



MANAGEMENT PLAN FOR THE

Hartley Natural Area

OF THE DULUTH NATURAL AREAS PROGRAM

DATE: 11/25/19

Nominated by: City of Duluth Parks & Recreation Division



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Introduction

This management plan for the Hartley Natural Area was developed following the requirements of the Duluth Natural Area Program (DNAP) ordinance. The purpose of this plan is to provide guidance for maintaining and improving the ecological function of the natural features for which the Hartley Natural Area was nominated to the program (see nomination report in Appendix A), including significant native plant communities, natural water feature area, and geological landform area.

The 2014 Hartley Park Master Plan, 2017 Duluth Traverse Mini Master Plan, and the 2015 Duluth Cross Country Ski Trail Master Plan, as well as agreements with the Hartley Nature Center (HNC) and others are additional guiding documents related to the infrastructure and uses within the Hartley Natural Area that this plan is intended to inform and does not supersede.

The City of Duluth will implement this plan with the assistance of its partners with interests within the natural area. In particular, HNC, located immediately adjacent to the natural area, is the primary partner in stewardship. Other partners involved in stewardship, management, and maintenance of features within the natural area include Stewardship Network Duluth Cooperative Invasive Species Management Area (CISMA), Cyclists of Gitchee Gumees Shores (COGGS), Duluth Cross Country Ski Club (DXC), and the Superior Hiking Trail Association (SHTA).

This plan presents an inventory of natural resources and human uses within the natural area, describes threats to the ecological function of these features, describes strategies for preserving the natural features, and presents an implementation plan with prioritized actions, timelines, and costs.

Natural Area Conditions

This section provides an inventory of natural resources in each of the three scientific categories for which the Hartley Natural Area was nominated to the DNAP, describes human use of the natural area, and discusses the current status of land ownership for future preservation.

While the boundaries of the Hartley Natural Area predominantly overlap with the boundaries of Hartley Park, there are some distinct differences (Figure 1). In particular, the natural area boundary does not include HNC and the adjoining large parking lot or the ballfields at Como Park (Glen Avon). Though the boundaries are slightly different, existing plans developed for Hartley Park, such as those listed in the Introduction, apply to those areas of the park located within the natural area.

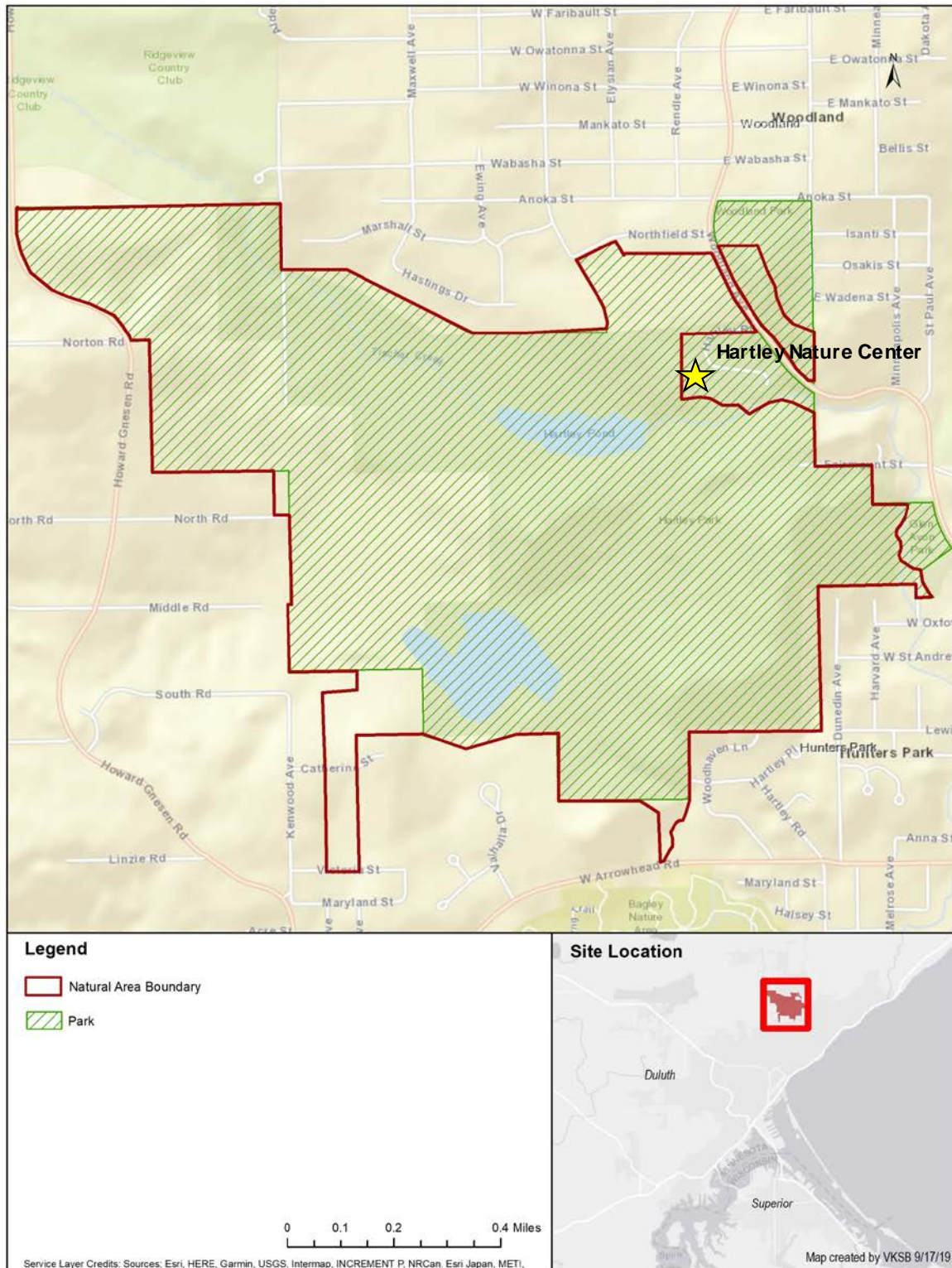


Figure 1: Hartley Natural Area in Comparison to Hartley Park



NATURAL RESOURCES INVENTORY

The significant natural resources for which the Hartley Natural Area was nominated include significant native plant communities, natural water features, and geological landforms. This section describes information provided in the Hartley Natural Area nomination report (Appendix A), as well as additional information from a 2019 field survey and other sources.

Significant Native Plant Communities

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). The NRRI report is provided in Appendix B.

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). 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).

Table 1: Native Plant Communities in the Hartley Natural Area

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

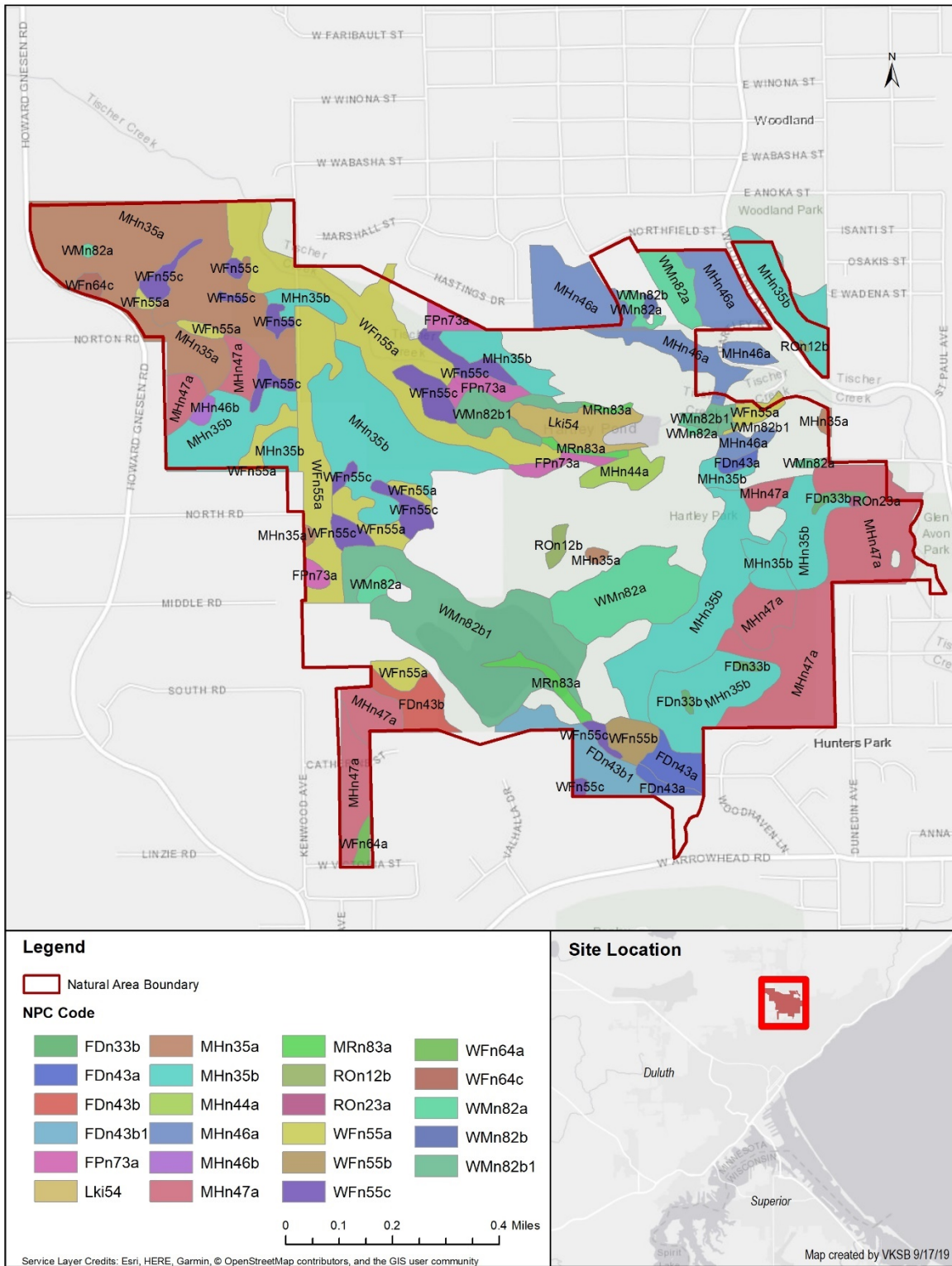


Figure 2: Native Plant Communities in the Hartley Natural Area

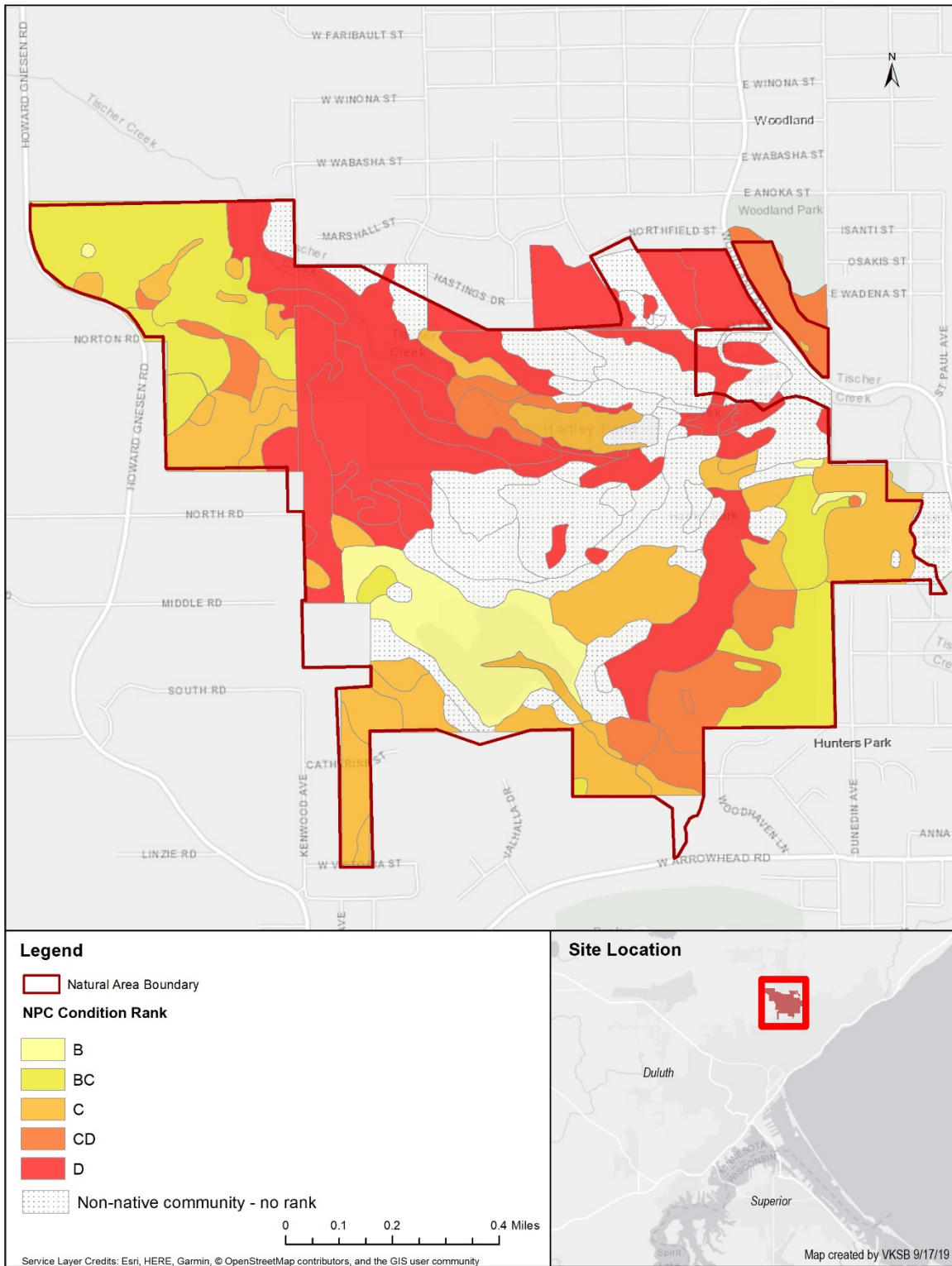


Figure 3: Condition Ranks of Native Plant Communities in the Hartley Natural Area



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 (Figure 4). 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.

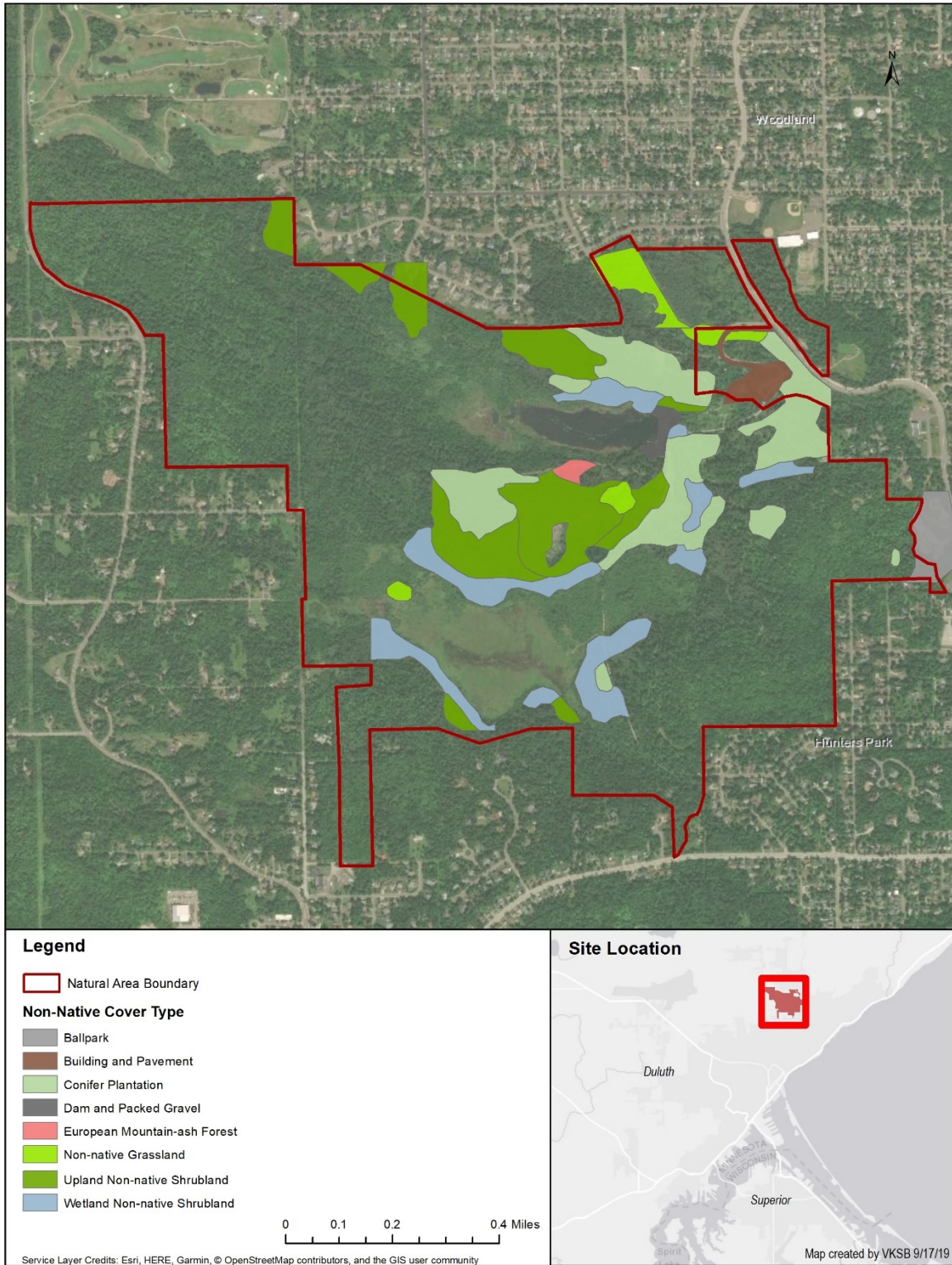


Figure 4: Non-Native Plant Communities in the Hartley Natural Area



The 2019 vegetation surveys focused primarily on identifying or confirming NPCs and were not intended to identify rare species. However, one rare tree species, butternut (*Juglans cinerea*), was identified in the northeastern end of the natural area. This species was listed by MNDNR as special concern in 1996 due to a lethal fungal disease called butternut canker. In 2013, butternut was listed as an endangered species in Minnesota.

Another unique feature within Hartley Natural Area is a group of eastern white pine trees that have a genetic history of natural resistance to white pine blister rust. Cuttings collected by the University of Minnesota Cloquet Forestry Center and the United State 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. A brief history of these trees is provided in Appendix C.

Natural Water Features

Natural water features within the Hartley Natural Area include Tischer Creek and numerous vernal pools.

Tischer Creek

Two branches of Tischer Creek, one of 16 designated trout streams in the city of Duluth, flow through Hartley Natural Area (Figure 5). The main stem originates upstream of the natural area within the city of Rice Lake. It flows into the natural area on the northwest corner through a wet forest and alder swamp system and is eventually impounded by the dam that forms Hartley Pond. Downstream of the pond, the creek flows through a willow swamp, sedge meadow, and black ash wet forest before it leaves the natural area. The headwaters of the West Tischer Creek are located within Hartley's large wet meadow on the south (Figure 5).

