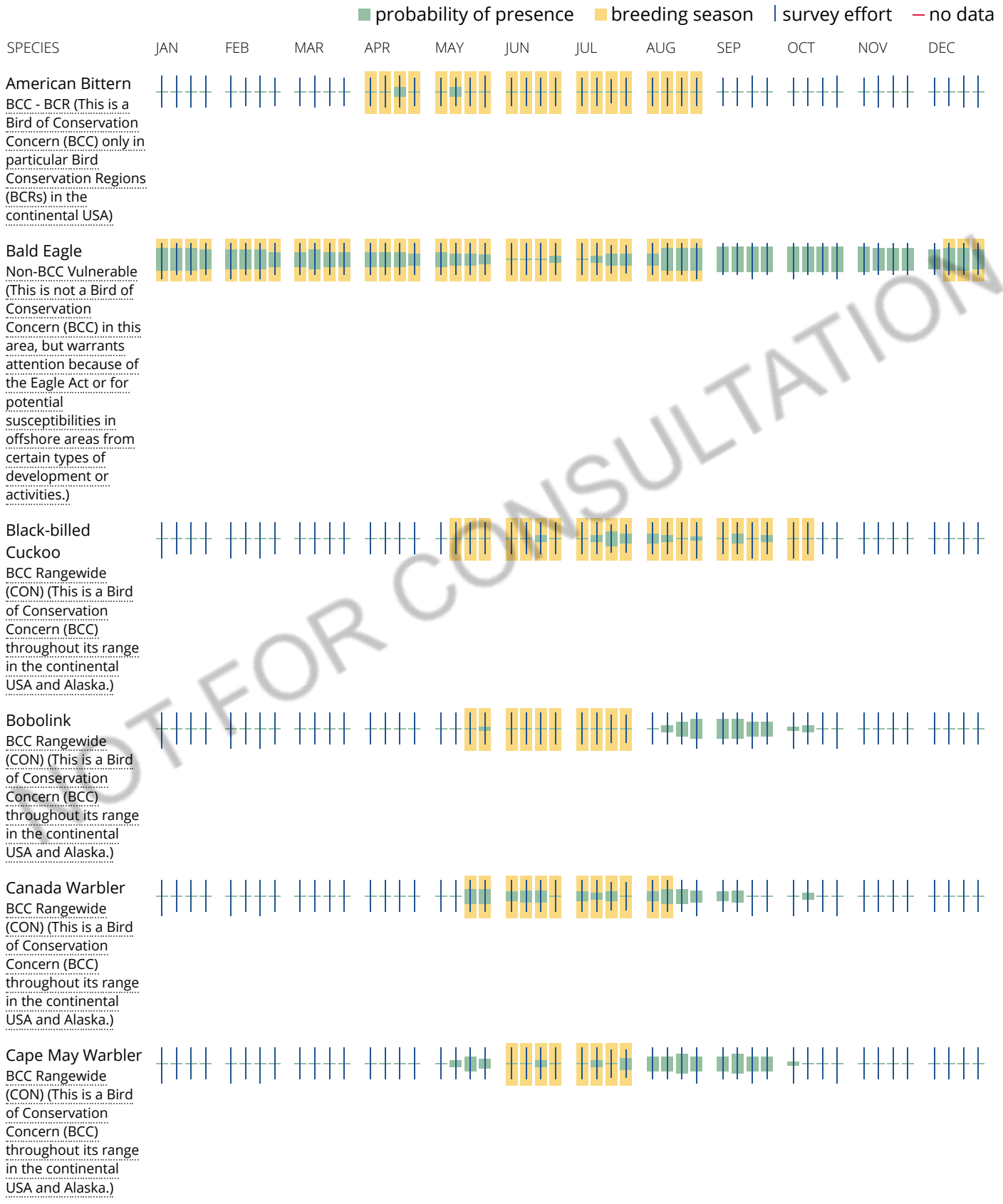
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Connecticut Warbler
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

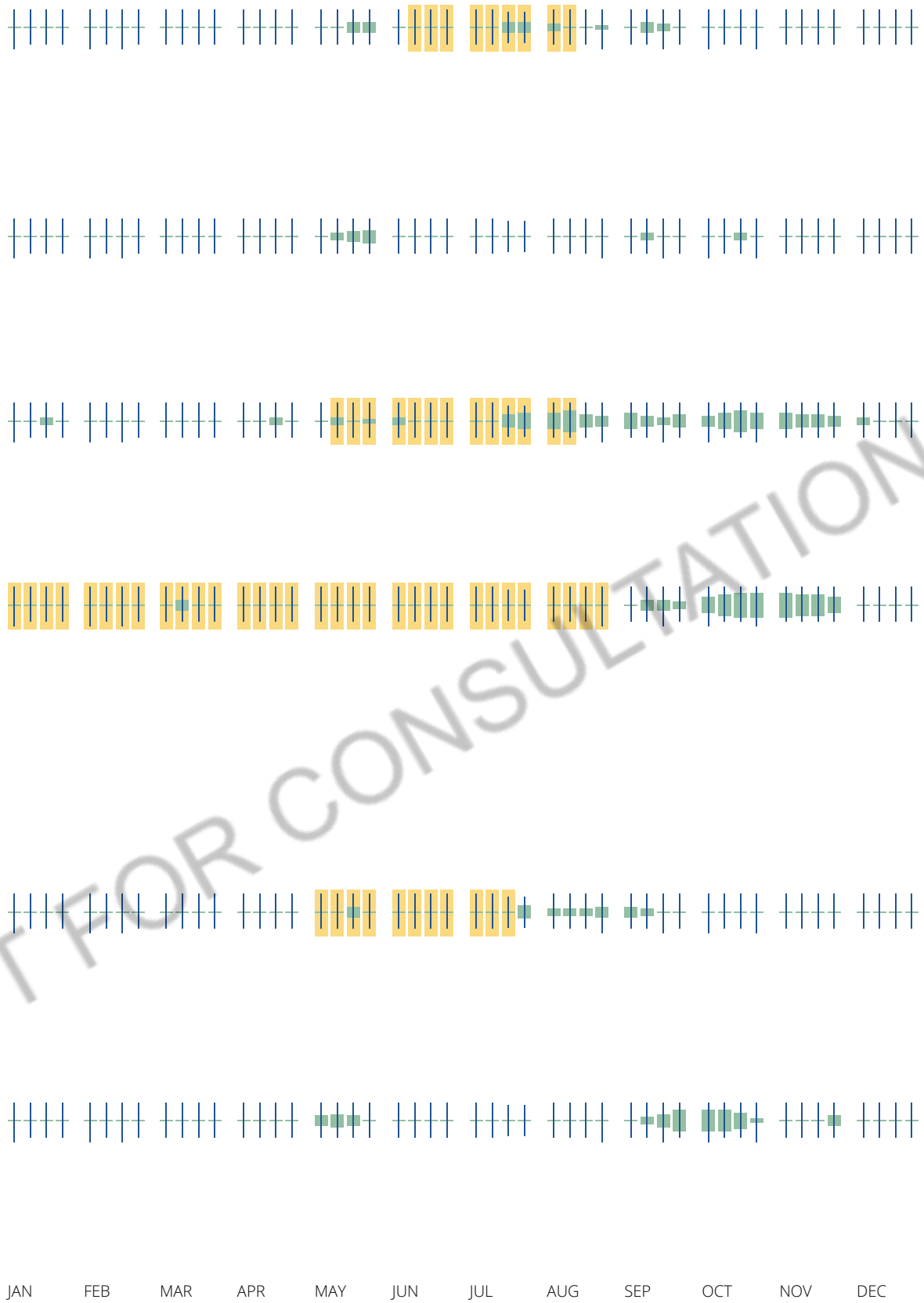
Dunlin
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Evening Grosbeak
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Golden Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

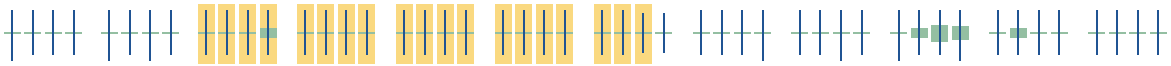
Golden-winged Warbler
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Harris's Sparrow
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



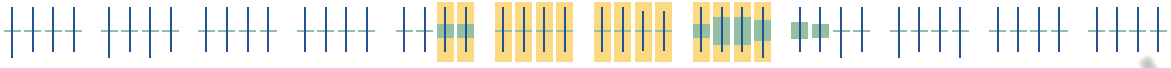
Lesser Yellowlegs
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Long-eared Owl
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

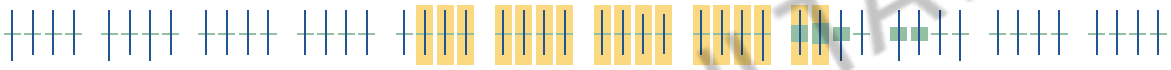


Marbled Godwit
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Olive-sided Flycatcher
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

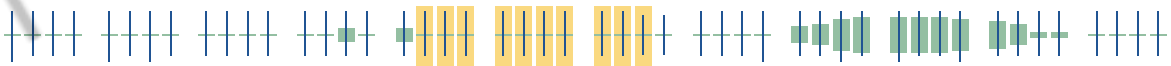


Red-headed Woodpecker
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Ruddy Turnstone
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Rusty Blackbird
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Semipalmated Sandpiper
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Whimbrel
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Wood Thrush
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds

guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ “What does IPaC use to generate the migratory birds potentially occurring in my specified location”. Please be aware this report provides the “probability of presence” of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the “no data” indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or

minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND

- PEM1Ad
- PEM1C
- PEM1Cd
- PEM1D

FRESHWATER FORESTED/SHRUB WETLAND

- PSS1/EM1A
- PSS1D
- PSS4D

PFO1D
PFO4/SS1D
PFO1/SS1A
PSS1/EM1C

FRESHWATER POND

PABG
PUBG

RIVERINE

R3UBH
R4SBC

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix C. MNDNR Native Plant Community Species Lists

FDn33 Northern Dry-Mesic Mixed Woodland – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Canada mayflower (*Maianthemum canadense*)	98	●●●
Wild sarsaparilla (*Aralia nudicaulis*)	91	●●
Bracken (*Pteridium aquilinum*)	84	●●●
Large-leaved aster (Aster macrophyllus)	84	●●●
Common strawberry (*Fragaria virginiana*)	81	●
Wood anemone (*Anemone quinquefolia*)	74	●
Sweet-scented bedstraw (*Galium triflorum*)	70	●
Dwarf raspberry (*Rubus pubescens*)	68	●●
Bunchberry (*Cornus canadensis*)	66	●●
Starflower (*Trientalis borealis*)	65	●
Bluebead lily (*Clintonia borealis*)	65	●●
Rose twistedstalk (*Streptopus roseus*)	63	●
Spreading dogbane (*Apocynum androsaemifolium*)	50	●
Pale vetchling (*Lathyrus ochroleucus*)	44	●
Lindley's aster (*Aster ciliolatus*)	43	●
Veiny pea (*Lathyrus venosus*)	42	●
Twinflower (*Linnaea borealis*)	42	●●
One-sided pyrola (*Pyrola secunda*)	28	●
Red baneberry (*Actaea rubra*)	28	●
Columbine (*Aquilegia canadensis*)	28	●
Pale bellwort (*Uvularia sessilifolia*)	27	●
Early meadow-rue (*Thalictrum dioicum*)	27	●
Groundpine (*Lycopodium dendroideum or L. hickeyi*)	24	●
Round-leaved pyrola (*Pyrola rotundifolia*)	23	●
Northern bedstraw (*Galium boreale*)	23	●●
Hairy Solomon's seal (*Polygonatum pubescens*)	23	●
Maryland black snakeroot (*Sanicula marilandica*)	22	●
Cow wheat (*Melampyrum lineare*)	21	●
American vetch (*Vicia americana*)	18	●
Large-flowered bellwort (*Uvularia grandiflora*)	17	●
Spinulose shield fern or Glandular wood fern*	17	●
Gaywings (*Polygala paucifolia*)	15	●
Grasses & Sedges		
Mountain rice grass (*Oryzopsis asperifolia*)	77	●●●
Pennsylvania sedge (*Carex pensylvanica*)	29	●●
False melic grass (*Schizachne purpurascens*)	23	●●
Low Shrubs		
Lowbush blueberry (*Vaccinium angustifolium*)	81	●●
Red raspberry (*Rubus idaeus*)	52	●
Wintergreen (*Gaultheria procumbens*)	40	●
Velvet-leaved blueberry (*Vaccinium myrtilloides*)	24	●
Shrubs		
Beaked hazelnut (*Corylus cornuta*)	95	●●●●
Juneberries (*Amelanchier* spp.)	86	●●
Bush honeysuckle (*Diervilla lonicera*)	80	●●
Fly honeysuckle (*Lonicera canadensis*)	60	●
Chokecherry (*Prunus virginiana*)	58	●
Prickly or Smooth wild rose (*Rosa acicularis* or *R. blanda*)	52	●
Round-leaved dogwood (*Cornus rugosa*)	34	●●
Mountain maple (*Acer spicatum*)	31	●●●
Downy arrowwood (*Viburnum rafinesquianum*)	28	●
Prairie willow (*Salix humilis*)	22	●
Hairy honeysuckle (*Lonicera hirsuta*)	21	●
Green alder (*Alnus viridis*)	18	●●
Snowberry or Wolfberry (*Symphoricarpos albus or S. occidentalis*)	13	●●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Red pine	49	●●●●	27	●●●	6	●
Paper birch	47	●●●	65	●●●	32	●
Quaking aspen	35	●●●	30	●●●	50	●
White pine	31	●●●●	19	●●	39	●
Red maple	27	●●	51	●●●	69	●●
Balsam fir	20	●●●	38	●●●	65	●
Jack Pine	18	●●●	8	●●	–	–
Big-toothed aspen	15	●●●	15	●●●	9	●
White spruce	12	●	15	●●	22	●
Northern red oak	11	●	31	●●	44	●
Black spruce	6	●●●●	7	●●	3	●