MNDNR has stocked brook trout in Tischer Creek almost yearly since 1955. Brook trout can be found throughout Tischer Creek and West Tischer Creek. Twenty other fish species have been found in the creek in surveys completed by MNDNR through 2009. Bluegill, golden shiner, largemouth bass, and pumpkinseed sunfish are species that have only been collected in Hartley pond (MNDNR, 2010). Stocking of fish in Hartley Pond was discontinued in 2008.

Tischer Creek and West Tischer Creek are supported by wetland systems within Hartley Natural Area. These natural wetland areas in the headwaters provide base flow to the stream during dry conditions, maintain the input of cool water to prevent overheating, and reduce peak flow events that may cause flooding and downstream erosion.

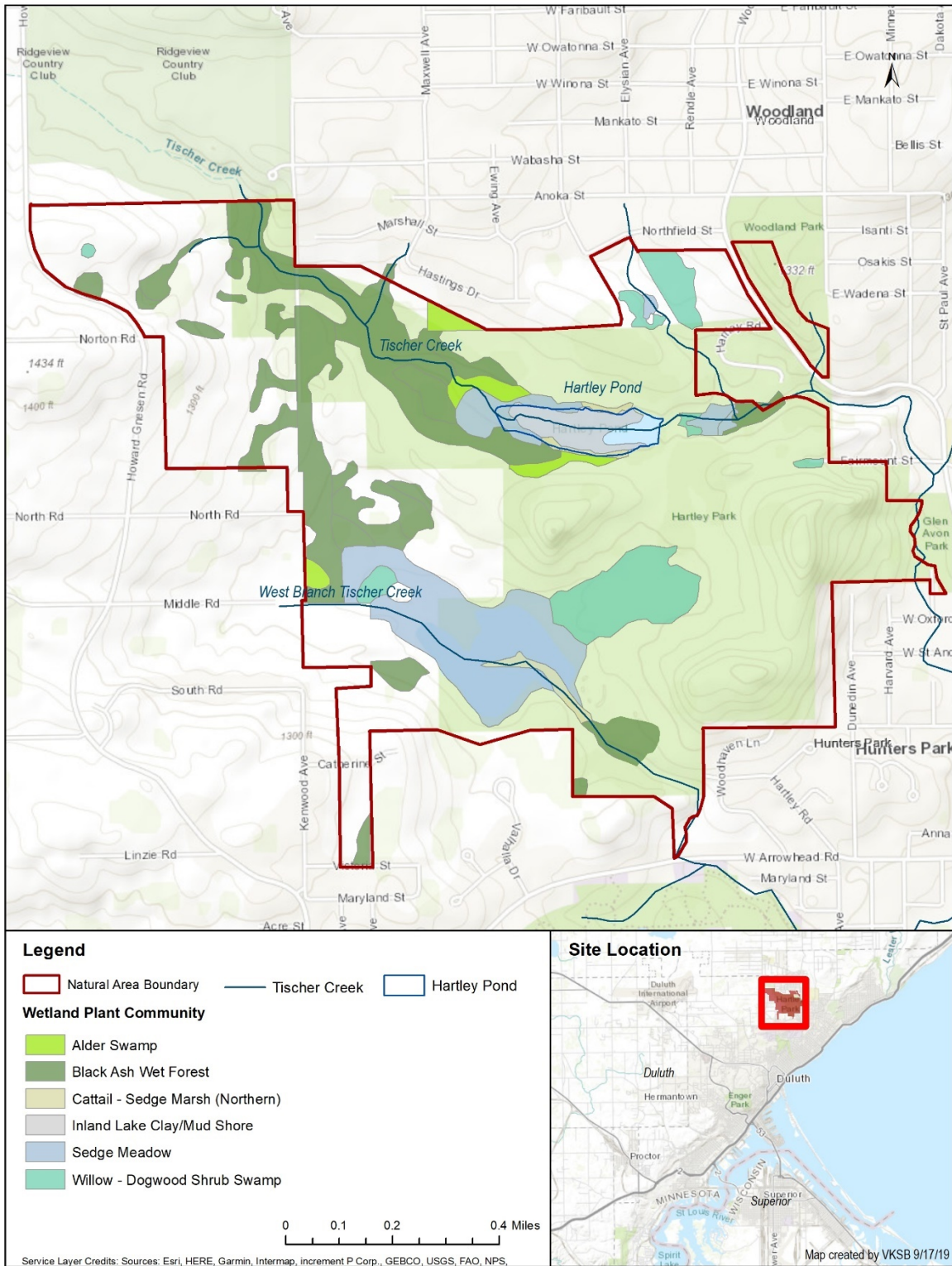


Figure 5: Tischer Creek and Associated Wetlands within the Hartley Natural Area



Vernal pools

Vernal pools are small seasonally flooded wetlands that provide vital open water habitat for many native amphibians (e.g. blue-spotted salamanders, spring peepers, chorus frogs, gray treefrogs, wood frogs) and aquatic insects that require fish-free wetlands to survive. Plants and animals supported by vernal pools are the primary food base for terrestrial wildlife in northern forests (i.e., reptiles, small mammals, etc.).

Not all melt pools are vernal pools. A vernal pool should have standing water for at least 3-4 months, long enough for amphibians and other dependent wildlife to complete their life cycles and occur consistently every year with normal precipitation.

Multiple vernal pools exist in the Hartley Natural Area. Work conducted by researchers from UMD-NRRI in 2014 identified 21 vernal pools within the natural area and 44 possible vernal pools (Figure 6; Olker et al, 2014). The pools provide breeding habitat for a suite of northern amphibian species, including the following that were identified in 2014: wood frog, northern leopard frog, spring peeper, western chorus frog, gray treefrog, mink frog, and blue-spotted salamander. All of these species require wetlands, such as vernal pools, for breeding, but also need upland terrestrial habitat for foraging, migration, and/or overwintering. Hartley Natural Area is unique because it includes the breeding habitat for these amphibian species and the upland terrestrial habitat within an intact forested area, providing a safer environment for movement between habitats and migration (e.g., no roads to cross).

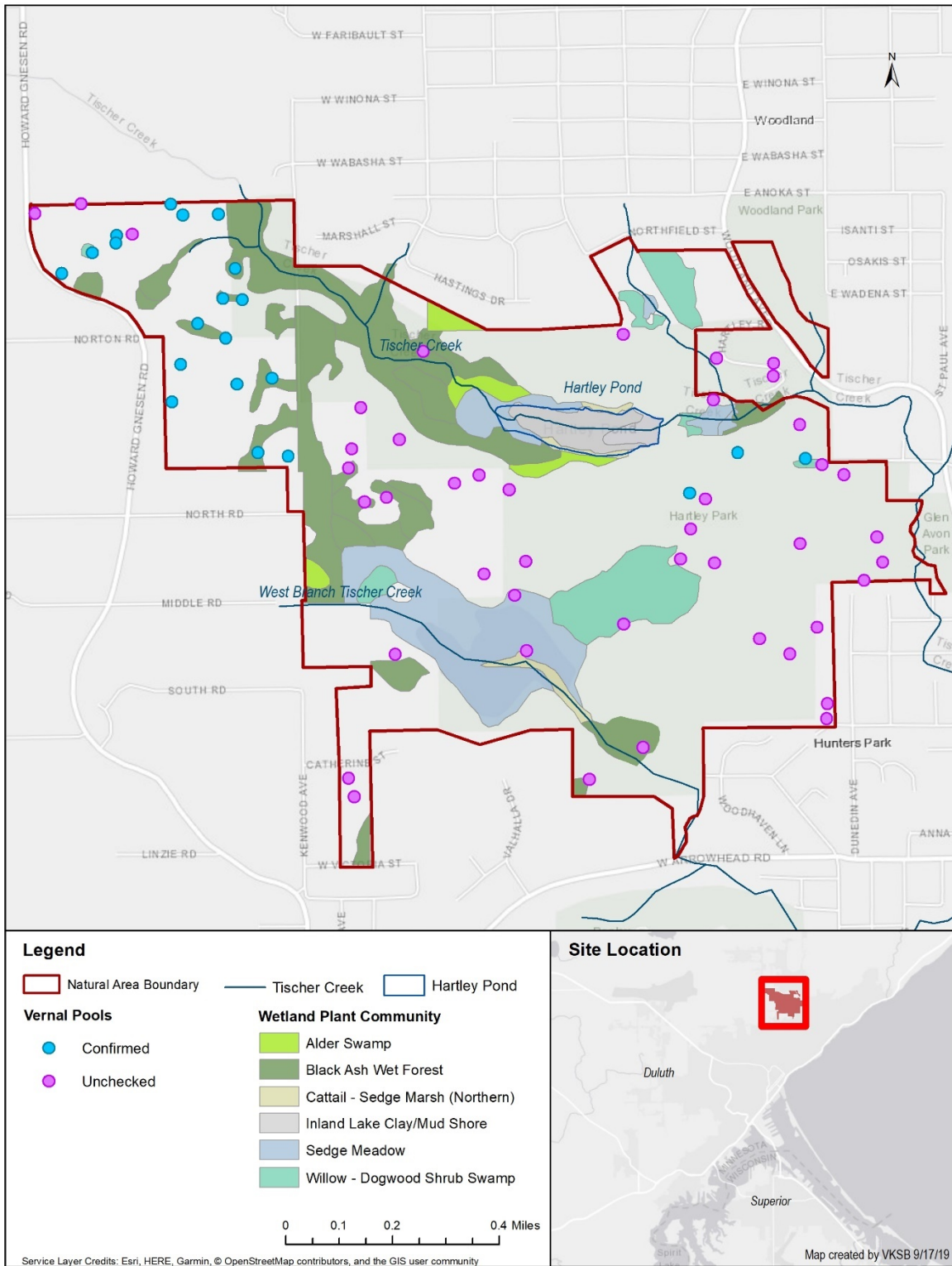


Figure 6: Vernal Pools within the Hartley Natural Area



Geological Landforms

The Tettegouche Till Plain, a band of rolling topography at the crest of the slope overlooking Lake Superior and the St. Louis River, forms the backbone of Duluth. Hartley Natural Area contains the substantially undisturbed geological landform of the Tettegouche Till Plain, illustrating the northwest to southeast flutes formed by the glacier (Figure 8).

The evidence of geologic history within Hartley Natural Area exemplifies the Midcontinent Rift, including volcanism, intrusion, and crystallization of plutonic rocks such as the Duluth Gabbro Complex, and deposition of sediments, about 1.1 billion years ago. This was followed by the Tettegouche Till Plain glaciation period that sculpted the landscape of Hartley. The rock outcrops at Rock Knob and on the east side of the natural area are indicators of this geologic history (Figure 3).

HUMAN USES

The Hartley Natural Area and Hartley Nature Center are well-loved by city of Duluth residents.

HNC provides environmental education to thousands of students from Duluth and the surrounding area each year. HNC Programs include school/group trips, day camps, early childhood programming, member events, and a nature-based preschool. HNC also offers skis, snowshoes, and other equipment for rental and use with the natural area. In 2018, over 10,000 people participated in HNC programming.

Outside of HNC programming, city residents use the natural area for a myriad of uses, including hiking, biking, trail running, dog-walking, cross-country skiing, snowshoeing, climbing, fishing, and paddling. An extensive trail system, consisting of multi-use trails (hiking, biking), cross-country ski trails, and the Superior Hiking Trail, supports these uses within the natural area boundaries (Figure 7). In both 2018 and in 2019, over 100,000 user passes were recorded by a counter located on the trail at Hartley Pond.

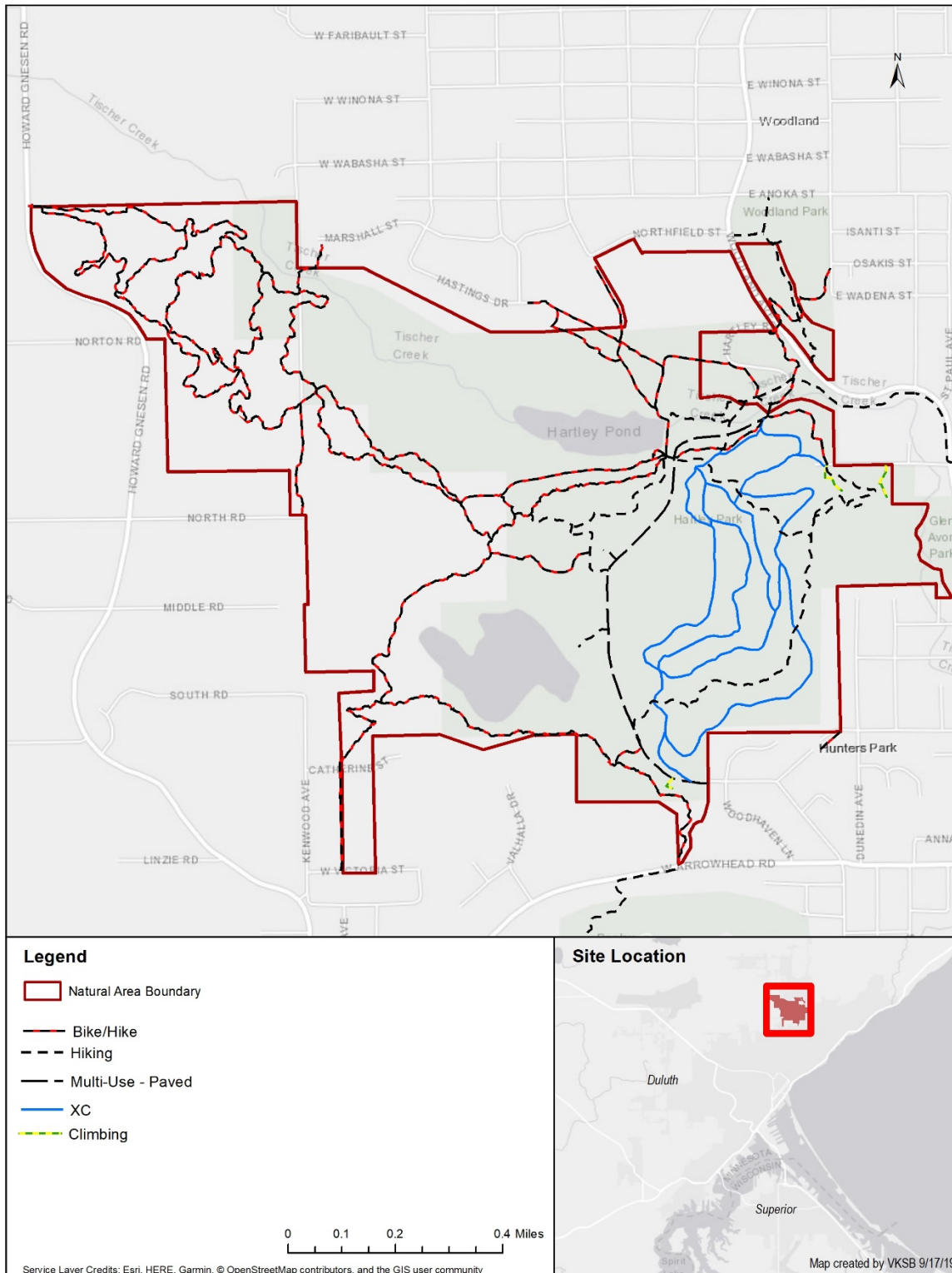


Figure 7: Trails within the Hartley Natural Area



During the Hartley Park master planning process, an analysis of needs for the existing trail system was completed. The Hartley Master Plan (SRF et al, 2014) describes recommended improvements to the trail system based on this analysis. Once the recommendations in the master plan are completed, no additional trails will be developed within the natural area.

LAND OWNERSHIP

The Hartley Natural Area consists of 66 land parcels covering 620.41 acres. One parcel was listed as tax forfeit, five parcels were owned by the Hartley Nature Center, and the rest are owned by the City of Duluth. St. Louis County has agreed to convey the tax forfeit one-acre parcel with a trail running through it to the City. HNC agreed to transfer the ownership title of its five parcels to the City with the condition to return them to HNC should there ever be land use changes to those parcels other than permanent protection. The DNAP is set up to permanently protect these lands and this condition provides an added protection requested by the landowner.

Part of the work to be completed after the Hartley Natural Area is final will be to update the park boundary and re-zone it to P-1 (Park and Open Space District). The additional land area added to the park boundary will include the HNC and the County parcels conveyed to the City. It should be noted, the natural area will not match park area exactly because the HNC building and parking lot and the ball fields do not meet the nomination requirements.

Threats

The primary threats to the ecological integrity of the special features for which Hartley Natural Area was nominated to the DNAP are described in this section. While additional threats may exist, the focus of management actions for the natural area is on the following:

- Stream impoundment at Hartley Pond
- Invasive species
- Human uses

STREAM IMPOUNDMENT AT HARTLEY POND

Hartley Pond is a manmade impoundment of Tischer Creek that was originally created in the 1920's by Mr. Cavour Hartley for a duck and goose sanctuary on his property. The pond was dredged and the dam was improved in 1963 by the Woodland Community Club, but the dam was largely washed out in heavy streamflows in 1972 (City of Duluth, 1974). The present dam was constructed downstream of the original structure in 1975. While the pond is used for recreational and aesthetic enjoyment, its presence



impacts the ecological integrity of Tischer Creek in several ways. In addition, accumulated sediment in the impoundment limits the function of the dam as a flood control structure.

Trout streams are cold water systems, requiring lower temperatures to support the cold water fish assemblage. While the reaches of Tischer Creek within Hartley Natural Area are not currently impaired, based on the Minnesota Pollution Control Agency's (MPCA) watershed assessments, the stream reach below Hartley Pond has been determined to have increased water temperature compared to the reach upstream of the pond. Temperature data was collected in 2000-2002 and in 2016 at six locations on the Tischer Creek main stem and one tributary location. The percent of hours of water temperatures lethal to brook trout was 1% or less at all stations except the station below Hartley pond, where lethal water temperatures were recorded in 9% of hours. Stressful temperatures occurred 41% of the time below the pond, with 1 to 11% elsewhere (South St. Louis SWCD, 2017). Longitudinal temperature monitoring conducted by MNDNR on three dates in 2010 demonstrates the increase in stream temperature that occurs within Hartley Pond (Figure 8).

Warming of waters in the pond is caused by solar heating of the shallow, slow moving water, as well as lack of riparian cover. The outlet at the dam drains the water from the surface of the pond, which is typically the warmest. Given the pond's shallow depth, it is possible that water temperatures are consistently warm throughout its water column.

In addition to causing temperature impacts, the dam at Hartley Pond is a barrier to fish passage and sediment transport and changes the natural flow regime within Tischer Creek. Controlled flow from the dam overflow structure results in periods with little to no flow below the dam, which reduces baseflow throughout the creek's downstream reaches (MNDNR, 2010).