*Spinulose shield fern or Glandular wood fern (*Dryopteris carthusiana* or *D. intermedia*)

FDn43 Northern Mesic Mixed Forest – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Wild sarsaparilla (*Aralia nudicaulis*)	91	●●
Large-leaved aster (*Aster macrophyllus*)	89	●●●●
Bluebead lily (*Clintonia borealis*)	88	●
Bunchberry (*Cornus canadensis*)	87	●
Canada mayflower (*Maianthemum canadense*)	87	●
Starflower (*Trientalis borealis*)	80	●
Sweet-scented bedstraw (*Galium triflorum*)	71	●
Rose twistedstalk (*Streptopus roseus*)	69	●
Dwarf raspberry (*Rubus pubescens*)	67	●
Twinflower (*Linnaea borealis*)	60	●
Groundpine (*Lycopodium dendroideum* or *L. hickeyi*)	54	●
Bracken (*Pteridium aquilinum*)	47	●●●
Common strawberry (*Fragaria virginiana*)	46	●
Wood anemone (*Anemone quinquefolia*)	44	●
Spinulose shield fern or Glandular wood fern*	39	●
Red baneberry (*Actaea rubra*)	34	●
One-sided pyrola (*Pyrola secunda*)	30	●
Running clubmoss (*Lycopodium clavatum*)	29	●
Naked miterwort (*Mitella nuda*)	26	●
Common oak fern (*Gymnocarpium dryopteris*)	26	●
Lady fern (*Athyrium filix-femina*)	22	●
Bristly clubmoss (*Lycopodium annotinum*)	21	●●
Goldthread (*Coptis trifolia*)	20	●
Spreading dogbane (*Apocynum androsaemifolium*)	17	●
Palmate sweet coltsfoot (*Petasites frigidus*)	17	●
Pale vetchling (*Lathyrus ochroleucus*)	17	●
Common polypody (*Polypodium virginianum*)	15	●
Kidney-leaved violet (*Viola renifolia*)	15	●
Shining firmoss (*Huperzia lucidula*)	14	●●
Veiny pea (Lathyrus venosus)	14	●
Alpine enchanter's nightshade (*Circaea alpina*)	12	●
Cow wheat (*Melampyrum lineare*)	12	●
Grasses & Sedges		
Mountain rice grass (*Oryzopsis asperifolia*)	58	●
Bluejoint (*Calamagrostis canadensis*)	19	●●●
Long-stalked sedge (*Carex pedunculata*)	18	●
False melic grass (*Schizachne purpurascens*)	17	●
Drooping wood sedge (*Carex arctata*)	16	●
Low Shrubs		
Red raspberry (*Rubus idaeus*)	38	●
Velvet-leaved blueberry (*Vaccinium myrtilloides*)	36	●
Lowbush blueberry (*Vaccinium angustifolium*)	36	●
Thimbleberry (*Rubus parviflorus*)	30	●●
Shrubs		
Beaked hazelnut (*Corylus cornuta*)	93	●●●
Fly honeysuckle (*Lonicera canadensis*)	83	●
Mountain maple (*Acer spicatum*)	77	●●●
Bush honeysuckle (*Diervilla lonicera*)	67	●●
Juneberries (*Amelanchier* spp.)	64	●
Prickly or Smooth wild rose (*Rosa acicularis* or *R. blanda*)	33	●
Round-leaved dogwood (*Cornus rugosa*)	25	●
Chokecherry (*Prunus virginiana*)	24	●
Hairy honeysuckle (*Lonicera hirsuta*)	22	●
Downy arrowwood (*Viburnum rafinesquianum*)	15	●
Prairie willow (*Salix humilis*)	7	●●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Paper birch	69	●●●	62	●●	37	●
Quaking aspen	46	●●●	37	●●●	50	●
Balsam fir	46	●●●	74	●●●	90	●●
White pine	39	●●●●	18	●	38	●
White spruce	36	●●	40	●●	46	●
Red pine	22	●●●●	2	●	2	●
White cedar	20	●●●●	24	●●●	18	●
Red maple	16	●●	25	●●	40	●●
Black spruce	11	●●	14	●●	13	●
Jack pine	5	●●	2	●●	1	●
Mountain ashes	1	●	10	●	58	●

*Spinulose shield fern or Glandular wood fern (*Dryopteris carthusiana* or *D. intermedia*)