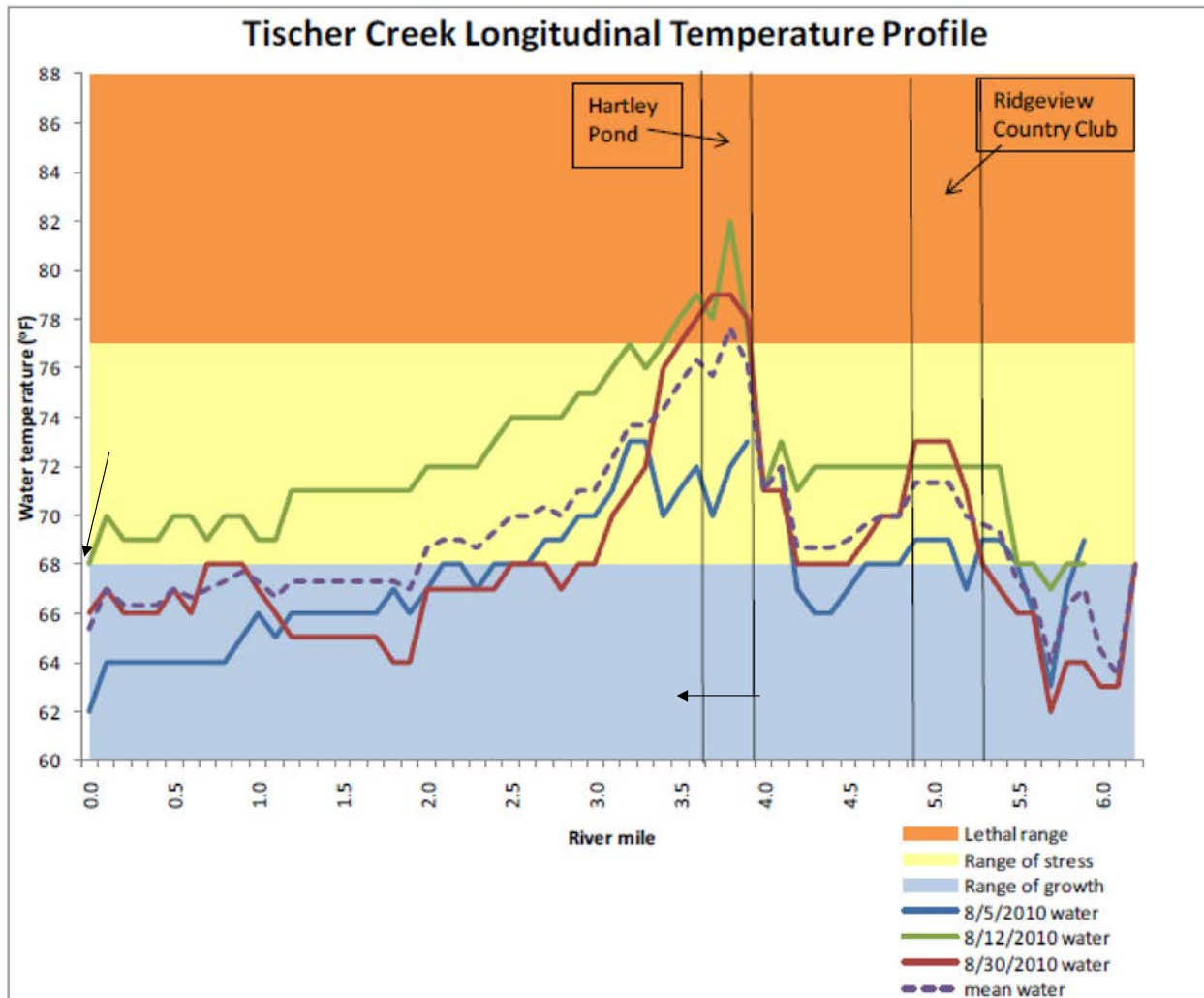


Figure 8: Temperature Profiles in Tischer Creek in August 2010.

(Source: MNDNR, Duluth Area Fisheries Office)

Several agencies have identified the need to address temperature impacts to Tischer Creek from Hartley Pond, including MNDNR in the Tischer Creek Management Plan (MNDNR, 2010), the South St. Louis Soil and Water Conservation District (SWCD) in their 2016/17 Tischer Creek Stream Assessment, and MPCA in the 2018 Draft Duluth Urban Area Watershed Restoration and Protection report. The South St. Louis SWCD also identified a need to conduct riparian restoration downstream of Hartley Pond to address lack of canopy species, lack of shade, and presence of invasive species. The Hartley Master Plan calls for the City to conduct a feasibility study “to assess preservation of Hartley Pond and restoration of Tischer Creek”.



INVASIVE SPECIES

Invasive species have a variety of negative effects in an ecosystem. They can displace, weaken or kill desirable plants resulting in loss of diversity; pose human health risks; degrade wildlife habitat; interfere with recreational activities; disrupt urban and community ecosystems, and divert millions of dollars for their control (MN Invasive Species Advisory Council, 2015).

Invasive plants can be more problematic in urban forests, such those in the Hartley Natural Area, because they are able to quickly colonize areas with high levels of disturbance. Compaction and erosion in high use areas such as trails provides more opportunities for invasive species to establish. Invasive species are better able to take advantage of these conditions than native species and can quickly populate disturbed sites.

Invasives are introduced via hitchhiking of seeds on boots, tires, domestic animals, and equipment. They can also be spread by wildlife and domestic animals, and infestations can encroach from surrounding areas.

The NPC survey conducted in 2019 identified a total of 44 invasive species present in Hartley Natural Area (Table 2; Reschke et al, 2019). Of these, glossy buckthorn, valerian, common buckthorn, and common dandelion are the most prevalent species.

Table 2: Invasive Plant Species Found in Hartley Natural Area in 2019

Scientific name	Common name	No. of Polygons Present (of 124 total)
<i>Frangula alnus</i>	glossy buckthorn	80
<i>Valeriana officinalis</i>	valerian	72
<i>Rhamnus cathartica</i>	common buckthorn	69
<i>Taraxacum officinale</i>	common dandelion	66
<i>Tanacetum vulgare</i>	tansy	58
<i>Plantago major</i>	common plantain	54
<i>Hieracium aurantiacum</i>	orange hawkweed	47
<i>Cirsium arvense</i>	Canada thistle	41
<i>Phalaris arundinacea</i>	reed canary grass	41
<i>Lonicera sp., alien</i>	Eurasian honeysuckle	25
<i>Leucanthemum vulgare</i>	ox-eye daisy	23
<i>Lotus corniculatus</i>	bird's-foot trefoil	13
<i>Arctium sp.</i>	burdock	12
<i>Cirsium vulgare</i>	bull thistle	12
<i>Syringa x prestoniae</i>	Preston's lilac	12
<i>Stellaria sp.</i>	stichwort or chickweed	11
<i>Convallaria majalis</i>	lily-of-the-valley	8
<i>Hesperis matronalis</i>	dame's rocket	8



<i>Hieracium sp. (yellow)</i>	hawkweed	8
<i>Lonicera caerulea ssp. edulis</i>	honeyberry	8
<i>Lupinus polyphyllus</i>	large-leaved lupine	8
<i>Campanula cervicaria</i>	bristly bluebells	6
<i>Fallopia japonica</i> var. <i>japonica</i> (= <i>Polygonum cuspidatum</i>)	Japanese knotweed	5
<i>Acer ginnala</i>	Amur maple	4
<i>Campanula rapunculoides</i>	European bellflower	4
<i>Glechoma hederacea</i>	creeping charlie	4
<i>Aegopodium podagraria</i>	goutweed	3
<i>Bromus inermis</i>	smooth brome	3
<i>Galeopsis tetrahit</i>	hemp nettle	3
<i>Medicago sativa</i>	alfalfa	3
<i>Sorbus aucuparia</i>	European mountain ash	3
<i>Syringa cf. vulgaris</i>	common lilac	3
<i>Typha sp. (alien?)</i>	cattail	3
<i>Berberis thunbergii</i>	Japanese barberry	2
<i>Lythrum salicaria</i>	purple loosestrife	2
<i>Matricaria discoidea</i>	pineapple weed	2
<i>Medicago lupulina</i>	black medick	2
<i>Sonchus sp.</i>	sow thistle	2
<i>Typha sp. - alien</i>	narrowleaf cattail	2
<i>Verbascum thapsis</i>	common mullein	2
<i>Acer platanoides</i>	Norway maple	1
<i>Hemerocallis fulva</i>	orange daylily	1
<i>Sorbaria sorbifolia</i>	false spiraea	1
<i>Syringa reticulata</i>	Amur lilac	1

HUMAN USES

Trails provide opportunities for people to connect with nature, improve health and well-being, and, in the case of Hartley Natural Area, to be educated about the natural world.

Disturbance of the natural area is inherent with human use. These disturbances can be threats to ecological function if human uses are not carefully considered and managed. A thorough review of available research in the US and abroad on the impacts of recreation on the ecology of natural areas was conducted by Metro, the regional planning authority for the Portland, OR area (Henning, 2017). This section relies heavily on information summarized in this highly regarded literature review.

Trails and trail use have been found to have negative impacts to soils, vegetation, water quality, plants, and wildlife (Henning, 2017). All human uses impact the ecology of a natural area in some manner. The level and type of impact is dependent both on the type of use and the frequency of use; no one user group has greater impacts in all categories. For example, hikers typically cause greater amounts of trail



widening and associated impacts on vegetation; they are also likely the group most prone to creating unauthorized trails (in part because they are often the most common type of user and because they can readily move off trail on foot). Bikers can cause trail incision and have greater effects on wildlife than hikers. While it is important to understand possible impacts by different user groups in order to properly plan for and manage impacts, it is also important to consider these impacts without bias towards any one set of users. Regarding impacts to trails themselves, the literature is inconclusive about which user group causes the most damage on a one-to-one basis (Henning, 2017).

Damage from trails is generally greatest during trail construction. Further impacts can and do occur over time from users. These impacts include:

- Vegetation damage adjacent to trails
- Soil erosion and compaction
- Trail widening and incision

Effects on ecological processes by trails and trail use in a natural area can include:

- Riparian habitat and water quality – disturbed riparian vegetation; altered drainage patterns and increased runoff
- Habitat loss, fragmentation, and edge effects – altered vegetation structure and invasive species introductions along corridors; creation of zones of avoidance for wildlife
- Introduction of invasive species – trail users transport species along trail systems, with multi-use trails tending to have more invasive species than single-use trails

Strategies

Strategies for managing native plant communities, special species, non-native or cultural plant communities, invasive species, special water features, and trails within the Hartley Natural Area are described in this section.

NATIVE PLANT COMMUNITIES

The DNAP uses NPCs to assess and manage all natural areas within the city. The classification of NPCs is a scientifically based method to assist understanding and managing an area's natural resources. A NPC is composed of plant species that were commonly associated prior to European development. Identifying a NPC today indicates a relatively high degree of naturalness, or lack of human disturbance. NPC species lists can also be used as a template for restorations or reintroductions. In addition to identifying NPCs, data can be collected to also identify growth stage and condition rank (a measure of quality).

Forest and wetland ecosystems rely on certain types of natural disturbance processes to recruit, and maintain their array of native plants and animals, recycle nutrients, and stimulate growth and



reproduction. The techniques used to manage any vegetation should be based on mimicking, or using, the natural ecosystem processes that shape a particular NPC, such as fire, windthrow, or flooding.

Plant communities within the Hartley Natural Area will be managed to maintain or improve the condition rank of each NPC, while recognizing natural development through growth stages.

Management actions should be aligned with an understanding of the timing, extent, severity, and frequency of natural dynamics of each NPC to the extent practicable.

Management recommendations follow for each of the major plant community systems in the Hartley Natural Area.

Fire Dependent Forest/Woodland

Aspen- Birch Woodlands (FDn33b), White Pine – Red Pine Forests (FDn43a), and Aspen – Birch Forest, Balsam Fir Subtype (FDn43b1)

Dry-mesic mixed forests and woodlands on well-drained soils; generally shallow soils over bedrock and often coarse sandy or gravelly textures such as those associated with glacial features. These soil characteristics make these communities prone to drought. Accordingly, these forests are often dominated by conifers, but can also be dominated by early-successional hardwoods or be a mixed composition of the two. Dominant tree species include red and white pine, quaking aspen, paper birch, balsam fir, white spruce and white cedar. Later successional species such as white pine, white spruce, white cedar and balsam fir are more dominant in the forests (FDn43) than in the woodlands. Characteristic understory species include Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*) and large-leaved aster (*Eurybia macrophylla*), as well as the shrub beaked hazelnut (*Corylus cornuta*).

Historically, fire was the major source of succession in these systems with some type of fire occurring every 50-100 years. Frequent fires encouraged the growth of species tolerant to and dependent on fire for their lifecycles. Importantly, fires also impacted these plant communities by maintaining a more open canopy that increases the light available on the forest floor, and by driving nutrient cycling with episodic releases, but also leeching of, nutrients after fire. Windthrow was uncommon in these systems, meaning that most disturbance events resulted in large patches of affected areas.

Management: These forests have three major growth stages (young, mature, and old stands) that support different suites of plant and animal species. Reintroducing fire in the form of prescribing burning would be the ideal management solution but may be challenging to use in this urban forest setting. Targeted stand harvests that open the canopy and clear the ground layer could be used instead to emulate stand replacing fires. This should be rotated so that a single stand experiences a ‘disturbance event’ every 50-100 years. Clearing of brush with some controlled burning between these larger events could also be used to replicate light surface fires. Although such disturbances are necessary to maintain healthy fire dependent communities, there has been an overall decline in the old growth stage of these forests across MN. Therefore, effort should be made to promote mature and old stands of these



forests. Planting of late-successional species such as white pine, white cedar, and red oak are recommended and protection from deer browse will be required. Thinning of early successional species such as birch and aspen may also be required in these areas if it is not happening naturally.

Frequent disturbances also make these communities prone to invasion by non-native species. Ongoing monitoring and control of invasive shrubs, such as buckthorn and non-native honeysuckles will be required. Forest pests and diseases can be major threats to healthy forest systems; continual attention should be paid for unusual symptoms of decline in tree species.

Mesic Hardwood Forest

Aspen – Birch – Basswood Forests (MHn35a), Red Oak – Sugar Maple – Basswood (Bluebead Lily) Forests (MHn35b), Aspen – Birch – Red Maple Forests (MHn44a), Aspen – Ash Forests (MHn46a), Black Ash – Basswood Forests (MHn46b), and Sugar Maple – Basswood (Bluebead Lily) Forests (MHn47a)

Dry-mesic to wet-mesic forests occur on well-drained and loamy to poorly drained and clayey soils, often with high local water tables. They are generally located on level-ground over glacial lake deposits, moraines, or till plains, but occasionally over bedrock hills. These soil characteristics buffer these communities from drought; however, they only occasionally experience saturated soils after snowmelt or heavy rains. These moist, level soils create a rich humus layer that provides predictable access to water and nutrients. Accordingly, these forests are generally dominated by hardwoods such as sugar maple, basswood, paper birch, quaking aspen, black ash and northern red oak. Balsam fir is also a typical component of these forests. These forests have continuous, dense canopies that restrict the amount of light reaching the forest floor and have well-defined sub-canopy, shrub and herbaceous layers. Characteristic understory species are adapted to low-light conditions and include wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), dwarf raspberry (*Rubus pubescens*), sweet-scented bedstraw (*Galium triflorum*), large-leaved aster (*Eurybia macrophylla*), lady fern (*Arthyrium felix-femina*), rose twisted stalk (*Streptopus roseus*), and Pennsylvania sedge (*Carex pennsylvanica*). The shrubs beaked hazelnut (*Corylus cornuta*), chokecherry (*Prunus virginiana*), and fly honeysuckle (*Lonicera canadensis*) are also common. Unique spring ephemerals are also found in these forests, and capture light and energy before full canopy closure.

The typical source of mortality in these systems is windthrow or other small-scale disturbances, with fire uncommon due to the moist soils. In general, these systems, once mature, can operate for thousands of years with little management. Catastrophic disturbances such as fire or large windthrow events occur approximately every 1000 years. A large windthrow event affected many areas of the natural area in July 2016. Patchy windthrow or light surface fires happened more often, about every 150 years.

Management: These systems generally require low maintenance once mature. Patchy windthrow is the most common disturbance and still operates in these areas today. Allowing this type of disturbance to proceed naturally will be the main management action required in these areas. However, these forests do have various stages of development, from young to mid-aged to mature forests, and successional progression may need to be assisted in certain areas. Aspen dominate in young stands but are replaced



by later successional species such as white pine, sugar maple, basswood, white spruce and yellow birch in older stands. In densely overgrown areas, selective clearing of aspen accompanied by planting of late successional species could speed progression towards mature mesic hardwood forests. The planting of long-lived conifers, such as white pine, spruce and cedar, is especially recommended as they suffer from over browsing by deer, and protection from deer browse will be required. Finally, due to logging and other human disturbances the amount of mature mesic hardwood forests in Minnesota has declined substantially. Therefore, maintaining as much of this community in older age classes as possible is desirable.

Additional management concerns include invasive species, erosion and trails, and forest pests and diseases. First, these communities can be prone to invasion by non-native species. Ongoing monitoring and control of invasive species, such as buckthorn, non-native honeysuckles, and garden lily of the valley (*Convallaria majalis*) will be required. Additionally, invasive earthworms reduce the humus layer in these forests and threaten to permanently change the community composition of these systems. Reducing the spread of these invaders will help maintain the full diversity of mesic hardwood systems. When repairing and maintaining trails, care needs to be taken to avoid working these areas when soils are saturated, generally in the spring, which compacts soils and destroys plants and plant roots. Trails also need to be planned so that they drain away water and maintain a dry surface during these times. Trails can damage fragile understory plants in these areas. Forest pests and diseases can be major threats to healthy forest systems and continual attention should be paid for unusual symptoms of decline in tree species.

Wet Forests

Black Ash - Aspen - Balsam Poplar Swamp (Northeastern) (WFn55a), Black Ash – Yellow Birch - Red Maple – Basswood Swamp (Eastcentral) (WFn55b), Black Ash - Mountain Maple Swamp (Northern) (WFn55c), Black Ash - Conifer Swamp (WFn64a), and Black Ash – Alder Swamp (Northern) (WFN64a)

Wet forest systems are hardwood forests on wet, mucky mineral soils in shallow basins and groundwater seepage areas and on low, level terrain near rivers, lakes, or wetlands. Standing water is typical in the spring and grading from wet to dry by late summer. Forest is stable and can consist solely of black ash or black ash mixed with other hardwood species including alder, basswood, red maple, quaking aspen, green ash, balsam poplar and, yellow birch and white cedar.

Management: The objective for wet forest communities in the Hartley Natural Area is to manage for mature growth stages with limited presence of non-native species. Timber harvest is not recommended for these plant communities. Natural windfall events will create adequate opportunities for regeneration. However, response to emerald ash borer impacts may be advised. Planting of red maple, northern white cedar, basswood, and yellow birch in gaps created by windfalls or in areas of mortality caused by emerald ash borer may keep these plant communities intact. Wet soil conditions can be conducive to invasive species, such as reed canary grass, with invasion following natural or manmade clearing and disturbance. Trail routing should be avoided in wet forest community types. Where trails are necessary, raised boardwalks should be used to avoid negative impacts to the soils and plant



communities. Monitoring for invasive species and response should follow wind throw events and emerald ash borer treatments.