MHn35 Northern Mesic Hardwood Forest – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Wild sarsaparilla *(Aralia nudicaulis)*	94	●●●
Large-leaved aster *(Aster macrophyllus)*	93	●●
Rose twistedstalk *(Streptopus roseus)*	87	●
Canada mayflower *(Maianthemum canadense)*	86	●●
Wood anemone *(Anemone quinquefolia)*	74	●
Large-flowered bellwort *(Uvularia grandiflora)*	73	●●
Sweet-scented bedstraw *(Galium triflorum)*	73	●
Bluebead lily *(Clintonia borealis)*	71	●
Clayton's sweet cicely *(Osmorhiza claytonii)*	67	●
Hairy Solomon's seal *(Polygonatum pubescens)*	61	●
Starflower *(Trientalis borealis)*	61	●
Round-lobed hepatica *(Anemone americana)*	60	●
Lady fern *(Athyrium filix-femina)*	59	●●
Pale bellwort *(Uvularia sessilifolia)*	54	●
Bracken *(Pteridium aquilinum)*	51	●●
Rugulose or Yellow violet *(Viola canadensis* or *V. pubescens)*	50	●
Dwarf raspberry *(Rubus pubescens)*	48	●
Early meadow-rue *(Thalictrum dioicum)*	47	●
Rattlesnake fern *(Botrychium virginianum)*	46	●
Pale vetchling *(Lathyrus ochroleucus)*	40	●
Maryland black snakeroot *(Sanicula marilandica)*	39	●
Common strawberry *(Fragaria virginiana)*	39	●
Red baneberry *(Actaea rubra)*	39	●
Zigzag goldenrod *(Solidago flexicaulis)*	38	●
Groundpine *(Lycopodium dendroideum* or *L. hickeyi)*	36	●
American spikenard *(Aralia racemosa)*	35	●
Common false Solomon's seal *(Smilacina racemosa)*	32	●
Wild ginger *(Asarum canadense)*	23	●
Veiny pea *(Lathyrus venosus)*	22	●
Elliptic shinleaf *(Pyrola elliptica)*	22	●
Lindley's aster *(Aster ciliolatus)*	21	●
Interrupted fern *(Osmunda claytoniana)*	16	●●
Grasses & Sedges		
Mountain rice grass *(Oryzopsis asperifolia)*	91	●●
Pennsylvania sedge *(Carex pensylvanica)*	85	●●●
Long-stalked sedge *(Carex pedunculata)*	38	●
Bearded shorthusk *(Brachyelytrum erectum)*	35	●
Drooping wood sedge *(Carex arctata)*	17	●
Low Shrubs		
Trailing blackberries *(Rubus flagellaris* and similar *Rubus* spp.)	14	●●
Lowbush blueberry *(Vaccinium angustifolium)*	12	●
Shrubs		
Beaked hazelnut *(Corylus cornuta)*	86	●●●
Chokecherry *(Prunus virginiana)*	72	●
Fly honeysuckle *(Lonicera canadensis)*	62	●
Pagoda dogwood *(Cornus alternifolia)*	62	●
Juneberries *(Amelanchier* spp.)	52	●
Mountain maple *(Acer spicatum)*	49	●●
Bush honeysuckle *(Diervilla lonicera)*	45	●
Leatherwood *(Dirca palustris)*	42	●●
Downy arrowwood *(Viburnum rafinesquianum)*	41	●
Prickly gooseberry *(Ribes cynosbati)*	34	●
Hairy honeysuckle *(Lonicera hirsuta)*	24	●
Round-leaved dogwood *(Cornus rugosa)*	18	●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Sugar maple	82	●●●●	88	●●●●	93	●●●●
Basswood	65	●●●	52	●●●	67	●
Paper birch	61	●●●	31	●●●	12	●
Northern red oak	49	●●●	25	●●	77	●
Quaking aspen	31	●●●	13	●●	44	●
Red maple	31	●●●	37	●●	60	●
Ironwood	24	●●	68	●●●	72	●●
Big-toothed aspen	13	●●●	-	-	9	●
Bur oak	11	●●	9	●●	12	●
Yellow birch	10	●●	8	●●	-	-
Balsam fir	8	●●	18	●●	48	●
White spruce	-	-	8	●	14	●

MHn44 Northern Wet-Mesic Boreal Hardwood-Conifer Forest — Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Canada mayflower *(Maianthemum canadense)*	95	●
Wild sarsaparilla *(Aralia nudicaulis)*	93	●●●
Sweet-scented bedstraw *(Galium triflorum)*	85	●
Dwarf raspberry *(Rubus pubescens)*	85	●●
Large-leaved aster *(Aster macrophyllus)*	84	●●●
Rose twistedstalk *(Streptopus roseus)*	79	●
Common strawberry *(Fragaria virginiana)*	75	●
Red baneberry *(Actaea rubra)*	74	●
Wood anemone *(Anemone quinquefolia)*	73	●
Lady fern *(Athyrium filix-femina)*	71	●●
Bluebead lily *(Clintonia borealis)*	69	●
Clayton's sweet cicely *(Osmorhiza claytonii)*	68	●
Bunchberry *(Cornus canadensis)*	66	●
Maryland black snakeroot *(Sanicula marilandica)*	64	●
Starflower *(Trientalis borealis)*	64	●
Wild ginger *(Asarum canadense)*	62	●●
Bracken *(Pteridium aquilinum)*	61	●●
Early meadow-rue *(Thalictrum dioicum)*	59	●
Naked miterwort *(Mitella nuda)*	55	●
Palmate sweet coltsfoot *(Petasites frigidus)*	49	●
Round-lobed hepatica *(Anemone americana)*	42	●
Spinulose shield fern or Glandular wood fern*	41	●
Lindley's aster *(Aster ciliolatus)*	40	●
Pale vetchling *(Lathyrus ochroleucus)*	37	●
Rattlesnake fern *(Botrychium virginianum)*	37	●
Pale bellwort *(Uvularia sessilifolia)*	34	●
Large-flowered bellwort *(Uvularia grandiflora)*	31	●●
Nodding trillium *(Trillium cernuum)*	31	●
Woodland horsetail *(Equisetum sylvaticum)*	29	●
Side-flowering aster *(Aster lateriflorus)*	29	●
Grasses & Sedges		
Mountain rice grass *(Oryzopsis asperifolia)*	73	●●
Pennsylvania sedge *(Carex pensylvanica)*	72	●●●
Long-stalked sedge *(Carex pedunculata)*	63	●●

	freq%	cover
Bearded shorthusk *(Brachyelytrum erectum)*	41	●
Pointed woodrush *(Luzula acuminata)*	33	●
Drooping wood sedge *(Carex arctata)*	27	●
Graceful sedge *(Carex gracillima)*	26	●
Bladder sedge *(Carex intumescens)*	20	●
Low Shrubs		
Red raspberry *(Rubus idaeus)*	29	●
Lowbush blueberry *(Vaccinium angustifolium)*	18	●
Tall Shrubs		
Beaked hazelnut *(Corylus cornuta)*	86	●●●
Chokecherry *(Prunus virginiana)*	67	●
Bush honeysuckle *(Diervilla lonicera)*	62	●●
Juneberries *(Amelanchier* spp.*)*	58	●
Mountain maple *(Acer spicatum)*	58	●●●
Fly honeysuckle *(Lonicera canadensis)*	56	●
Downy arrowwood *(Viburnum rafinesquianum)*	52	●
Prickly gooseberry *(Ribes cynosbati)*	44	●
Pagoda dogwood *(Cornus alternifolia)*	37	●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Quaking aspen	70	●●●●	40	●●	59	●
Paper birch	65	●●	36	●	22	●
Balsam fir	41	●●●	49	●●●	60	●
White spruce	31	●●●	23	●●	25	●
Red maple	27	●●●	28	●●●	48	●
Black ash	22	●●	48	●●	60	●●
Basswood	20	●●●	19	●●	28	●
Bur oak	16	●●	18	●●	25	●
White pine	15	●●●	-	-	-	-
Balsam poplar	12	●●●	9	●●	18	●
Sugar maple	10	●●●	18	●●●	28	●●
Green ash	10	●	16	●●	33	●●
White cedar	9	●●●●	-	-	-	-
Northern red oak	8	●●●	-	-	27	●

* Spinulose shield fern or Glandular wood fern *(Dryopteris carthusiana* or *D. intermedia)*