Shrub Swamps

Willow - Dogwood Shrub Swamp (WMn82a) and Alder Swamp (FPn73a)

Shrub swamps are open wetlands dominated by dense cover of broad-leaved graminoids and tall shrubs. These communities are typically present on mineral to sapric peat soils in basins and along streams. Tall shrubs such as willows (*Salix spp.*), red-osier dogwood (*Cornus sericea*), and speckled alder (*Alnus incana*) can be dense, along with meadowsweet (*Spiraea alba*). Paper birch, black ash, red maple, American elm, and tamarack saplings are occasionally present in the shrub layer. Trees taller than 16ft (5m) are rarely present and if so, have less than 25% cover. Peak water levels are high enough and persistent enough to prevent trees from becoming established, although there may be little or no standing water much of the growing season. The invasive species common reed grass (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*) have become increasingly abundant in this community type over the past several decades, reducing species diversity in many occurrences.

Management: Maintain NPC as is, discourage invasive species including *Phragmites ssp.* and purple loosestrife by limiting disturbance. An early detection and treatment plan for these species should be developed and implemented to ensure treatment of small patches of invasive plants before they spread. Shrub swamps don't exhibit age related growth stages. Die-back and community composition changes can be seen when water levels remain higher or lower for extended periods.

Wet Meadow and Marsh

Cattail - Sedge Marsh (Northern) (MRn83a) and Sedge Meadow (WMn82b and WMn82b1)

Emergent marsh communities are typically dominated by cattails in areas where standing water is present most of the year. They can be present as floating mats along shorelines in lakes, ponds, and river backwaters or rooted in mineral soil in shallow basins. Vegetation is often composed of dense stands of cattails interspersed with pools of open water. Shallow water wetlands throughout much of the state have been invaded by dense stands of the non-native species narrow-leaved cattail (*Typha angustifolia*) and hybrid cattail (*T. x glauca*). Marshes dominated by the native species broad-leaved cattail (*T. latifolia*) are considered higher-quality and are increasingly rare in Minnesota. Substrate surface is usually covered with plant litter, especially dead cattail stalks. Marshes are transitional between shallow aquatic communities and wet meadows.

Management: The objective for these communities is to manage to enhance sedge marsh and sedge meadow characteristics. Cattail often comes to dominate these communities in stable conditions, decreasing plant diversity and lowering habitat quality for wildlife. Occasional physical disturbance by mechanical removal, prescribed burning, or water level management will benefit these communities. Trail routing should be avoided in wet meadow and marsh community types. Where trails are necessary, boardwalks should be used to avoid negative impacts to the soils and plant communities.



Lakeshore System

Inland Lake Clay/Mud Shore (Lki54a)

This community exists in a vegetated near shore zones composed of terrestrial forms of aquatic plants or annual plants that establish seasonally on silty, sandy, or mucky substrates. Wave action, ice scour and fluctuating water levels are important for maintaining open architecture of this plant community. This community may expand seasonally as mud flats become exposed following decreasing water levels. A combination of wetland and aquatic species will be found including umbrella or nut sedges (*Cyperus* spp), spikerushes (*Eleocharis* spp), rushes (*Juncus* spp), bulrushes (*Scirpus* spp), smartweeds (*Polygonum* spp), plantains (*Plantago major* and *P. rugelii*), goosefoots (*Chenopodium* spp.), beggarticks or bur marigolds (*Bidens* spp), arrowheads (*Sagittaria* spp), giant bur reed (*Sparganium eurycarpum*), and golden dock (*Rumex maritimus*). These species often form dense stands by later summer or autumn. Floating leaved aquatic species such as water lilies (*Nuphar* spp. and *Nymphaea* spp.) are common, and other rooted macrophytes, such as pondweeds (*Potamogeton* spp.), water stargrass (*Zosterella dubia*), mud plantain (*Heteranthera limosa*), and water shield (*Brasenia schreberi*) are expected. This NPC is common and widespread throughout Minnesota.

Management: The extent of this NPC is dependent on the seasonal water fluctuations. More stable conditions will encourage the establishment of cattail, or sedge dominated communities. Management of lake levels should mimic natural hydrologic patterns to the extent practicable. Physical disturbance from excessive public use of the lake shore increases the likelihood invasive species, such as purple loosestrife or phragmites, will become established. Clearly defined and maintained lake access points will reduce this risk. An early detection and treatment plan for these species should be developed and implemented to ensure treatment of small patches of invasive plants before they spread.

Rock Outcrop System

Crystalline Bedrock Outcrop (Northern) (ROn12b) and Bedrock Shrubland (Inland) (ROn23a)

Rock outcrop communities exist on areas of exposed Pre-Cambrian bedrock. Lichens and bryophyte cover is high, and herbaceous cover is sparse to patchy. Tree and shrub cover is absent to sparse in outcrops and patchy to interrupted in shrublands. Areas of ROn23 are generally larger in size with a greater cover of woody plants. Plant species in these communities generally experience greater environmental extremes than species in surrounding terrestrial communities, including more rapid fluctuations in substrate temperature, higher rates of desiccation, and more limited nutrient availability. Fires may act to keep rock outcrops open by eliminating woody species and consuming shallow organic soils. Many typical plants are adapted to drought, which like fire, may slow or prevent succession of open outcrop communities to shrub- or tree-dominated communities by periodically killing desiccation-intolerant trees and shrubs. It is likely that bedrock shrublands are a long-lived successional community following intense fire in woodlands or forests, with successive fires acting to slow the eventual return of the site to woodland.



Management: Management needs are few. Occasional prescribed burning could assist in keeping bedrock areas open. Lichen and bryophytes are extremely sensitive to trampling and disturbance. These communities can be better protected through educational signage near clearly marked climbing and hiking routes. Monitoring and mapping the lichens and bryophytes may be useful to determine if re-routing trails or closing overused areas is warranted.

SPECIAL SPECIES

The endangered butternut trees and the blister-rust resistant white pine stand may require special management considerations within Hartley Natural Area. An evaluation of necessary actions to protect these species will be included as part of the plant community management and restoration plan, as described in the Prioritized Actions below. Maps of these species will not be made available to the public.

CULTURAL OR NON-NATIVE PLANT COMMUNITIES

In general, the DNAP program encourages the establishment of NPCs to the extent possible. As described in the natural resources inventory, there are five plant communities within Hartley Natural Area that do not classify as NPCs: conifer plantation, European mountain ash forest, non-native grassland, upland non-native shrubland, and wetland non-native shrubland (Figure 4). In some instances, these cultural or non-native plant communities may be desired to remain as such. However, in other cases, it may be desirable to transition these non-native communities to NPCs. The plant community survey conducted in 2019 provides valuable information on possible NPC targets for these instances.

The current focus of non-native plant community restoration within Hartley Natural Area is on management of several pine plantations that were planted throughout the area with a focus on thinning the plantations, adding additional species to increase biodiversity and restore ecological function. Actions to address these plantations are described in Prioritized Actions below.

INVASIVE SPECIES

Invasive plant species are ubiquitous throughout the Hartley Natural Area. Their control is an integral part of stewardship efforts. Management must address both existing infestations, as well as the ongoing possibility of introduction of new seeds through human use and disturbance.

Control of Existing Invasive Infestations

Invasive control is a primary focus of stewardship efforts within Hartley Natural Area. The City will continue to work with partners (HNC, CISMA, COGGS, and SHTA) to control infestations of invasive plant species within the natural area. The City and its partners will continually assess available control techniques for invasive species.



Management of New Introductions

Given the popularity and use of Hartley Natural Area, management of new introductions of invasive species is vital to long term control or eradication. This must include both education of natural area users and requirements for use of BMPs for restoration and maintenance activities.

The City and its partners will work in partnership to address both education and control of invasive species. Future management efforts, including detection, monitoring, and treatment of invasive species will be focused according to the habitat restoration and invasive species plan to be developed for the natural area (see Prioritized Actions below).

NATURAL WATER FEATURES

Strategies for managing the natural water features of Tischer Creek and vernal pools are described in this section.

Tischer Creek

Tischer Creek has an aquatic life and recreation beneficial use designation of 2A “general cold water habitat (lakes and streams)” (Minnesota Rule 7050.0470). Minnesota rules state that “the quality of class 2A surface waters shall be such as to permit the propagation and maintenance of a healthy community of cold water aquatic biota, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is also protected as a source of drinking water” (Minnesota Rule 7050.0222).

Management of Tischer Creek, its tributaries, and the surrounding landscape within the Hartley Natural Area will be with the intent to comply with water quality standards appropriate to the class 2A designation, as specified in Minnesota Rule 7050.0222 and to support the health of the unique cold water fishery.

Vernal Pools

As described above, vernal pools are temporary aquatic environments in many forest communities that occur following spring melt and persist for a few months before drying up for the year. They are important habitats for amphibians and invertebrates.

Many vernal pools within the natural area have been mapped and these should be verified. Any additional vernal pools found should also be geolocated. Floating boardwalks have been installed at pools with heaviest traffic and will be maintained to limit degradation of these sensitive areas. Appropriate protections will be implemented for any newly identified vernal pools. Trails should not be routed through vernal pools.

TRAILS



Trails are an integral part of the user experience of the Hartley Natural Area. The Hartley Master Plan (SRF et al, 2014) identified a set of necessary trail improvements based on input from the community and user groups. Once these projects are complete, the trail system will be in accordance with the Hartley Park Master Plan, the Duluth Traverse Mini Master Plan (Confluence et al., 2017), and the Duluth Cross Country Ski Trail Master Plan (Larson, 2015).

Since most of the trail system is complete within the natural area, the focus of impact reduction must be on proper trail maintenance, prevention of unauthorized trail segments, and education of users regarding appropriate trail use and best management practices (BMPs) for invasive species control.

All trail restoration and realignments must follow best practices in sustainable trail design, management, and maintenance principles and must consider impacts to NPCs and natural water features. The City will work with partners (COGGS, DXC, SHT, and HNC) to maintain the trail system and to educate users on proper BMPs related to trail use (for example, invasive species and erosion control).

Unauthorized “social” trails are not allowed within the natural area. Social trails are generally created by members of the general public versus members of organized groups. The City will work with partners to eliminate unauthorized trails and educate users about the negative impacts of unauthorized trail creation.

Implementation

Management of natural resources in the Hartley Natural Area will rely on the approaches described in the previous section. A set of prioritized actions has been selected based on the identified threats to ecological function in the natural area. Selection of priorities also considered results of the Hartley master planning process and ongoing stewardship priorities of City partners. The prioritized actions with associated timelines and costs, as well as partner responsibilities for implementing this Hartley Natural Area Management Plan are described in this section.

PRIORITIZED MANAGEMENT ACTIONS

A set of seven prioritized actions were identified for the Hartley Natural Area. These are summarized in Table 3 and described below. Funding will be sought from appropriate sources for these projects. Possible sources include: Great Lakes Restoration Initiative, MNDNR, Conservation Partners Legacy Fund, Lessard-Sams Outdoor Heritage Council, National Oceanic and Atmospheric Administration Coastal Program, and the National Fish and Wildlife Federation Sustain Our Great Lakes program.

Table 3: Prioritized Actions for the Hartley Natural Area



Action	Cost	Responsible Parties	Target Completion Date
Tischer Creek/Hartley Pond Feasibility Study	\$79,000	City of Duluth	2021
Tischer Creek/Hartley Pond Restoration	\$320,000 to \$1,400,000	City of Duluth; MNDNR	2025
Invasive Species Control in Priority Areas	\$140,000 (funds secured)	Community Action Duluth; City of Duluth	2020
Develop Plant Community Management and Restoration Plan	\$20,000	City of Duluth	2021
Conifer Plantation Conversion	None expected	City of Duluth	2027
Northwest Hills Trail and Forest Management	\$20,000 (funds secured)	City of Duluth; COGGS	2020
Vernal Pool Identification and Mapping	\$5,000	HNC	2021

Hartley Pond/Tischer Creek Feasibility Study

The City will hire a consultant to conduct a feasibility study to evaluate options for addressing temperature issues in Tischer Creek caused by Hartley Pond considering ecological function, recreational use of Hartley Pond, and downstream flood risk impacts. Estimated costs for conducting a feasibility study and for a range of possible restoration alternatives were developed for this project by Barr Engineering Co. for purposes of seeking funding. The report describing their assumptions, including the list of tasks for the study, is provided in Appendix D.

The estimated cost for completing a feasibility study is \$79,000. The City will seek funds for completing the study as well as for the restoration work with the goal of completing the study in 2021.

Per the Hartley Master Plan (SRF et al, 2014), the results of the feasibility study must be presented to and approved by the Parks and Recreation Commission before any commitments are made, or funds expended, on any recommendations regarding Tischer Creek/Hartley Pond restoration.

Hartley Pond/Tischer Creek Restoration

Once the feasibility study has been completed, reviewed, and approved by the Parks and Recreation Commission, the selected restoration alternative will be implemented. The estimated cost for restoration is \$320,000 to \$1,400,000 with an estimated accuracy of -20% to +30%. This cost range is for a reasonable range of possibilities for the site and is to be used for high-level conceptual planning purposes only. Descriptions of the alternatives and important assumptions related to the cost estimates are provided in Appendix D. The City will seek funds for restoration with the goal of completing restoration in 2024.



Invasive Species Control in Priority Areas

Invasive species control for buckthorn, honeysuckle, garlic mustard, Japanese knotweed, wild parsnip, barberry, amuir maple have been undertaken for the last five years by the City, HNC, and Community Action Duluth. Since 2015, 125 acres have been treated (Figure 9). In addition to managing and restoring these areas, additional treatment is intended for other areas within the natural area. Recently, Community Action Duluth received grant funds for treatment in the northeast corner of the natural area below Northfield Street (\$90,000), as well as the treatment of areas identified on Figure 9 for 2019-2020 (\$50,000). Future control actions should be in accordance with a management and restoration plan to be developed for the natural area (described below).

Develop a Plant Community Management and Restoration Plan

A plan will be developed for restoring impacted habitat and protecting high quality habitat within the natural area based on the 2019 NPC survey data. The plan will outline management actions related to invasive species control (including detection, mapping, control, monitoring, and management) and conversion of non-native plant communities to more resilient NPCs. The plan will focus on a set of target invasives that are the most ecologically threatening and prioritizing treatment areas be treated with a timeline to monitor and manage for success. Using the survey data from 2019, NPC restoration targets will be selected for areas of cultural or non-native plant communities within the natural area. This effort will involve evaluation of soils, topography, and NPCs in adjacent areas to select appropriate communities. The plan will also include evaluation of necessary outreach and protection strategies for the endangered butternut trees and the blister-rust resistant white pine stand. Field assessment will be used to verify selected restoration targets. Restoration actions will then be identified and prioritized. Implementation of the plan will be a cooperative effort between the City, HNC, and other appropriate partners (e.g., CISMA, COGGS, SHTA). The estimated cost for developing this plan is \$20,000 with a target completion date of 2021.

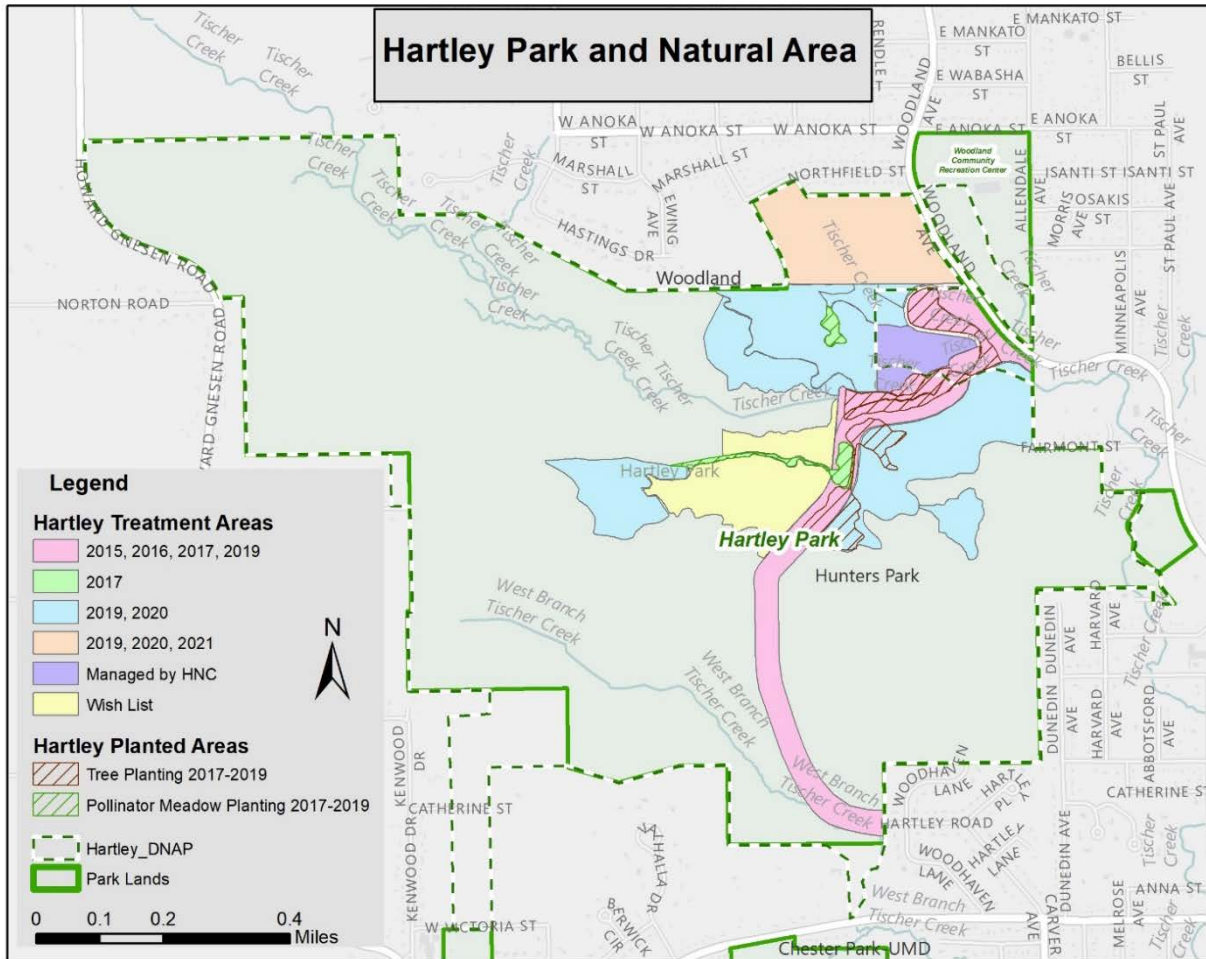


Figure 9: Invasive Species Treatment Areas in Hartley Natural Area

Conifer Plantation Conversion

The Hartley Park Master Plan (SRF, 2014) states that “The purpose of red pine management in the Park shall be to increase the species and age diversity of the red pine plantation in a manner that also preserves the survival of mature red pines and the stand’s cathedral-like feeling.” Consistent with this and the other recommendations for the conifer plantations in the Hartley Park Master Plan, five anthropomorphic red pine plantations are the focus for converting to appropriate NPCs (Figure 10). This conversion will be a slow, generational conversion with the restoration actions intended to improve the health of the existing trees within the plantations, provide a healthy understory, and increase overall plant species diversity which will in turn better support wildlife diversity. Thinning of the existing conifer plantations will continue along with planting of tree and shrub species appropriate for the target NPCs. The areas and needed restoration actions are as follows:



1. Soapbox Knoll – The east half of this stand in and around the Hartley Nature playscape was thinned in the early 2000's. Future thinning should be evaluated and would include one thinning event followed by planting of native tree species appropriate for the target NPC. Additional planting of native species should be considered after 5-10 years. The portion outside of the playscape was thinned conservatively by the City in 2016. The buffer located along the north shore of the pond should be cut at this time. Thinning will be conducted in 2021 or 2022 followed by planting of native tree species. Additional planting of native species should be considered after 5-10 years. Further thinning would then be deferred for 15-30 years.
2. Rock Knob – Thinning of the middle portion of this stand was conducted in 2016. Additional thinning should occur in 2021 or 2022 to remove 25-33% of the existing stand and again in 2027 to remove an additional 25-33%. In conjunction with each thinning action, additional planting of native species should be evaluated based on the expected plant community composition in the target NPC. After the second scheduled thinning in 2027, additional cutting should then be deferred for 20 years. Additional planting of native species should be considered on a 5-10-year interval.
3. Ski Trail – This pine stand in the middle of the ski trail system has not been thinned and was mostly missed by the blowdown event of 2016. Thinning will be conducted 2020 to remove 25-33% of the stand with planting of native tree species. Additional thinning should occur in 2025 to remove 25-33% of the stand and again in 2030 to remove an additional 25-33%. This stand would then be unmanaged for 20 years. Additional planting of native species should be considered after 5-10 years.
4. Hartley Pond – Not much remains of this stand as it was thinned in 2016 by the City and also hit hard by the 2016 blowdown. There are a few isolated pockets of red pine and a small patch of Norway spruce that will need to be evaluated. The City replanted much of this stand with trees and the logging laydown area was converted to a pollinator meadow.
5. Tischer Creek – This pine stand was thinned by the City in 2016 and also hit by the 2016 windstorm. The next steps are to thin the remaining portions of the stand that were missed by the windstorm along Woodland Ave and along Tischer creek followed by planting of native tree species appropriate for the target native plant community. Remnant patches of Norway spruce remain and will be evaluated for removal at the time of thinning.

It is anticipated that sale of timber from the thinning will result in a profit which will be used to complete the native plantings. In all areas, invasive species will be monitored, and control implemented as appropriate.

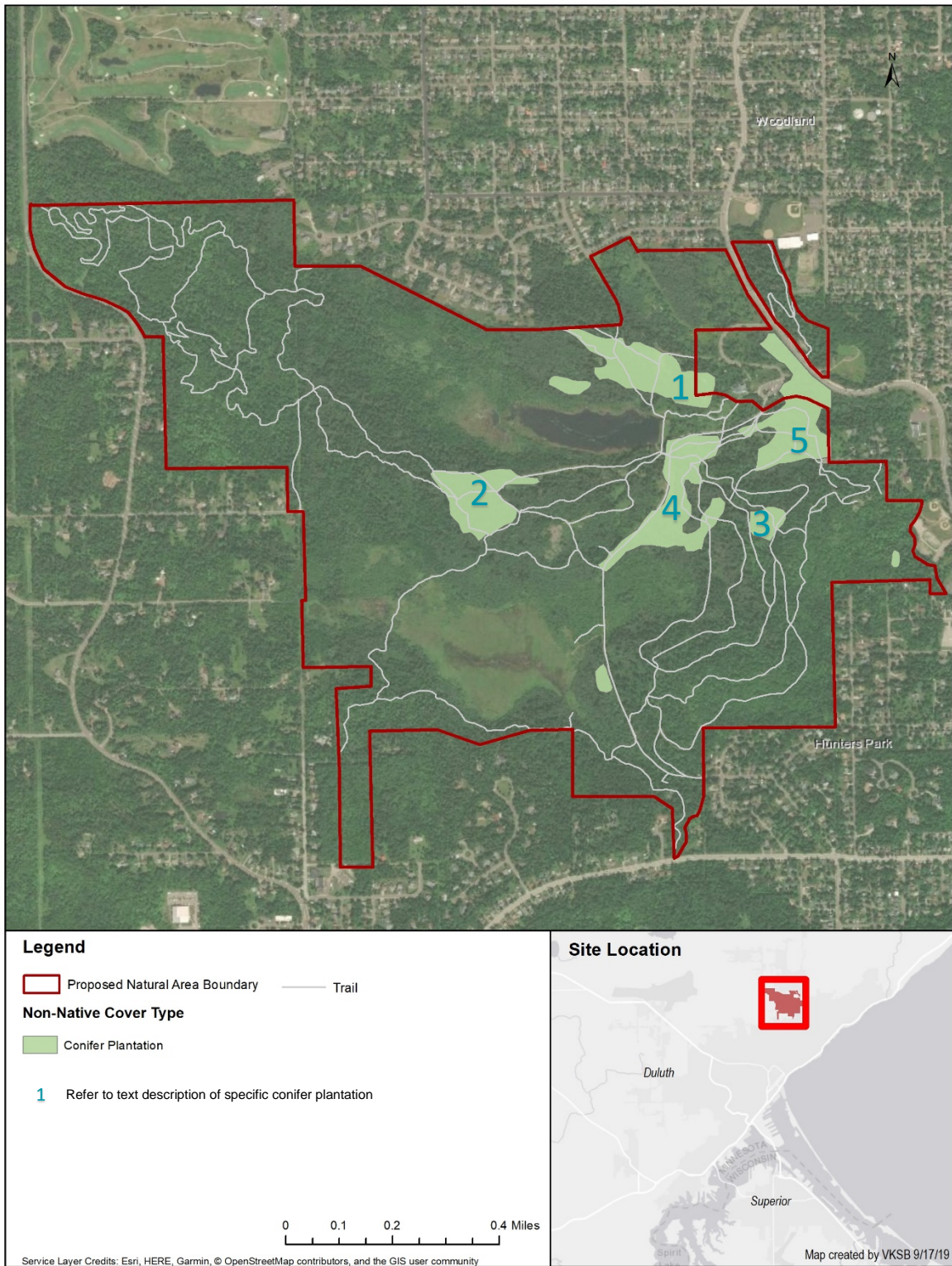


Figure 10: Conifer Plantations to be Thinned



Northwest Hills Trail and Forest Management

The forest in the northwest corner of the natural area was heavily affected by the wind storm of July 2016. Many trees were downed, creating significant safety hazards and blocking trails through the area. A City project planned for Fall 2019 involves dropping damaged and leaning trees in the proposed trail corridor and along Howard Gnesen to within three feet of the ground, with a goal of trees being in contact with the ground for habitat structure on the forest floor. A 60-foot buffer will be created along the road where the most intense blowdown occurred. COGGS will relocate the existing trail to a more appropriate and sustainable corridor, which will be 60 feet wide centered on the trail (Figure 11). Approximately one quarter mile of trail will be eliminated with this work. The intent of this project is to officially reopen the trails in that portion of the park and provide a safe corridor to use. It also it hoped that this work will reduce fire risk by creating a swath through the blowdown by eliminating small ladder fuels to prevent or slow down a wildfire jumping into the canopy. Funds have been received to complete the tree work, which will be contracted by the City for about \$20,000. COGGS will then complete the trail work and has funds in hand for finishing the project in 2020.

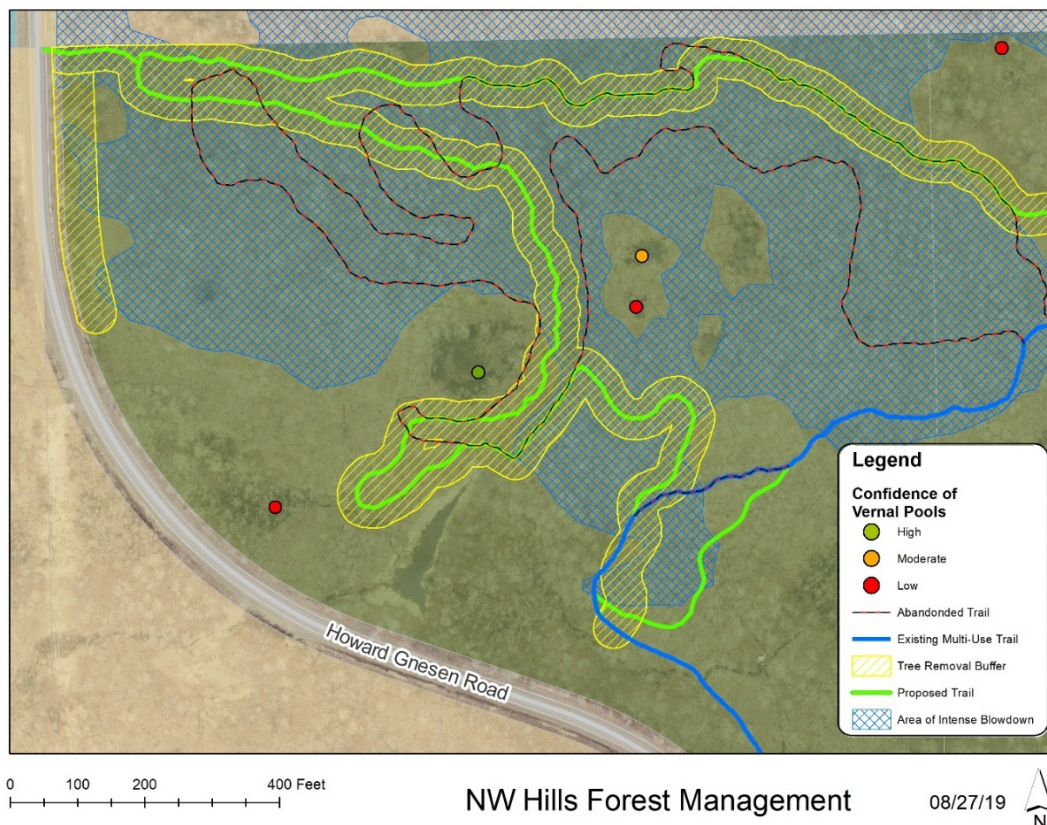


Figure 11: Northwest Hills Trail and Forest Management



Vernal Pool Mapping and Identification

The focus of this effort is to identify and map vernal pools throughout the nature center. The 44 vernal pools identified in previous efforts (Figure 6; Olker et al., 2014) will be verified. Additional pools will be mapped and verified. Once field surveys and mapping are complete, vernal pool locations will be overlaid on maps of the natural area with trails, etc. to identify any protections that should be implemented for newly identified pools. HNC will lead this effort, which is anticipated to be completed in 2021. Funds required for this work are estimated at \$5,000.

RESPONSIBILITIES

Responsibilities for implementation of this Hartley Natural Area Management Plan are described in this section.

City of Duluth

The city of Duluth is responsible for implementing the strategies and prioritized actions described in this plan. The City will work in close collaboration with partners, in particular HNC, to implement the plan.

The City will present annual progress updates on the plan to the City of Duluth Natural Resource Commission.

Hartley Nature Center

HNC is a strong partner with the City for stewardship of natural resources within Hartley Natural Area. HNC developed a Park Stewardship Plan (HNC Park Stewardship Committee, 2011) with the following forest stewardship guidelines for stewardship projects, which align with the strategies in this plan:

- *Projects must not increase the presence of invasive species.*
- *Projects must not decrease the diversity of native flora or fauna.*
- *Projects must not degrade the quality of established native plant communities*
- *Projects must not negatively affect the quality of nearby waterways.”*

HNC is in a signed agreement (2002 add reference) with the City that allows the organization non-exclusive rights to use Hartley Park (as well as the land it leases under the agreement which is not part of the designated natural area) for its educational programming. Under the agreement, HNC may not deny access or use of the park by members of the public who are not participating in HNC’s programs. The City must strive to conduct maintenance and repairs to Hartley Park as much as reasonably possible with as little interference as possible to HNC programming.

HNC has been involved in the development of this natural area management plan and will be involved throughout implementation of the plan.



Trail User Groups

Implementation of this plan requires cooperation and participation of the user groups responsible for trails management and repair. In particular, COGGS, DXC, and SHTA will be asked to:

- Develop user education on appropriate trail use with the City. The issues to be addressed include, but are not limited to the following:
 - Stay on the trail to minimize trail widening and trampling of native vegetation
 - Stay off trails when they are wet
 - Clean bikes, shoes, and other equipment regularly to minimize introduction of invasive species
 - Unauthorized trails are strictly forbidden
- Use sustainable trail construction techniques
- Implement BMPs for invasive species control during all maintenance and construction activities
- Train all volunteers and contractors to comply with sustainable trail construction and invasive species BMP requirements
- All trail restoration/realignment efforts must be reviewed for compliance with this plan

The City is currently developing city-wide agreements with COGGS and SHTA that will define responsibilities of the organization and the City related to maintaining trails.



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Appendices





Appendix A

Hartley Natural Area Nomination Report



Nomination of
Hartley Park
to the
Duluth Natural Areas Program

July 2018

Nominated by:

City of Duluth in cooperation with Hartley Nature Center

PREFACE

The Duluth Natural Areas Program (DNAP) was created as a city program to protect and preserve Duluth's natural heritage by using mechanisms to identify valued environmental properties owned by the city and/or other owners interested in participating by establishing a means to protect such properties from development or exploitation. The qualifications for lands to be incorporated into the DNAP and the various avenues to protect these special places are specified in the ordinance (Duluth City Code, Chapter 2, Article XXIX, Sect 2-152) and its complimentary guidelines.

Hartley is a prime candidate for the DNAP. Duluth's declared purpose for Hartley Nature Center is to *"foster and enhance educational and recreational activities aimed at promoting the preservation of, learning about, and understanding of the natural environment of the Duluth area."* Most of Hartley's city owned lands as well as some additional lands owned by the state and Hartley Nature Center meet the requirements of the DNAP because the lands are viable examples of significant native plant communities, natural water features and geologic landforms representative of the area and the land owners have expressed an interest in permanently protecting them.

This report provides the following information established in the guidelines for nominating Hartley lands to the DNAP:

- Nomination in Brief – background of the DNAP and the categories met for the nomination
- Nomination Area and Land Ownership – map of the land parcels incorporating the nomination area along with an ownership table
- Significant DNAP Scientific Criteria – assessment of the three environmental criteria (plants, water, geology) for which the lands are being nominated.

I. NOMINATION IN BRIEF

Hartley Nature Center has worked in partnership with the City of Duluth to complete this application for Hartley Park to be included in the Duluth Natural Area Program (DNAP) and requests submission to the Planning Commission and City Council for review under Duluth City Code, Chapter 2, Article XXIX, Sect 2-152. Hartley Park has areas of high natural quality and unique environmental value that should be preserved and managed for future generations. Furthermore, on-going restoration is enhancing Hartley as Duluth's premier nature-based park.

A natural-area program within an urban environment creates opportunities and challenges different than in remote settings. While most natural areas require management and restoration of ecological features, management and restoration in urban areas must deal with past and present human pressure. The land-use history at Hartley Park offers a range of opportunities to protect high-quality natural features as well as opportunities to restore degraded plant communities to healthier ecological condition. Furthermore, Hartley Park's urban setting offers an opportunity to demonstrate Duluth's commitment to permanent protection of an important and well-known park already perceived by residents as a natural area. Finally, the combination of history, location, and mission offers the ability to demonstrate and educate the public about ecological restoration and land management focused on natural features.

The Master Plan for Hartley Park approved by the City of Duluth on July 21, 2014 says that *"The Park is ... a laboratory, classroom, and regional showcase for ecological restoration ... learning about, creating and advocating for visionary restoration of Hartley's diverse landscapes and similar landscapes in northern Minnesota."* It says that *"The Park provides a unique, immersive nature experience."* and that *"Preservation and restoration of natural resources is unusually important to the use of Hartley Park. Ecological restoration is not only essential to the extensive environmental education programming occurring in the Park, but it is integral to place-appropriate recreational use."* and *"to the unique purpose of Hartley as Duluth's premier nature-based park."*

The Hartley Park nomination includes approximately 621.80 acres in Duluth's east side. All of the lands nominated are parcels owned by the City of Duluth, State of Minnesota, and Hartley Nature Corporation: The area is one of the best and largest remaining examples of viable natural areas representative of the Duluth areas under the Significant Native Plant Communities, Natural Water Features, and Geological Landforms as described in the DNAP Guidelines under Article IV, Sections A, C, and E as follows:

Section A. Significant Native Plant Communities—Hartley Park is a viable and functional ecosystem within the City limits, including fourteen distinct, high quality occurrences of plant communities native to Duluth and a designation by MN DNR a site of Biodiversity Significance.

Section C. Natural Water Feature Area—Hartley Park includes the headwaters of both branches of Tischer Creek, a designated trout stream (MN Dept. of Natural Resources Class 2A cold water sport or commercial fish and associated aquatic life, and their habitats; i.e. the most sensitive surface waters) as well as numerous vernal pools, and unique wetlands.

Section E. Geological Landforms Area—Hartley Park contains outcrops from the Midcontinent Rift 1.1 billion years ago, as well as evidence from the Tettegouche Till Plain.

II. NOMINATION AREA AND LAND OWNERSHIP

The City of Duluth, in partnership with Hartley Nature Center, is nominating Hartley Park for inclusion in the Duluth Natural Areas Programs (DNAP). The “Declaration of Policy” of the City’s lease agreement with Hartley Nature Center approved by the Duluth City Council on July 22, 2002 states that *“The City hereby declares its intention that the primary use of Hartley Park shall be that of a nature center and, as such, that Hartley Park be used as a facility to foster and enhance educational and recreational activities aimed at promoting the preservation of, learning about, and understanding of the natural environment of the Duluth area. In order to serve this purpose, the City hereby declares its intention to maintain ownership and control of Hartley Park as it presently exists, to develop, in cooperation with Lessee, a plan to manage Hartley Park with the intent of protecting its natural qualities...”*. Management to restore and protect natural qualities throughout the park is central to the Hartley Park Master Plan approved by the City of Duluth in 2014. Park management will prevent fragmentation, foster ecological restoration and provide ecological resiliency to the diverse complex of plant communities.