MHn46 Northern Wet-Mesic Hardwood Forest – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Wild sarsaparilla *(Aralia nudicaulis)*	86	●●
Lady fern *(Athyrium filix-femina)*	85	●●●
Canada mayflower *(Maianthemum canadense)*	83	●
Dwarf raspberry *(Rubus pubescens)*	83	●●
Large-leaved aster *(Aster macrophyllus)*	81	●●
Sweet-scented bedstraw *(Galium triflorum)*	79	●
Wild ginger *(Asarum canadense)*	71	●
Common strawberry *(Fragaria virginiana)*	69	●
Clayton's sweet cicely *(Osmorhiza claytonii)*	65	●
Wood anemone *(Anemone quinquefolia)*	65	●
Rose twistedstalk *(Streptopus roseus)*	64	●
Jack-in-the-pulpit *(Arisaema triphyllum)*	64	●
Maryland black snakeroot *(Sanicula marilandica)*	64	●
Red baneberry *(Actaea rubra)*	63	●
Early meadow-rue *(Thalictrum dioicum)*	57	●
Rugulose or Yellow violet *(Viola canadensis* or *V. pubescens)*	54	●
Rattlesnake fern *(Botrychium virginianum)*	53	●
Large-flowered bellwort *(Uvularia grandiflora)*	50	●
Bluebead lily *(Clintonia borealis)*	49	●
Starflower *(Trientalis borealis)*	49	●
Spinulose shield fern or Glandular wood fern*	49	●
Nodding trillium *(Trillium cernuum)*	43	●
Naked miterwort *(Mitella nuda)*	42	●
Side-flowering aster *(Aster lateriflorus)*	38	●
Woodland horsetail *(Equisetum sylvaticum)*	35	●●
Ostrich fern *(Matteuccia struthiopteris)*	33	●●●
Touch-me-not *(Impatiens* spp.)	29	●
Sensitive fern *(Onoclea sensibilis)*	28	●
Palmate sweet coltsfoot *(Petasites frigidus)*	26	●
Hooked crowfoot *(Ranunculus recurvatus)*	24	●
Wood nettle *(Laportea canadensis)*	17	●●●
Grasses & Sedges		
Pennsylvania sedge *(Carex pensylvanica)*	67	●●●
Long-stalked sedge *(Carex pedunculata)*	56	●●
Bearded shorthusk *(Brachyelytrum erectum)*	50	●
Graceful sedge *(Carex gracillima)*	49	●
Mountain rice grass *(Oryzopsis asperifolia)*	47	●●
Dewey's sedge *(Carex deweyana)*	36	●
Bladder sedge *(Carex intumescens)*	36	●
Pointed woodrush *(Luzula acuminata)*	36	●
Shrubs		
Beaked hazelnut *(Corylus cornuta)*	92	●●●
Chokecherry *(Prunus virginiana)*	71	●
Mountain maple *(Acer spicatum)*	67	●●●
Juneberries *(Amelanchier* spp.)	44	●
Swamp red currant *(Ribes triste)*	42	●
Pagoda dogwood *(Cornus alternifolia)*	36	●
Highbush cranberry *(Viburnum trilobum)*	25	●
Nannyberry *(Viburnum lentago)*	25	●
American hazelnut *(Corylus americana)*	24	●●●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Black ash	65	●●●●	58	●●●	71	●●
Basswood	60	●●	56	●●	63	●
Quaking aspen	38	●●●	17	●●●	38	●
Paper birch	36	●●	21	●●	11	●
Bur oak	35	●●●	26	●	43	●
Red maple	32	●●●	40	●●●	60	●
Sugar maple	25	●●●	46	●●●	53	●●●
Northern red oak	15	●●●	15	●	46	●
Yellow birch	14	●●	8	●	-	-
American elm	14	●	40	●●	44	●
Green ash	14	●●●	22	●●	31	●●
White spruce	11	●●	13	●	14	●
Balsam fir	11	●●●	17	●	35	●
White cedar	8	●●●	-	-	-	-
Big-toothed aspen	-	-	8	●●	-	-
Balsam poplar	-	-	-	-	8	●

* Spinulose shield fern or Glandular wood fern *(Dryopteris carthusiana* or *D. intermedia)*

MHn47 Northern Rich Mesic Hardwood Forest – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Lady fern (*Athyrium filix-femina*)	91	●
Clayton's sweet cicely (*Osmorhiza claytonii*)	84	●
Hairy Solomon's seal (*Polygonatum pubescens*)	79	●
Wild sarsaparilla (*Aralia nudicaulis*)	78	●●
Rose twistedstalk (*Streptopus roseus*)	78	●
Canada mayflower (*Maianthemum canadense*)	74	●
Rattlesnake fern (*Botrychium virginianum*)	74	●
Jack-in-the-pulpit (*Arisaema triphyllum*)	73	●
Large-flowered bellwort (*Uvularia grandiflora*)	70	●●
Large-leaved aster (*Aster macrophyllus*)	69	●
Rugulose or Yellow violet (*Viola canadensis* or *V. pubescens*)	67	●
Wood anemone (*Anemone quinquefolia*)	65	●
Sweet-scented bedstraw (*Galium triflorum*)	61	●
American spikenard (*Aralia racemosa*)	60	●
Bluebead lily (*Clintonia borealis*)	56	●
Starflower (*Trientalis borealis*)	54	●
Wild ginger (*Asarum canadense*)	53	●
Spinulose shield fern or Glandular wood fern*	51	●
Red baneberry (*Actaea rubra*)	48	●
Zigzag goldenrod (*Solidago flexicaulis*)	44	●
Blue cohosh (*Caulophyllum thalictroides*)	44	●
Common oak fern (*Gymnocarpium dryopteris*)	43	●
Round-lobed hepatica (*Anemone americana*)	43	●
Dwarf raspberry (*Rubus pubescens*)	40	●
Nodding trillium (*Trillium cernuum*)	39	●
Common false Solomon's seal (*Smilacina racemosa*)	38	●
Groundpine (*Lycopodium dendroideum* or *L. hickeyi*)	31	●
Pale bellwort (*Uvularia sessilifolia*)	30	●
Bloodroot (*Sanguinaria canadensis*)	29	●
Early meadow-rue (*Thalictrum dioicum*)	27	●
Alpine enchanter's nightshade (*Circaea alpina*)	26	●
Ostrich fern (*Matteuccia struthiopteris*)	24	●
Wild leek (*Allium tricoccum*)	23	●
Maryland black snakeroot (*Sanicula marilandica*)	23	●
Meadow horsetail (*Equisetum pratense*)	21	●
Grasses & Sedges		
Pennsylvania sedge (*Carex pensylvanica*)	76	●●●
Mountain rice grass (*Oryzopsis asperifolia*)	74	●
Long-stalked sedge (*Carex pedunculata*)	64	●●
Dewey's sedge (*Carex deweyana*)	33	●
Drooping wood sedge (*Carex arctata*)	32	●
Bearded shorthusk (*Brachyelytrum erectum*)	27	●
Bladder sedge (*Carex intumescens*)	21	●
Shrubs		
Beaked hazelnut (*Corylus cornuta*)	69	●●
Fly honeysuckle (*Lonicera canadensis*)	69	●
Chokecherry (*Prunus virginiana*)	67	●
Mountain maple (*Acer spicatum*)	63	●●
Prickly gooseberry (*Ribes cynosbati*)	51	●
Pagoda dogwood (*Cornus alternifolia*)	49	●
Leatherwood (*Dirca palustris*)	42	●
Swamp red currant (*Ribes triste*)	21	●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Sugar maple	98	●●●●	96	●●●●	97	●●●●
Basswood	93	●●●	54	●●	78	●
Yellow birch	43	●●●	15	●●	13	●
Paper birch	24	●●	6	●	3	●
Northern red oak	19	●●	8	●	48	●
Black ash	19	●●	12	●	41	●
Ironwood	18	●●	54	●●●	67	●●
White cedar	10	●●	4	●	-	-
Red maple	9	●●	11	●	19	●
Green ash	9	●●	4	●	13	●
Balsam fir	6	●	10	●	47	●
Quaking aspen	5	●●	-	-	16	●
White pine	4	●●●	-	-	4	●
American elm	4	●	9	●●	38	●●