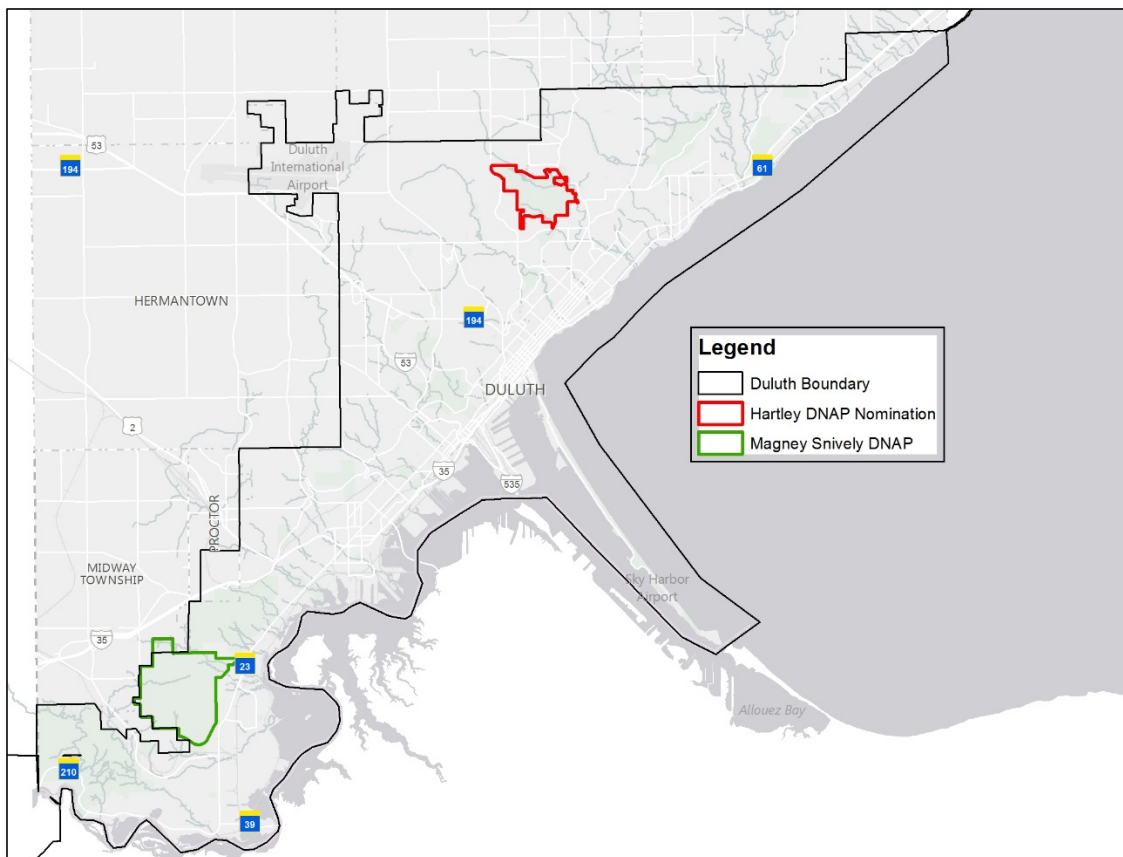


Figure 1: Hartley Park in proximity to the rest of the City of Duluth

The Hartley Park DNAP nomination includes approximately 621.80 acres in northeast Duluth. Figure 1 shows the proximity of Hartley Park in relation to the City of Duluth and the only currently existing DNAP area, Magney Snively, and figure 2 shows the proposed DNAP boundary for Hartley Park.

Figure 2 shows the proposed Hartley Park DNAP area in relation to the land ownership. Appendix A provides the parcel ownership table.

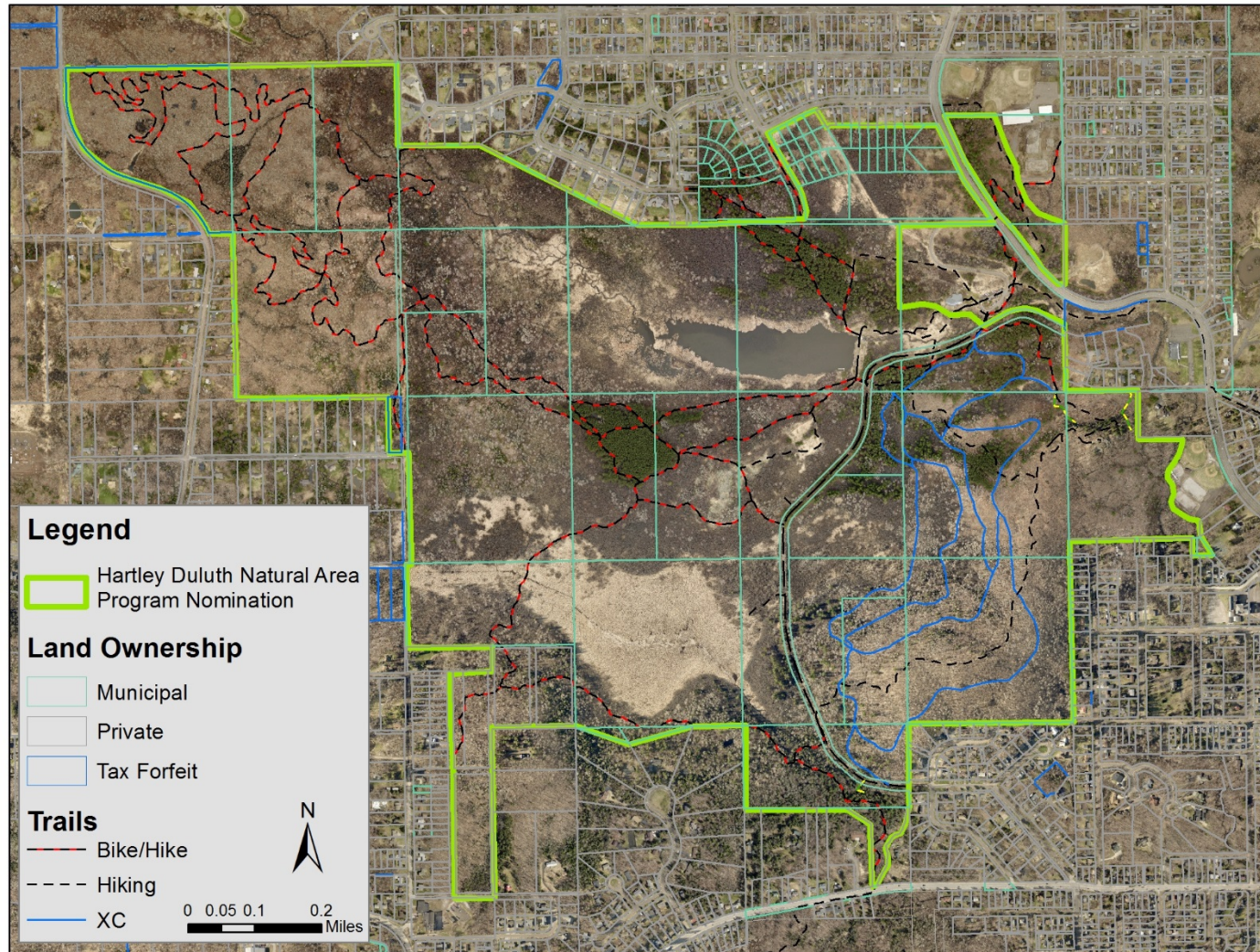


Figure 2: Hartley Park DNAP boundary

Hartley Park's wooded hills, fields, designated trout streams, pond, wetlands, and vernal pools provide ecological systems in a variety of habitats that include a rich diversity of flora and fauna. The park is identified with nature and is a community focus point for nature appreciation, education, preservation, and restoration.

The DNAP nominated area consists of approximately 574.90 acres owned by the City, 18.76 acres owned by Hartley Nature Corporation, and 28.14 acres owned by the State of Minnesota for a total of 621.80 acres (Figure 2).

III. SIGNIFICANT DNAP SCIENTIFIC CRITERIA

Hartley Park is one of the largest areas of natural communities in Duluth. The management plan will be used to prevent fragmentation, guide restoration efforts, and give ecological resiliency to the diverse complex of plant communities

Below is some background on the significant science criteria supporting this nomination.

Significant Native Plant Communities--14 high quality occurrences totaling 488 acres of different undisturbed and viable native plant communities to the Duluth area are present within Hartley Park (Figure 3). Appendix B provides the breakdown of native plant communities in acreage.

The Sugar Maple-Basswood-(Bluebead Lily) MHn56 forest type is relatively rare in the Tettegouche Till Plain, and its presence increases Hartley's ecological significance. The predominant natural vegetation of the Tettegouche Till Plain is northern hardwood forest of sugar maple and red oak (MHn56), like the 171.4 acres found at Hartley. In Duluth, most of this forest has been removed or converted to aspen forest. This is one of the largest remaining remnants of northern hardwoods in Duluth (the Magney Snively Forest is the largest remnant).

Adding to Hartley's significance is the large wet meadow (WMn82b) and willow swamp (WMn1a) complex. This is the largest wet meadow in Duluth within the Tettegouche Till Plain. Outside the Tettegouche Till Plain, only a few wet meadows along the St. Louis River are larger.

Hartley Park is also home to a group of eastern white pine trees that have the highest natural resistance to white pine blister rust of any trees ever found in Minnesota. Cuttings collected by science staff from the University of Minnesota Cloquet Forestry Center and the United State Forest Service from several trees in this stand have been grafted for research to enhance propagation of blister rust resistance into Minnesota forests. The protection of this unique stand through a DNAP designation is a high priority, as this small population provides the opportunity to re-establish this ecologically important species.

DNR Plant Community Types

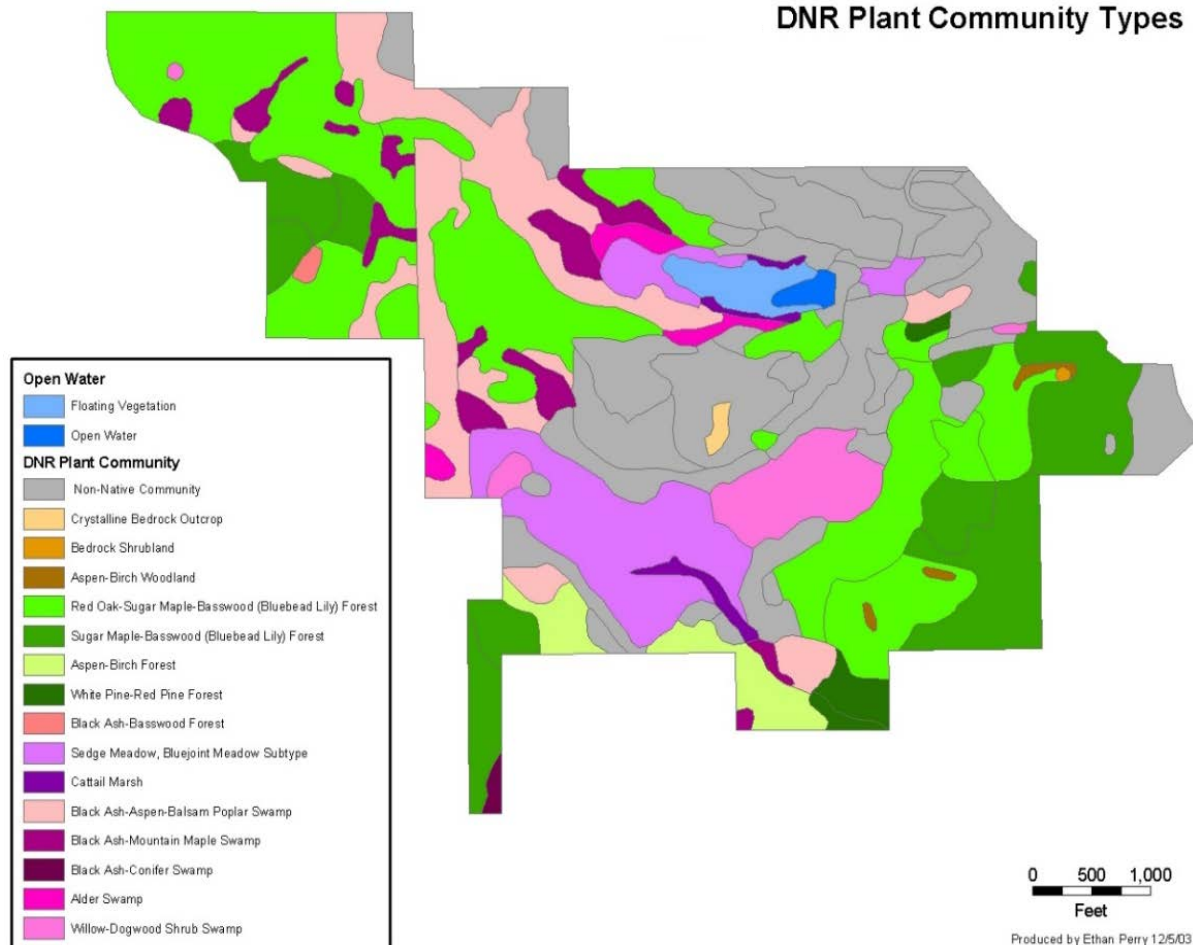


Figure 3 – MDNR Plant Community Types

The diversity of community types (two types of northern hardwood forest, three types of lowland forest, pine forest, wet meadow, willow swamp, etc.) is in and of itself significant. Further, 117 acres of BC-ranked plant communities (Figure 4) is considered significant for Duluth where all places have been impacted to some degree by humans and most places have been heavily impacted. These remnants stand among the best of natural vegetation in Duluth. Only the Magney-Snively and Park Point forests are assessed thus far as higher quality and the size of the wet meadow at Hartley further increases the significance. Using guidelines refined since the 2004 native plant community mapping and condition ranking, many of the previously unranked communities would now likely receive a D or CD ranking and some of the communities ranked D and CD would likely be ranked moderately higher. In addition, recent restoration projects focused on addressing non-native species and the lack of diversity in planted conifer stands to enhance the condition of lower ranked communities and is not represented in this mapping effort, nor are pending efforts to create new pollinator meadows.

Native Plant Community Ranks Hartley Park

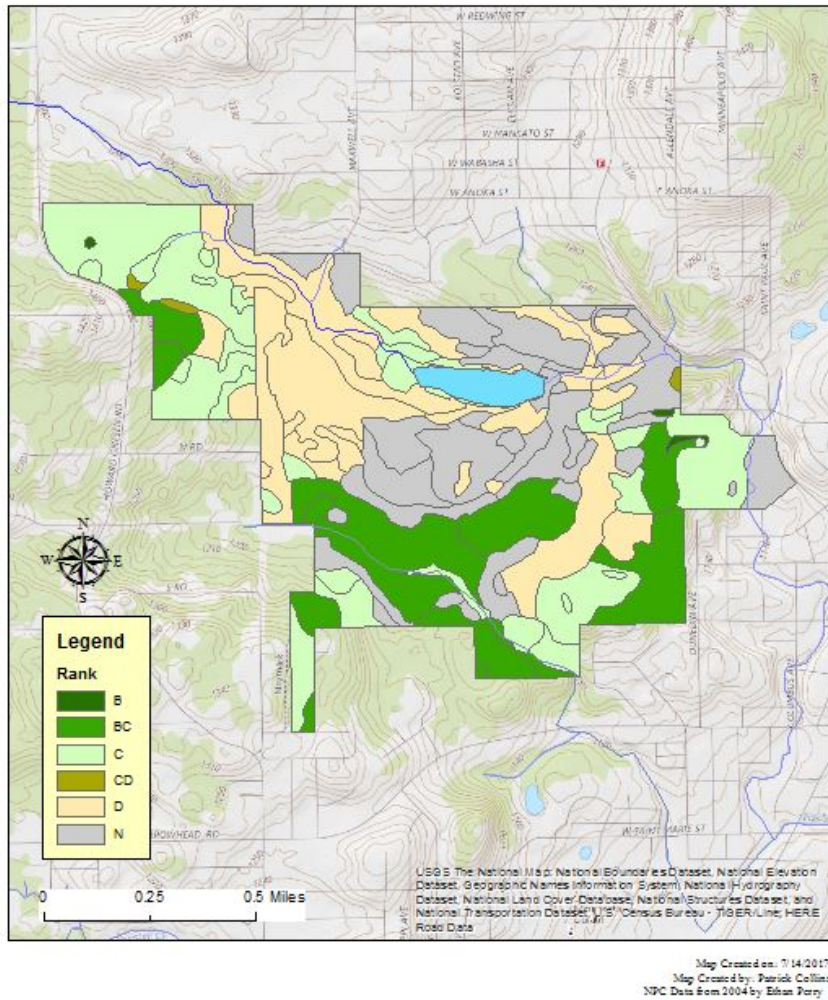


Figure 4 – Plant Diversity – Quality Rank

Most of the park will serve as a managed buffer for natural processes of native plant communities, and ongoing restoration will continue to improve the condition of those communities. In addition, the northwest of Hartley Park, across Howard Gnesen Road, there are natural areas linked with only a few intervening roads to the natural communities surrounding Wild Rice Lake. Connectivity to these natural areas may explain why animals such as otters and black bears frequent the habitat at Hartley Park.

Natural Water Feature Area—Hartley Park forms the wet meadow/shrub swamp headwaters of two branches of the designated cold-water trout stream, Tischer Creek. Coldwater streams are very sensitive to human caused disturbance, and therefore, are given the highest level of protection by the state. The Tischer Creek watershed (Figure 5) is one of Duluth’s 16 named trout stream watersheds that are grouped together as a potential management unit for the purpose of implementing the state’s new watershed restoration and protection strategy (WRAPS). Protection of the park’s streams and other aquatic resources is most easily and inexpensively accomplished by:

1. Protecting wetlands which provide water storage that reduces storm flows, streambank erosion, and downstream flooding (Figure 6);
2. Protecting and revegetating the stream and pond riparian zone; and,
3. Educating and informing the park's user groups.

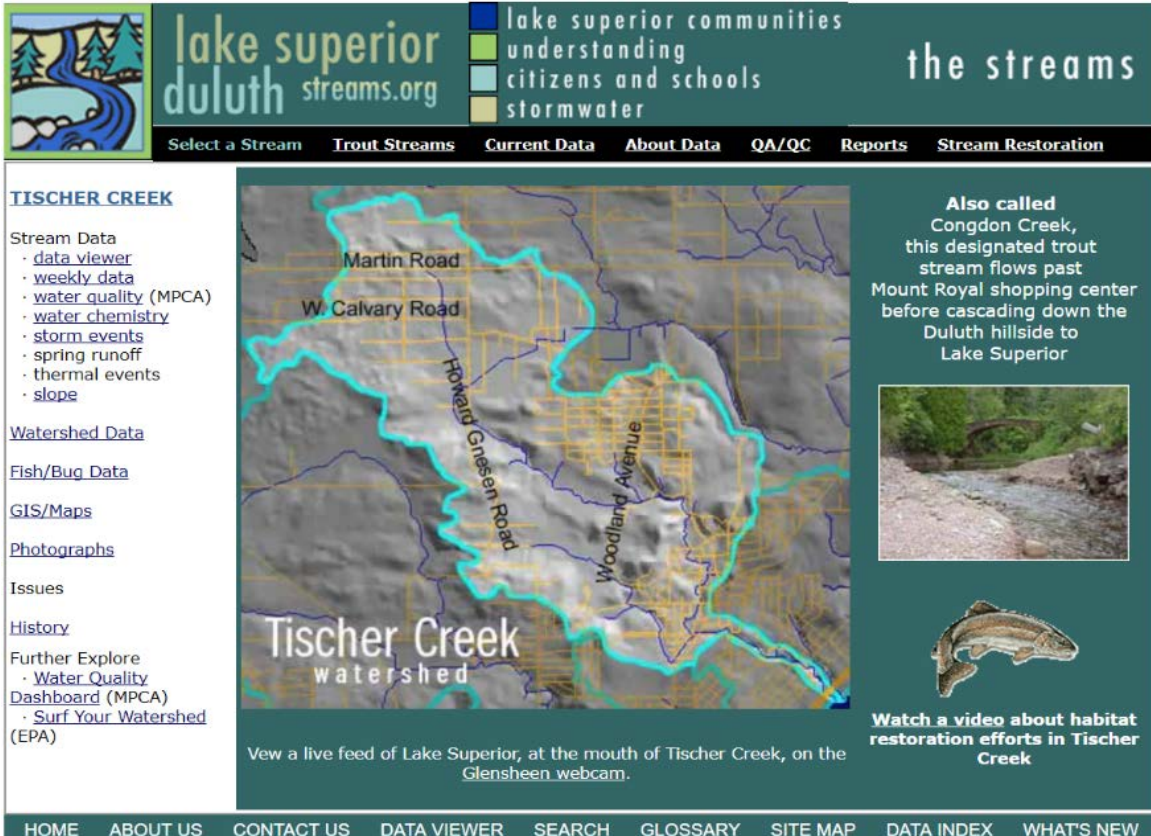


Figure 5 – Tischer Creek Watershed – Lake Superior Streams

Further, protecting the Tischer Creek ecosystem also serves to help protect the nearshore waters of Lake Superior, since it discharges into the lake at the Glesheen Mansion property. Headwater wetlands, such as those present in Hartley Park, are a critical component of protecting cold-water streams and the important habitat they provide. Protection of these natural wetland areas provides base flow to the streams during dry conditions, maintains the input of cool water to prevent overheating, and reduces peak flow events that cause flooding and downstream erosion. Additionally, because Lake Superior is extremely phosphorus deficient in regard to algal growth, protection of Hartley Park's natural features, also known as "green infrastructure" is important to minimize the loading of excess phosphorus to the lake.

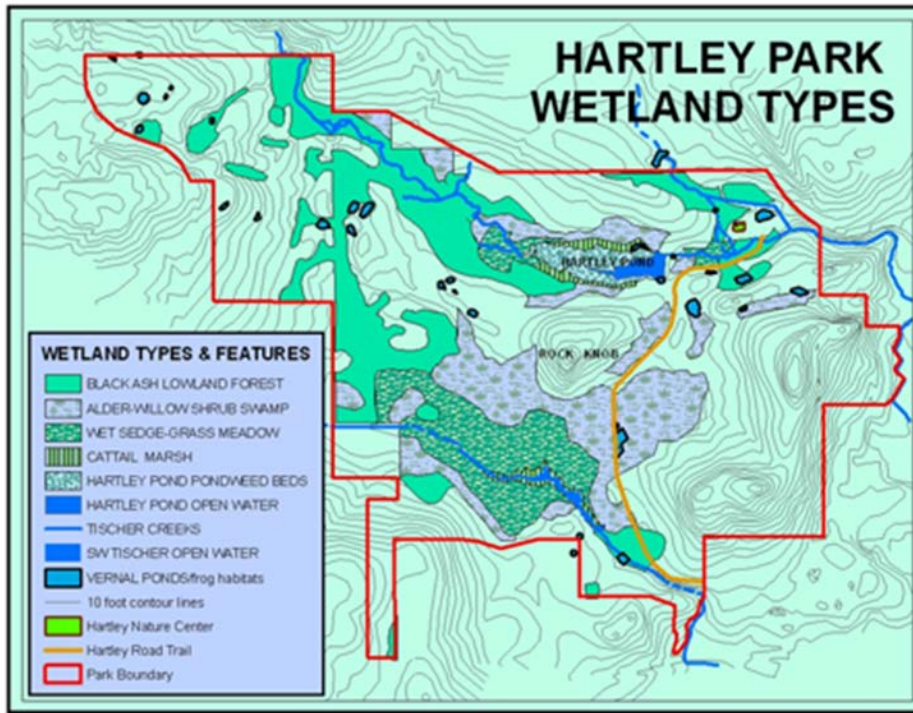


Figure 6: Wetland types within Hartley Park contribute to the health of Tischer Creek and retain water.

Vernal pools are small seasonally flooded wetlands that provide vital habitat for many native amphibians (e.g. blue-spotted salamanders, spring peepers, chorus frogs, gray treefrogs, wood frogs) and aquatic insects that require fish-free wetlands to survive. Plants and animals supported by vernal pools are the primary food base for terrestrial wildlife in northern forests (i.e., reptiles, small mammals, etc.). Research estimates 37,000 vernal pools may exist in the 740,000 acres of Minnesota’s Lake Superior coastal zone (5 pools per 100 acres); however, many are unmapped due to their small size and ephemeral nature. Scientists at NRRI-UMD completed a project funded by Minnesota’s Lake Superior Coastal Program (administered by MNDNR): “*Evaluating vital, small forested wetlands.*” The goal was to map potential vernal pool locations in the MN coastal zone, field verify vernal pool locations, and conduct public workshops to raise awareness about the value of vernal pools and recruit citizen scientists/volunteers to locate and monitor vernal pools throughout the MN Lake Superior coastal zone. The work included vernal pool surveys in National Forest, State Parks, and other public properties. In Hartley Park, the results show multiple vernal pools (Figure 7) that provide breeding habitat for a suite of northern amphibian species including the following observed in 2014: wood frog, northern leopard frog, spring peeper, western chorus frog, gray treefrog, mink frog, and blue-spotted salamander. All of these species require wetlands, such as vernal pools, for breeding, but also need upland terrestrial habitat for foraging, migration, and/or overwintering. Hartley Park is unique because it includes the breeding habitat for these amphibian species and the upland terrestrial habitat within an intact forested area, providing a safer environment for movement between habitats and migration (e.g., no roads to cross).

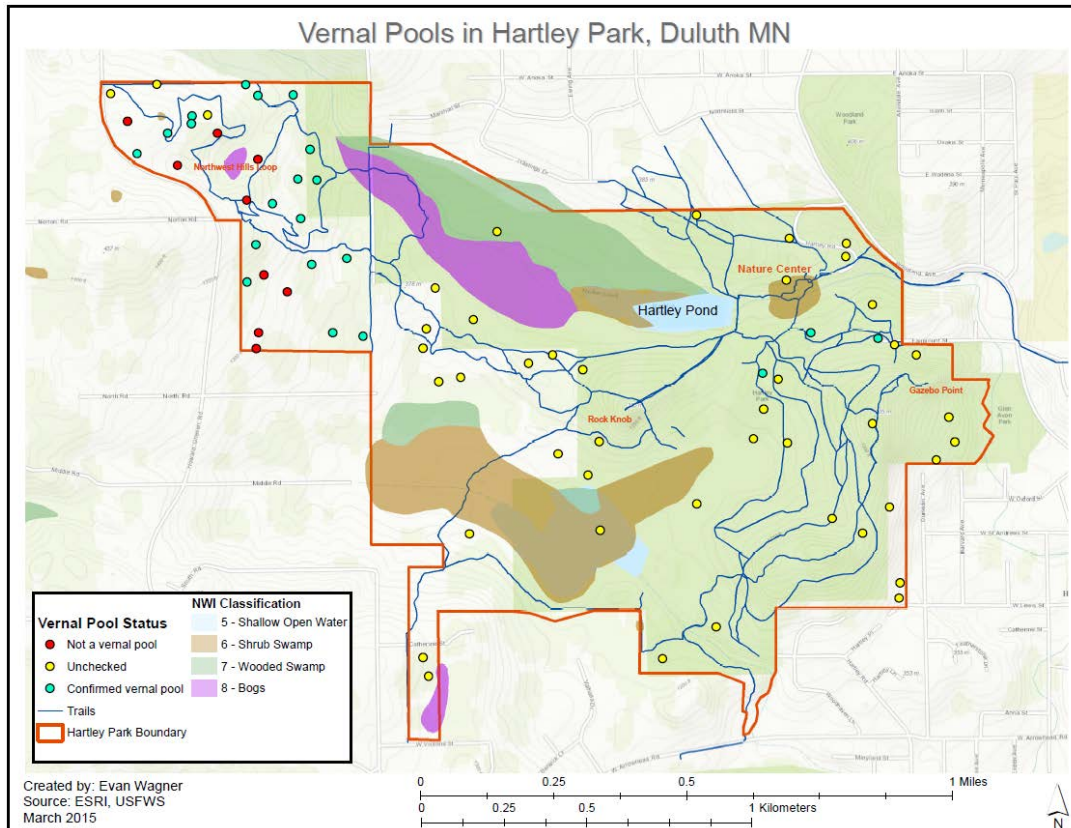


Figure 7 – Potential (yellow) and Verified (green) vernal pools in Hartley Park

Geologic Landforms Area—Tettegouche Till Plain - The Tettegouche Till Plain, a band of rolling topography at the crest of the slope overlooking Lake Superior and the St. Louis River, forms the backbone of Duluth. Hartley Park contains the substantially undisturbed geological landform of the Tettegouche Till Plain, illustrating the northwest to southeast flutes formed by the glacier (Figure 8).

The evidence of geologic history within Hartley Park exemplifies the Midcontinent Rift, including volcanism, intrusion, and crystallization of plutonic rocks such as the Duluth Gabbro Complex, and deposition of sediments, about 1.1 billion years ago.

This was followed by the Tettegouche Till Plain glaciation period that sculpted the landscape of Hartley.

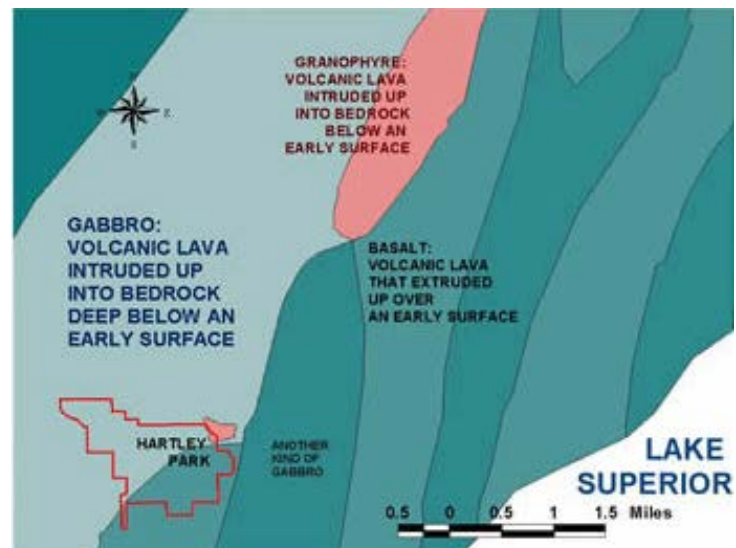


Figure 8: Approximate areas of geologic landforms

APPENDIX A: - Table of Parcels/Owners

Parcel #	Owner	Acres
010-2710-00330	53.5% of City of Duluth Parcel (36.19 acres)	19.37
010-3470-00250	State of Minnesota C278 L35	1.02
010-2710-00350	City of Duluth	38.83
010-2710-00525	City of Duluth	20.08
010-2710-00526	City of Duluth	20.07
010-2710-00540	City of Duluth	27.12
010-2710-00560	City of Duluth	39.14
010-2710-00572	City of Duluth	1.84
010-2710-00585	City of Duluth	17.30
010-2710-00595	City of Duluth	20.12
010-2710-00590	City of Duluth	9.6
010-2710-00596	City of Duluth	10.07
010-2710-00600	City of Duluth	40.25
010-2710-02820	City of Duluth	20.06
010-2710-02825	City of Duluth	20.07
010-2710-02830	City of Duluth	39.11

010-2710-02840	City of Duluth	20.04
010-2710-02860	City of Duluth	40.13
010-4405-00200	City of Duluth	0.52
010-4405-00210	City of Duluth	0.87
010-2710-03170	City of Duluth	39.09
010-2710-03180	City of Duluth	24.68
010-2710-03185	City of Duluth	12.30
010-2710-03190	City of Duluth	25.88
010-2710-03195	City of Duluth	11.52
010-2710-03200	City of Duluth	39.22
010-2710-03210	City of Duluth	18.40
010-1560-00740	HNC	3.95
010-1560-00500	HNC	3.92
010-3900-00010	HNC	3.44
010-1560-00330	HNC	1.46
010-1560-01360	HNC	5.99
010-2710-03245	City of Duluth	2.61
010-2116-00190	City of Duluth	0.24

010-2116-00200	City of Duluth	0.24
010-2116-00210	City of Duluth	0.25
010-2116-00220	City of Duluth	0.26
010-2116-00230	City of Duluth	0.41
010-2116-00240	City of Duluth	0.53
010-2116-00250	City of Duluth	0.27
010-2116-00260	City of Duluth	0.28
010-2116-00270	City of Duluth	0.29
010-2116-00280	City of Duluth	0.32
010-2116-00290	City of Duluth	0.33
010-2116-00300	City of Duluth	0.30
010-2116-00310	City of Duluth	0.32
010-2116-00320	City of Duluth	0.34
010-2116-00330	City of Duluth	0.35
010-2116-00340	City of Duluth	0.48
010-2116-00350	City of Duluth	2.71
010-2116-00480	City of Duluth	0.90
010-2116-00490	City of Duluth	0.37

010-2116-00500	City of Duluth	0.30
010-2116-00510	City of Duluth	0.29
010-2116-00520	City of Duluth	0.29
010-2116-00530	City of Duluth	0.29
010-2116-00540	City of Duluth	0.29
010-2116-00550	City of Duluth	0.29
010-2116-00560	City of Duluth	0.59
010-2116-00570	City of Duluth	0.50
010-2116-00580	City of Duluth	0.31
010-2116-00590	City of Duluth	0.31
010-2116-00600	City of Duluth	0.31
010-2116-00610	City of Duluth	0.31
010-2116-00620	City of Duluth	0.32
010-2116-00630	City of Duluth	0.41
010-2116-00640	City of Duluth	1.30
010-2116-00650	City of Duluth	8.43
	Total Acres:	621.80

APPENDIX B: - DNAP Plant Communities Found in Hartley Park

<u>DNR Code</u>	<u>Plant Community Type</u>	<u>Acreage in Hartley Park</u>
WMn1a	northern sedge meadow	52
CPn79a	northern alder swamp	53
WMn82b	willow-dogwood shrub swamp	23.9
MHn62b	wet-mesic black ash/sugar maple forest	1.1
WFn31c	very wet black ash swamp	1.3
WFn71c	wet black ash swamp	23.2
CTn1b	northern dry circumneutral cliff	0.3
LSn5a	lake superior dry bedrock shore	1.9
ROn1a	northern rock outcrop	1.3
FDn3b	dry-mesic red pine-white pine woodland	7.6
FDn4c	mesic aspen-birch-fir forest	16.3
MHn5b	northern rich maple-basswood forest	254.3
MHn61a	mesic white spruce-pine/paper birch forest	70
Total Acres:		506.2



Appendix B

Plant Communities of Hartley Park



Plant Communities of Hartley Park



Prepared by:

Carol Reschke, Kristi Nixon, Deb Pomroy, Ray Barnes, and George Host

Date: September 18, 2019

Report Number: NRRI/TR-2019/49

Prepared for:

City of Duluth, Minnesota

and

Hartley Nature Center

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INTRODUCTION

This project builds on and updates an ecological survey of Hartley Park in Duluth, Minnesota that was conducted in 2003 by consulting ecologist Ethan Perry to evaluate the potential to nominate the park to the Duluth Natural Areas Program (DNAP). In 2003 DNAP was a new program to provide legal protection to city-owned or private lands of ecological or geological significance. DNAP guidelines explain that land in Duluth can be eligible for this protection by meeting criteria in at least one of five categories. The 2003 ecological survey gathered information necessary to determine if parts of Hartley Park qualify for the Native Plant Communities category of DNAP criteria. Although Hartley Park was not designated under DNAP after the 2003 survey, the City of Duluth and Hartley Park managers recently wanted to update the maps and submit a DNAP nomination package in fall of 2019. The City of Duluth contracted with ecologists and geographic information system (GIS) staff at the University of Minnesota Duluth, Natural Resources Research Institute (NRRI) to update the maps. This technical report describes the methods and results of surveys conducted in summer 2019 to update the Plant Community maps of Hartley Park.

The project area for this map includes Hartley Park (660 acres) and 38 acres of adjacent open land that the park wants to evaluate for acquisition. The total area mapped in 2019 was 698 acres, with a wide variety of types of vegetation. To evaluate the quality of these vegetation types, the entire park was divided into patches or *polygons* of different plant community types, most of which were visited by ecologists, some more intensively than others. Access to some polygons was difficult due to steep topography and many trees blown down in a July 2016 wind storm. For these more remote or difficult-access polygons, air photo imagery was interpreted, and additional low-altitude air photos were acquired by NRRI staff using unmanned aerial vehicles (UAVs).

For native plant communities, the polygons were classified using the system developed by the MN DNR Biological Survey Program, described in the 2003 publication *Field Guide to the Native Plant Communities of Minnesota, The Laurentian Mixed Forest Province*. Since the names of the DNR communities are often long and not always descriptive of local vegetation, we have provided alternative cover names specific to Hartley (Table 1). Vegetation types not considered native plant communities (including conifer plantations, parking lots, ball fields, and areas dominated by non-native species) were divided into general land cover categories; these land cover types as a group are called “Cultural and other communities” similar to NOAA classifications of “Cultural” cover types so modified by human activities that they are not considered “natural” or native plant communities. The cultural cover types had a total of 168 acres. This report focuses primarily on the 530 acres of native plant communities in the project area.

MAPPING AND SAMPLING METHODS

This project was designed to use a combination of air photo and UAV imagery for interpretation and mapping of vegetation patterns. We used GIS shapefiles provided by Ethan Perry that showed boundaries of vegetation polygons that he mapped in Hartley Park, and we appended polygons for the additional areas that the City of Duluth staff added for this project, for a total of 698 acres in the Hartley map. These polygons boundaries were displayed with air photo imagery obtained from MnGeo WMS Service (fall 2017 FSA) as well as with a mosaic of UAV imagery flown May 31 and compiled in June 2019 by NRRI staff.

UAV imagery collection

NRRI staff flew the eBee (senseFly) fixed-wing UAV installed with an 18.2-megapixel Canon RGB camera over the park at an approximate altitude of 384 feet and flight lateral and longitudinal overlaps of 70% to attain imagery with a photo resolution of 1.61 inches per pixel. Images were compiled into a single orthomosaic image using the photogrammetry software Pix4Dmapper Pro version 4.2.27.

Plant community field surveys

The full park map was divided into seven overlapping field maps (Map A through G), with polygon numbers displayed in each polygon, as well as park trails. These maps were printed and laminated for use during plant community field surveys. The polygon boundaries were also downloaded into a file that could be displayed with maps on smart phones, so the field crew could confirm their location within each polygon.

Field forms were prepared for recording field map polygon codes (a combination of map letter and polygon number), DNR plant community type and code, ID number of one GPS point marked within the polygon, ecological system and class, quality rank, and DNR native plant community codes, along with space to record dominant and common plant species, diagnostic plant species, and invasive plant species observed within each polygon. Using these field forms and the field maps, field surveys were conducted from June 21 to July 24, 2019 by Deb Pomroy and Ray Barnes in consultation with Carol Reschke. Deb and Ray also compiled a checklist of invasive plants observed in each polygon they surveyed. Given the short time frame of this project, we did not attempt to survey every single polygon; the field surveys were intended to be a sample of more than half the polygons to confirm and/or update the plant communities identified from 2003 field surveys by Ethan Perry. Since Ethan's report preceded the final publication of the MN DNR's *Field Guide to Native Plant Communities of Minnesota*, there are some slight changes in plant community names and codes since Perry's survey of Hartley Park in 2003.

Deb and Ray found that it was most efficient to record species from each polygon, as well as notes on landform, soil, and substrates while in the field, and then later use those notes to determine plant community types using the keys in the MN DNR's *Field Guide*. They surveyed 85 of the 124 polygons in the final Hartley map, and those 85 polygons cover about 602 acres of the 698 acres mapped.

Based on the June and July field surveys, polygon boundaries were then updated in GIS to reflect a few changes and additions noted in the field. The data tables associated with the polygons were updated to include some revised quality ranks, current DNR native plant community names and codes. Acreages of each polygon were calculated in GIS. Mapping updates were completed in August 2019, and quality control review was completed in early September 2019. Metadata were written following the Minnesota Geographic Metadata Guidelines.