*Spinulose shield fern or Glandular wood fern (*Dryopteris carthusiana* or *D. intermedia*)

FPn73 Northern Rich Alder Swamp – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Dwarf raspberry *(Rubus pubescens)*	89	●
Crested fern *(Dryopteris cristata)*	86	●
Northern bugleweed *(Lycopus uniflorus)*	82	●
Northern marsh fern *(Thelypteris palustris)*	59	●
Common marsh marigold *(Caltha palustris)*	59	●
Red-stemmed aster *(Aster puniceus)*	59	●
Spinulose shield fern *(Dryopteris carthusiana)*	55	●
Touch-me-not *(Impatiens* spp.)	55	●●
Tufted loosestrife *(Lysimachia thyrsiflora)*	55	●
Three-leaved false Solomon's seal *(Smilacina trifolia)*	52	●●
Starflower *(Trientalis borealis)*	50	●
Marsh bellflower *(Campanula aparinoides)*	50	●
Bunchberry *(Cornus canadensis)*	48	●
Canada mayflower *(Maianthemum canadense)*	43	●
Northern blue flag *(Iris versicolor)*	43	●
Great water dock *(Rumex orbiculatus)*	41	●
Big-leaf white violet or Northern white violet*	39	●
Linear-leaved, Marsh, or Downy willow-herb**	39	●
Marsh cinquefoil *(Potentilla palustris)*	36	●
Cinnamon fern *(Osmunda cinnamomea)*	34	●●
Marsh skullcap *(Scutellaria galericulata)*	34	●
Spotted Joe pye weed *(Eupatorium maculatum)*	32	●
Arrow-leaved tearthumb *(Polygonum sagittatum)*	30	●
Three-cleft or Small bedstraw *(Galium trifidum* or *G. tinctorium)*	30	●
Bog goldenrod *(Solidago uliginosa)*	30	●
Mad dog skullcap *(Scutellaria lateriflora)*	25	●
Long-leaved chickweed *(Stellaria longifolia)*	25	●
Woodland horsetail *(Equisetum sylvaticum)*	23	●●
Sweet-scented bedstraw *(Galium triflorum)*	23	●
Flat-topped aster *(Aster umbellatus)*	23	●
Water horsetail *(Equisetum fluviatile)*	20	●
Bulb-bearing water hemlock *(Cicuta bulbifera)*	20	●
Naked miterwort *(Mitella nuda)*	20	●
Goldthread *(Coptis trifolia)*	18	●
Bluebead lily *(Clintonia borealis)*	18	●
Grasses & Sedges		
Bluejoint *(Calamagrostis canadensis)*	80	●●●
Soft-leaved sedge *(Carex disperma)*	57	●●
Bristle-stalked sedge *(Carex leptalea)*	45	●●
Lake sedge *(Carex lacustris)*	45	●●●●
Interior sedge *(Carex interior)*	34	●
Three-fruited bog sedge *(Carex trisperma)*	27	●
Fowl manna grass *(Glyceria striata)*	27	●●●
Poor sedge *(Carex paupercula)*	20	●
Low Shrubs		
Red raspberry *(Rubus idaeus)*	84	●
Labrador tea *(Ledum groenlandicum)*	50	●●
Lowbush blueberry *(Vaccinium angustifolium)*	27	●
Velvet-leaved blueberry *(Vaccinium myrtilloides)*	23	●
Tall Shrubs		
Speckled alder *(Alnus incana)*	98	●●●●●
Red-osier dogwood *(Cornus sericea)*	66	●●
Swamp gooseberry *(Ribes hirtellum)*	32	●
Juneberries *(Amelanchier* spp.)	32	●
Pussy willow *(Salix discolor)*	32	●
Skunk currant *(Ribes glandulosum)*	32	●
Dwarf alder *(Rhamnus alnifolia)*	30	●●
Bog birch *(Betula pumila)*	27	●●●
Mountain fly honeysuckle *(Lonicera villosa)*	23	●

Trees	Canopy		Understory	
	freq%	cover	freq%	cover
Paper birch	30	●	59	●
Tamarack	30	●	30	●
Black spruce	20	●	27	●
Black ash	16	●	27	●
Balsam fir	14	●	45	●
White cedar	11	●	23	●
Red maple	2	●	55	●

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

WFn55 Northern Wet Ash Swamp — Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Lady fern *(Athyrium filix-femina)*	90	●●●
Dwarf raspberry *(Rubus pubescens)*	90	●●●
Sweet-scented bedstraw *(Galium triflorum)*	76	●
Touch-me-not *(Impatiens* spp.)	71	●●
Common strawberry *(Fragaria virginiana)*	70	●
Wild sarsaparilla *(Aralia nudicaulis)*	70	●
Spinulose shield fern or Glandular wood fern*	67	●
Canada mayflower *(Maianthemum canadense)*	62	●
Alpine enchanter's nightshade *(Circaea alpina)*	61	●●
Jack-in-the-pulpit *(Arisaema triphyllum)*	61	●
Naked miterwort *(Mitella nuda)*	56	●
Wild ginger *(Asarum canadense)*	56	●
Woodland horsetail *(Equisetum sylvaticum)*	52	●
Clayton's sweet cicely *(Osmorhiza claytonii)*	51	●
Side-flowering aster *(Aster lateriflorus)*	48	●
Common oak fern *(Gymnocarpium dryopteris)*	44	●
Rose twistedstalk *(Streptopus roseus)*	43	●
Starflower *(Trientalis borealis)*	42	●
Early meadow-rue *(Thalictrum dioicum)*	41	●
Bluebead lily *(Clintonia borealis)*	40	●
Sensitive fern *(Onoclea sensibilis)*	40	●●
Red baneberry *(Actaea rubra)*	39	●
Ostrich fern *(Matteuccia struthiopteris)*	38	●●●
Large-leaved aster *(Aster macrophyllus)*	38	●●
Nodding trillium *(Trillium cernuum)*	38	●
Common marsh marigold *(Caltha palustris)*	37	●
Wood anemone *(Anemone quinquefolia)*	37	●
Northern bugleweed *(Lycopus uniflorus)*	37	●
Red-stemmed aster *(Aster puniceus)*	34	●
Spotted water hemlock *(Cicuta maculata)*	34	●
Flat-topped aster *(Aster umbellatus)*	33	●
Meadow horsetail *(Equisetum pratense)*	29	●
Grasses & Sedges		
Graceful sedge *(Carex gracillima)*	63	●●
Bladder sedge *(Carex intumescens)*	57	●●
Fowl manna grass *(Glyceria striata)*	51	●
Long-stalked sedge *(Carex pedunculata)*	37	●●
Bluejoint *(Calamagrostis canadensis)*	37	●●
Awl-fruited sedge *(Carex stipata)*	29	●●
Starry sedge *(Carex rosea* or *C. radiata)*	29	●
Drooping woodreed *(Cinna latifolia)*	28	●
Woody Vines		
Virginia creeper (*Parthenocissus* spp.)	50	●
Low Shrubs		
Red raspberry *(Rubus idaeus)*	57	●●
Tall Shrubs		
Mountain maple *(Acer spicatum)*	68	●●●
Beaked hazelnut *(Corylus cornuta)*	67	●●
Chokecherry *(Prunus virginiana)*	52	●
Swamp red currant *(Ribes triste)*	52	●
Poison ivy *(Toxicodendron rydbergii)*	37	●
Speckled alder *(Alnus incana)*	34	●●
Swamp gooseberry *(Ribes hirtellum)*	32	●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Black ash	91	●●●●	87	●●●	87	●●
Yellow birch	28	●●●	24	●●	21	●
Quaking aspen	26	●●●	21	●●	23	●
Paper birch	26	●●	20	●	13	●
Green ash	22	●●●	18	●●●	24	●●
Basswood	22	●●	28	●	34	●
Red maple	20	●●●	27	●●●	48	●
White cedar	18	●●●	9	●●	12	●
Balsam poplar	16	●●●	13	●●	19	●
American elm	16	●●	39	●●	58	●●
Balsam fir	14	●●●	31	●●	47	●
Bur oak	8	●●	12	●●	36	●
Sugar maple	-	-	20	●	23	●

* Spinulose shield fern or Glandular wood fern *(Dryopteris carthusiana* or *D. intermedia)*

WFn64 Northern Very Wet Ash Swamp – Species Frequency & Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Dwarf raspberry *(Rubus pubescens)*	94	●●
Lady fern *(Athyrium filix-femina)*	84	●
Touch-me-not *(Impatiens* spp.)	84	●●
Common marsh marigold *(Caltha palustris)*	80	●
Northern bugleweed *(Lycopus uniflorus)*	76	●
Spinulose shield fern or Glandular wood fern*	74	●
Sensitive fern *(Onoclea sensibilis)*	67	●●
Naked miterwort *(Mitella nuda)*	66	●
Common strawberry *(Fragaria virginiana)*	66	●
Crested fern *(Dryopteris cristata)*	65	●
Sweet-scented bedstraw *(Galium triflorum)*	65	●
Red-stemmed aster *(Aster puniceus)*	64	●
Mad dog skullcap *(Scutellaria lateriflora)*	61	●
Canada mayflower *(Maianthemum canadense)*	59	●
Alpine enchanter's nightshade *(Circaea alpina)*	56	●
Wild sarsaparilla *(Aralia nudicaulis)*	51	●
Starflower *(Trientalis borealis)*	45	●
Jack-in-the-pulpit *(Arisaema triphyllum)*	43	●
Spotted Joe pye weed *(Eupatorium maculatum)*	40	●
Side-flowering aster *(Aster lateriflorus)*	38	●
Northern blue flag *(Iris versicolor)*	38	●
Bur marigold and Beggarticks *(Bidens* spp.)	35	●
Bunchberry *(Cornus canadensis)*	35	●
Giant goldenrod *(Solidago gigantea)*	35	●
Common oak fern *(Gymnocarpium dryopteris)*	34	●
Cinnamon fern *(Osmunda cinnamomea)*	34	●●●
Northern marsh fern *(Thelypteris palustris)*	33	●
Rough bedstraw *(Galium asprellum)*	30	●
Woodland horsetail *(Equisetum sylvaticum)*	29	●●
Grasses & Sedges		
Fowl manna grass *(Glyceria striata)*	69	●●●
Awl-fruited sedge *(Carex stipata)*	57	●
Bluejoint *(Calamagrostis canadensis)*	54	●●●
Bladder sedge *(Carex intumescens)*	51	●
Bristle-stalked sedge *(Carex leptalea)*	48	●●●
Graceful sedge *(Carex gracillima)*	44	●
Lake sedge *(Carex lacustris)*	38	●●●
Fringed brome *(Bromus ciliatus)*	35	●
Drooping woodreed *(Cinna latifolia)*	33	●
Soft-leaved sedge *(Carex disperma)*	30	●
Climbing Plants		
Virginia creeper *(Parthenocissus* spp.)	43	●
Low Shrubs		
Red raspberry *(Rubus idaeus)*	69	●
Shrubs		
Speckled alder *(Alnus incana)*	70	●●●
Red-osier dogwood *(Cornus sericea)*	55	●
Mountain maple *(Acer spicatum)*	48	●●●
Wild black currant *(Ribes americanum)*	48	●
Swamp gooseberry *(Ribes hirtellum)*	47	●
Swamp red currant *(Ribes triste)*	44	●
Winterberry *(Ilex verticillata)*	42	●●
Chokecherry *(Prunus virginiana)*	37	●
Highbush cranberry *(Viburnum trilobum)*	33	●
Beaked hazelnut *(Corylus cornuta)*	33	●
Dwarf alder *(Rhamnus alnifolia)*	32	●
Juneberries *(Amelanchier* spp.)	30	●

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Black ash	87	●●●●	91	●●●●	83	●●
Yellow birch	17	●●	26	●●	19	●●
White cedar	17	●●●	21	●●	21	●
Paper birch	17	●	21	●	14	●
Balsam fir	13	●	36	●	45	●
Red maple	12	●●	34	●●	54	●
Tamarack	11	●●●	-	-	9	●
American elm	8	●●	29	●●	37	●
Red elm	6	●●	14	●	22	●

* Spinulose shield fern or Glandular wood fern *(Dryopteris carthusiana* or *D. intermedia)*

MRn83 Northern Mixed Cattail Marsh — Species Frequency & Cover

	freq%	cover
Grasses & Sedges		
Lake sedge *(Carex lacustris)*	45	●●●
Bristly sedge *(Carex comosa)*	41	●●
Red-stalked spikerush *(Eleocharis palustris)*	32	●
Bluejoint *(Calamagrostis canadensis)*	27	●●●
Rice cut grass *(Leersia oryzoides)*	23	●
Tall manna grass *(Glyceria grandis)*	23	●
Soft stem bulrush *(Scirpus validus)*	18	●●
Fen wiregrass sedge *(Carex lasiocarpa)*	14	●
Wild rice *(Zizania palustris)*	14	●●
Common reed grass *(Phragmites australis)*	14	●
Tussock sedge *(Carex stricta)*	14	●
Cyperus sedge *(Carex pseudocyperus)*	14	●●
River bulrush *(Scirpus fluviatilis)*	14	●●
Beaked sedge *(Carex utriculata)*	14	●●
Ovoid spikerush *(Eleocharis ovata)*	9	●
Lesser-panicled sedge *(Carex diandra)*	9	●
Aquatic sedge *(Carex aquatilis)*	9	●●
Fragrant cyperus *(Cyperus odoratus)*	9	●
Porcupine sedge *(Carex hystericina)*	9	●●
Woolgrass *(Scirpus cyperinus)*	9	●
Floating-Leaved & Submergent Forbs		
Star-duckweed *(Lemna trisculata)*	64	●●
Lesser-duckweed *(Lemna minor)*	59	●●
Greater duckweed *(Spirodela polyrhiza)*	55	●
Common bladderwort *(Utricularia vulgaris)*	45	●●
Common coontail *(Ceratophyllum demersum)*	36	●●
Water smartweed *(Polygonum amphibium)*	32	●
Flat-stemmed pondweed *(Potamogeton zosteriformis)*	14	●
Common white water-lily *(Nymphaea odorata)*	14	●
Straight-leaved pondweed *(Potamogeton strictifolius)*	9	●
Intermediate bladderwort *(Utricularia intermedia)*	9	●
Yellow pond lily *(Nuphar variegata)*	9	●
Unbranched bur reed *(Sparganium emersum)*	9	●
Emergent Forbs		
Broad-leaved arrowhead *(Sagittaria latifolia)*	64	●
Marsh skullcap *(Scutellaria galericulata)*	64	●
Three-cleft or small bedstraw *(Galium trifidum* or *G. tinctorium)*	59	●
Bur marigold and Beggarticks *(Bidens* spp.)	50	●
Tufted loosestrife *(Lysimachia thyrsiflora)*	45	●
Bulb-bearing water hemlock *(Cicuta bulbifera)*	41	●●
Great water dock *(Rumex orbiculatus)*	41	●
Marsh bellflower *(Campanula aparinoides)*	41	●
Clearweed *(Pilea* spp.)	36	●
Northern bugleweed *(Lycopus uniflorus)*	32	●
Broad-leaved cattail *(Typha latifolia)*	32	●●●●
Touch-me-not *(Impatiens* spp.)	32	●
Giant bur reed *(Sparganium eurycarpum)*	27	●●●
Water parsnip *(Sium suave)*	27	●
Linear-leaved, Marsh, or Downy willow-herb*	23	●
Spotted water hemlock *(Cicuta maculata)*	23	●
Dotted smartweed *(Polygonum punctatum)*	18	●
Sweet flag *(Acorus calamus)*	18	●●●
Swamp milkweed *(Asclepias incarnata)*	18	●
Northern marsh fern *(Thelypteris palustris)*	18	●
Cut-leaved bugleweed *(Lycopus americanus)*	18	●
Marsh cinquefoil *(Potentilla palustris)*	14	●
Spotted Joe pye weed *(Eupatorium maculatum)*	14	●
Marsh horsetail *(Equisetum palustre)*	9	●
Common mint *(Mentha arvensis)*	9	●
Stinging nettle *(Urtica dioica)*	9	●
Nodding smartweed *(Polygonum lapathifolium)*	9	●
Lady's thumb *(Polygonum persicaria)*	9	●
Common water plantain *(Alisma triviale)*	5	●
Shrubs		
Red-osier dogwood *(Cornus sericea)*	9	●●

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

WMn82 Northern Wet Meadow/Carr — Species Frequency & Cover

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

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

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

Appendix D. Hartley Park Northwest Hills Restoration Plan (The Nature Conservancy)

Hartley Park Northwest Hills Restoration Plan

Draft version by The Nature Conservancy for editing and approval by City of Duluth and Hartley Nature Center
8/17/2020

Overview
Hartley Park sustained several areas of blowdown during the July 2016 storm including an area in the "Northwest Hills" of the park. The blowdown areas and canopy gaps created by the storm are filling with upland brush including hazel and mountain maple, buckthorn, and aspen. The brush and aspen in these openings is hindering the recruitment of native canopy species. In order to increase the diversity of native and climate adapted tree species in the forest system, and provide for the future aesthetics of the park, we propose brush-sawing delineated canopy gap areas and planting the gaps next spring. An accompanying .pdf map document can be opened with Avenza Maps for a self-guided tour of the proposed (un-marked) treatment gaps.

Goals

1. October 2020 – Use brush saws to remove less desirable species in canopy gaps as site prep to create suitable growing conditions for future seedlings.
2. Spring 2021 - plant and install single-tree fences or tree shelters on white pine, red oak, yellow birch, white spruce and cedar in the brush sawn gaps.

Specifications
The site contains 36 gaps, sizes 0.01 – 0.87 acres, averaging 0.33 acres and totaling approximately 12 acres in the "Northwest Hills" area of Hartley Park. The gaps include blowdown areas that contain beaked hazel, mountain maple, and aspen regeneration, and lowland brush areas that contain alder and buckthorn. The areas are not currently flagged but would be flagged just prior to cutting.
All work can be completed by forestry contractors working for The Nature Conservancy. However, there will be opportunities for some volunteer tree planting and browse protection during the Spring of 2020 and maintenance and expansion of the restoration work for the next 10 years.
Site Prep: cut all woody vegetation less than 5" in diameter (breast height) within flagged gaps. This cutting will allow enough light for acceptable growth on planted seedlings. The reserved larger trees >5" will maintain an overall forested character.
Tree Planting: plant 8"-12" seedlings of white pine, red oak, yellow birch, white spruce, and Northern white cedar (other species if available) at approximately 10'x10' spacing in brush cut gaps
Browse Protection: All species vulnerable to deer browse will be protected at the time of planting by either fencing or tree shelters. Fencing- install 6' tall 3' diameter welded wire fencing secured with two rebar fence posts. Tree shelters- install 48" tall "Tubex" shelters on hardwood species and 48" "Tree Sentry" shelters on conifers. The proportion of fencing to tree shelters is to be determined.

Timeline
The brush-saw work would be completed in October, 2020. Flagging of the sites could be done 1-2 days in advance. Brush-saw work would likely be completed in 1 day, it is possible that it would take 2 days. Spring planting is typically performed from late April through late May. Planting and browse protection would likely be completed in one or two days.

Funding
All contracted labor and supplies will be funded by The Nature Conservancy's Outdoor Heritage Fund grant "Minnesota Forest Recovery Project: Phase I"