IMAGERY USED FOR MAPPING

The orthomosaic created by NRRI UAV flights (1.61-inch resolution) as well as the MnGeo statewide 2017 color FSA (Farm Service Agency) NAIP imagery (1-meter-resolution aerial photography) were used as imagery basemaps for vegetation mapping. Because of UAV communication, launch site, and safety issues, some areas of the park were inaccessible by the UAV; the NAIP images were used to fill in these areas.

NATIVE PLANT COMMUNITIES FOUND AT HARTLEY PARK

Based on a combination of Ethan Perry's surveys in 2003 and our surveys in 2019, we identified 23 native plant community types or subtypes that occur in Hartley. The MN DNR classification of plant communities is organized by ecological systems, and the 23 native plant communities at Hartley fall into eight ecological systems. Since the MN DNR plant community names are often long and unwieldy, we have assigned shorter names to each type for use by Hartley Nature Center, we call these shorter names the "Hartley Cover Name." A list of all the native plant communities organized by ecological system is provided in Table 1. Brief descriptions of each of the 22 native plant communities as they occur in Hartley are provided below. Plant common names are consistent with MN DNR's MNTaxa vascular plant checklist.

Fire-Dependent Forest/Woodland System (FD)

Northern Dry-Mesic Mixed Woodland Class (FDn33)

Aspen - Birch Woodland (FDn33b)

Hartley Cover Name: Bedrock Woodland

3 Polygons totaling 1.9 acres

Despite its name, this community at Hartley is dominated by red oak, though quaking aspen, big-tooth aspen, basswood, paper birch, and white spruce are also common. It occurs on shallow loamy soil over bedrock at the crests of steep slopes and cliffs. The trees are stunted, usually less than 30 feet tall, and the canopy is generally open, permitting a dense shrub layer. Beaked hazelnut and bush honeysuckle are the dominant shrubs. Bracken fern often forms a dense ground layer.

The community called *Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest* occurs in adjacent areas with slightly deeper soil over the bedrock. Where there is even less soil, *Crystalline Bedrock Outcrop* and *Bedrock Shrubland* communities occur.

Northern Mesic Mixed Forest Class (FDn43)

White Pine - Red Pine Forest (FDn43a)

Hartley Cover Name: White Pine Forest

3 Polygons totaling 7.6 acres

This forest type contains a mix of conifers, along with aspens and birches. Pines always have a strong presence, but they are not necessarily the dominant trees. At Hartley, this community contains many white pine trees, but few red pine. White spruce and balsam fir are usually common in the canopy. Beaked hazelnut, Canada honeysuckle, and mountain maple are the dominant shrubs. Common herbaceous plants include large-leaved aster, sarsaparilla, and Canada mayflower.

Aspen - Birch Forest (FDn43b)

Hartley Cover Name: Mixed Hardwood - Conifer Forest

1 Polygon totaling 6.0 acres

This forest type is essentially identical to the *White Pine - Red Pine Forest* type, but with few, if any, pines. The dominant tree species are white spruce, quaking aspen, and paper birch.

Aspen - Birch Forest, Balsam Fir Subtype (FDn43b1)

Hartley Cover Name: Mixed Hardwood - Conifer Forest

1 Polygon totaling 10.3 acres

This subtype is essentially identical to the *White Pine - Red Pine Forest* type, but with few, if any, pines. The dominant tree species are white spruce, balsam fir, quaking aspen, and paper birch, and balsam fir, quaking aspen, and paper birch are common in the understory.

Mesic Hardwood Forest System (MH)

Northern Mesic Hardwood Forest Class (MHn35)

Aspen - Birch - Basswood Forest (MHn35a)

Hartley Cover Names: Rich Aspen - Birch Forest

5 Polygons totaling 60.2 acres

At Hartley this forest type is the result of past disturbance of what was formerly mature Rich Northern Hardwood Forest or Northern Hardwood Forest; examples of disturbances are clearcutting and cultivation. Rich Aspen - Birch Forest is dominated by quaking aspen, with lesser amounts of paper birch, basswood, and sugar maple. The understory is usually less diverse than that of Northern Hardwood Forest, often dominated by glossy buckthorn and buckthorn.

Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest (MHn35b)

Hartley Cover Names: Northern Hardwood Forest

11 Polygons totaling 128.7 acres

At Hartley this forest type is a mature forest. Northern Hardwood Forest is usually dominated by red oak, with lesser amounts of sugar maple. Basswood, aspen, and paper birch are also present. Beaked hazelnut, mountain maple, and bush honeysuckle are the dominant shrubs; glossy buckthorn and buckthorn are also common shrubs. Common herbaceous plants include bracken fern, large-leaved aster, and bluebead lily.

Northern Wet-Mesic Boreal Hardwood-Conifer Forest Class (MHn44)

Aspen - Birch - Red Maple Forest (MHn44a)

Hartley Cover Names: Aspen - Birch Forest

1 Polygon of 4.4 acres

This forest type is dominated by quaking aspen, with paper birch and box elder also present in the canopy, with red maple and black ash in the understory. Common shrubs include beaked hazelnut, speckled alder, along with non-native Preston lilac, Japanese knotweed, glossy buckthorn, and buckthorn. Characteristic herbaceous plants include bunchberry and Solomon's seal.

Northern Wet-mesic Hardwood Forest (MHn46)

Aspen - Ash Forest (MHn46a)

Hartley Cover Name: Aspen - Ash Forest

5 Polygons totaling 34.8 acres

In Hartley, this forest type is dominated by quaking aspen, balsam poplar, and paper birch, with some box elder and willow mixed in. Butternut, an endangered species in Minnesota, was found in two polygons of this forest type. Non-native shrubs glossy buckthorn and buckthorn are

common in the understory, as well as several non-native herbaceous plants such as tansy, valerian, and Canada thistle.

Black Ash - Basswood Forest (MHn46b)

Hartley Cover Name: Wet-mesic Hardwood Forest

1 Polygon of 1.1 acres

This small polygon of moist forest (not quite a wetland and not quite an upland) does not fit into any of the typical forest types of the Duluth area. Ethan Perry tentatively classified it as *Black Ash - Basswood Forest*, which normally occurs south of Duluth. The canopy is dominated by quaking aspen, black ash, and balsam poplar, but basswood, sugar maple, and yellow birch are also mixed in. The herbaceous layer includes species of both wet forests and upland forests, including woodland horsetail, wood nettle, touch-me-not, common enchanter's nightshade, ostrich fern, bracken, sensitive fern, toothed wood fern, and dewberry. A lot of blowdown in the vicinity has made access to the one polygon difficult, and it was not surveyed in 2019.

Northern Rich Mesic Hardwood Forest Class (MHn47)

Sugar Maple - Basswood - (Bluebead Lily) Forest (MHn47a)

Hartley Cover Names: Rich Northern Hardwood Forest

8 Polygons totaling 73.8 acres

This is a mature forest type is very similar to *Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest*. It tends to be moister and richer, and generally lacks the bracken fern and bush honeysuckle that indicate the drier type. Rich Northern Hardwood Forest is dominated by sugar maple, with lesser amounts of red oak, basswood, and yellow birch. Ironwood is a common subcanopy tree. Beaked hazelnut, mountain maple, Canada honeysuckle, and choke cherry are dominant shrubs. Common non-native shrubs are glossy buckthorn, buckthorn, and Japanese barberry. Common herbaceous plants include lady fern, baneberry, and wild leeks.

Wet Forest System (WF)

Northern Wet Ash Swamp Class (WFn55)

Black Ash - Aspen - Balsam Poplar Swamp (Northeastern) (WFn55a)

Hartley Cover Name: Aspen - Black Ash Swamp

9 Polygons totaling 65.7 acres

This is the driest of the wetland forest types. Pools of open water are rare. Quaking aspen and black ash are co-dominant, while common shrubs include speckled alder, red-osier dogwood, and choke cherry. The herbaceous layer is thick and includes fowl meadow-grass, dewberry, flat-topped aster, tall meadow-rue, smooth goldenrod, and toothed wood-fern. Non-native species, including glossy buckthorn, buckthorn, bittersweet nightshade, valerian, and tansy are also common.

Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral) (WFn55b)

Hartley Cover Name: Black Ash - Hardwood Swamp

1 Polygon of 4.1 acres

This is a wet forest dominated by black ash, with quaking aspen, balsam poplar and balsam fir also present in the canopy. In Hartley there are many non-native shrubs and saplings in the understory including buckthorn, glossy buckthorn, Amur maple, and Eurasian honeysuckles. Characteristic herbaceous species include hairy Solomon's seal and purple meadow-rue.

Black Ash - Mountain Maple Swamp (Northern) (WFn55c)

Hartley Cover Name: Black Ash Swamp

12 Polygons totaling 21.8 acres

This black ash swamp is wetter than *Black Ash - Aspen - Balsam Poplar Swamp*. Pools are common. Black ash is by far the dominant tree species. The shrub layer, mostly speckled alder, is often sparse. Non-native glossy buckthorn and buckthorn are present in the understory. Common herbaceous species include marsh marigold and ostrich fern. The presence of touch-me-not and jack-in-the-pulpit indicate this type instead of *Black Ash - Aspen - Balsam Poplar Swamp*.

Northern Very Wet Ash Swamp Class (WFn64)

Black Ash - Conifer Swamp (Northeastern) (WFn64a)

Hartley Cover Name: Black Ash - Conifer Swamp

1 Polygon of 1.3 acres

The single example of this type at Hartley has an uneven floor, with dry hummocks rising above pools of water (covering approximately half the area). Black ash and white cedar are co-dominant, with a few yellow birches mixed in. The sparse shrub layer includes speckled alder, along with young black ash and balsam fir. The herbaceous layer on the hummocks includes goldthread, oak fern, bluebead lily, and Canada mayflower.

Black Ash - Alder Swamp (Northern) (WFn64c)

Hartley Cover Name: Black Ash - Alder Swamp

1 Polygon of 1.4 acres

The single example of this wet forest type at Hartley is dominated by black ash with some quaking aspen and a few balsam poplar. The shrub layer is primarily mountain maple and speckled alder. The ground layer is very wet with some small depressions or pools. Characteristic herbaceous species include awl-fruited sedge (*Carex stipata*), bluejoint, fowl manna grass, touch-me-not, dwarf raspberry, and lady fern.

Forested Rich Peatland System (FP)

Northern Alder Swamp Class (FPn73)

Alder Swamp (FPn73a)

Hartley Cover Name: Alder Swamp

4 Polygons totaling 8.6 acres

Speckled alder forms a canopy in these swamps, but the wetness and richness of the soil is variable. At Hartley, *Alder Swamp* includes some areas with standing water for most of the growing season, where bluejoint grass is dominant in the understory, and some drier areas, which are similar to *Black Ash - Aspen - Balsam Poplar Swamp*, but without the tree canopy. Many areas which might otherwise have been *Alder Swamp* or *Wet Forest* are instead dominated by glossy buckthorn. Please note that speckled alder and glossy buckthorn are often the same height and shape in Hartley Park, they must be seen up close to distinguish the species.

Rock Outcrop System (RO)

Northern Bedrock Outcrop Class (ROn12)

Crystalline Bedrock Outcrop (Northern) (ROn12b)

Hartley Cover Name: Bedrock Outcrop

2 Polygons totaling 1.5 acres

This plant community occurs on rocky summits and ridges where a lack of soil results in less than 50% cover by herbaceous plants and less than 25% cover by woody species. At Hartley only two examples were large enough to be mapped as a polygon. Smaller rock outcrops are embedded within *Bedrock Shrubland* and *Aspen - Birch Woodland* polygons. The larger polygon (35) at Hartley has been disturbed in the past and continues to receive heavy foot traffic, resulting in the near absence of the normally thick layer of lichens and in the dominance of non-native species in the crevices with enough soil to support herbaceous plants. These species include tansy, yarrow, timothy grass, and Canada bluegrass. Native species include ragweed, red-osier dogwood, and sumac.

Northern Bedrock Shrubland Class (ROn23)

Bedrock Shrubland (Inland) (ROn23a)

Hartley Cover Name: Bedrock Shrubland

1 Polygon of 0.3 acres

This plant community occurs on rocky summits and ridges where thin soil results in less than 25% tree cover, but denser growth of shrubs and herbaceous plants. The one example at Hartley contains a small *Crystalline Bedrock Outcrop* in the center and grades into the surrounding *Aspen - Birch Woodland*. The open center contains rusty woodsia fern, pale corydalis, and thimbleweed, but is dominated by non-native herbaceous species such as tansy and Canada bluegrass. The surrounding shrubland is higher quality, including junberry and sumac, but also the non-native Tartarian honeysuckle. There are a few red oaks and white pines.

Lakeshore System (LK)

Inland Lake Clay/Mud Shore Class (LKi54)

Clay/Mud Shore (Inland Lake) (LKi54a)

Hartley Cover Name: Aquatic Vegetation

1 Polygon of 8.6 acres

The one polygon consists of floating-leaf and submerged aquatic vegetation in shallow water in the pond below the dam. Dominant plants are floating pondweed, coontail, sago pondweed, and flat-stemmed pondweed, with water stargrass and duckweeds also common.

Wet Meadow/Carr System (WM)

Northern Wet Meadow/Carr Class

Willow - Dogwood Shrub Swamp (WMn82a)

Hartley Cover Name: Willow Swamp

7 Polygons totaling 30.9 acres

This type of open wetland has at least 25% cover of tall shrubs, including willow, red-osier dogwood, and speckled alder, but alder is not a dominant species. These shrubs are often mixed with grasses, sedges, and wildflowers typical of *Sedge Meadows*. In fact, *Willow - Dogwood Shrub Swamp* often develops as shrubs fill in an open *Sedge Meadow*. At Hartley, however, some examples of *Willow - Dogwood Shrub Swamp* are in wetter soil (with standing water through much of the growing season). Non-native glossy buckthorn is also common.

Sedge Meadow, Bluejoint Meadow Subtype (DNR code: WMn82b1)

Hartley Cover Name: Wet Meadow

4 Polygons totaling 52.4 acres

Sedge Meadows are seasonally flooded wetlands dominated by grasses and sedges with relatively wide leaves. Those surveyed at Hartley fall into the *Bluejoint Meadow Subtype* due to the dominance of bluejoint grass. The diversity of sedges and wildflowers can be quite high, however. On the other hand, areas dominated by the non-native reed canary grass have very low diversity. One sedge meadow polygon that was not surveyed was not identified to subtype.

Marsh System (MR)

Northern Mixed Cattail Marsh Class (MRn83)

Cattail - Sedge Marsh (Northern) (MRn83a)

Hartley Cover Name: Cattail Marsh

3 Polygons totaling 4.5 acres

These deepwater marshes are dominated by invasive narrowleaf cattails and purple loosestrife; other grass-like plants are common including sedges, woolgrass, and bluejoint. Some are nearly monocultures of invasive cattails, while others contain quite a diversity of other wetland species.

Table 1: Hartley Plant Communities and Cover Types and Acres (of total 698 acres mapped).

<i>DNR_System</i>										
DNR Community Type	Hartley Cover Name	Cover Code	Total	Total	<i>Acres by quality rank</i>					
<i>Fire-Dependent Forest/Woodland System</i>			polygons	acres	no rank	B	BC	C	CD	D
Aspen - Birch Woodland	Bedrock Woodland	FDn33b	3	1.9		1.0	0.5		0.4	
White Pine - Red Pine Forest	White Pine Forest	FDn43a	3	7.6				2.8	4.8	
Aspen - Birch Forest	Mixed Hardwood-Conifer Forest	FDn43b	1	6.0				6.0		
Aspen - Birch Forest, Balsam Fir Subtype	Mixed Hardwood-Conifer Forest	FDn43b1	1	10.3				10.3		
<i>Mesic Hardwood Forest System</i>										
Aspen - Birch - Basswood Forest	Rich Aspen - Birch Forest	MHn35a	5	60.2			58.4			1.8
Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest	Northern Hardwood Forest	MHn35b	11	128.7			9.9	20.0	29.3	69.5
Aspen - Birch - Red Maple Forest	Aspen - Birch Forest	MHn44a	1	4.4						4.4
Aspen - Ash Forest	Aspen - Ash Forest	MHn46a	5	34.8						34.8
Black Ash - Basswood Forest	Wet-mesic Hardwood Forest	MHn46b	1	1.1				1.1		
Sugar Maple - Basswood - (Bluebead Lily) Forest	Rich Northern Hardwood Forest	MHn47a	8	73.8			26.4	36.9	10.5	
<i>Wet Forest System</i>										
Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	Aspen - Black Ash Swamp	WFn55a	9	65.7				5.6	1.7	58.4
Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral)	Black Ash - Hardwood Swamp	WFn55b	1	4.1					4.1	
Black Ash - Mountain Maple Swamp (Northern)	Black Ash Swamp	WFn55c	12	21.8			0.6	13.5		7.8
Black Ash - Conifer Swamp (Northeastern)	Black Ash - Conifer Swamp	WFn64a	1	1.3				1.3		
Black Ash - Alder Swamp (Northern)	Black Ash - Alder Swamp	WFn64c	1	1.4				1.4		
<i>Forested Rich Peatland System</i>										
Alder Swamp	Alder Swamp	FPn73a	4	8.6				1.3	3.0	4.3

<i>Rock Outcrop System</i>	Hartley Cover Name	Cover Code	polygons	acres	no rank	B	BC	C	CD	D
Crystalline Bedrock Outcrop (Northern)	Bedrock Outcrop	ROn12b	2	1.5				0.1		1.3
Bedrock Shrubland (Inland)	Bedrock Shrubland	ROn23a	1	0.3					0.3	
<i>Lakeshore System</i>										
Inland Lake Clay/Mud Shore	Aquatic Vegetation	LKi54	1	8.6				8.6		
<i>Wet Meadow/Carr System</i>										
Willow - Dogwood Shrub Swamp	Willow Swamp	WMn82a	7	30.9	1.7	0.9	2.1	19.7		6.7
Sedge Meadow	Wet Meadow	WMn82b	1	0.6						0.6
Sedge Meadow, Bluejoint Subtype	Wet Meadow	WMn82b1	4	51.8		42.6			7.0	2.3
<i>Marsh System</i>										
Cattail - Sedge Marsh (Northern)	Cattail Marsh	MRn83a	3	4.5				2.8		1.8
					subtotal acres by rank:					
					1.7	44.4	97.7	131.4	61.1	193.6
					<i>no rank</i>	<i>B</i>	<i>BC</i>	<i>C</i>	<i>CD</i>	<i>D</i>

<i>Cultural / other communities</i>			Total	Total
Hartley subtype	Hartley Cover Name	Cover Code	polygons	acres
	Ballpark	C7	1	8.8
	Building and Pavement	C8	1	5.0
	Conifer Plantation	C1	8	51.5
	Dam and Packed Gravel	C9	1	2.0
	European Mountain-ash Forest	C2	1	1.3
	Non-native Grassland	C3	5	10.4
	Open Water	C6	2	2.6
Upland Mesic Non-native Shrubland	Upland Non-native Shrubland	C4a	6	30.7
Upland Wet-mesic Non-native Shrubland	Upland Non-native Shrubland	C4b	4	22.5
	Wetland Non-native Shrubland	C5	9	33.1

RARE SPECIES

The vegetation surveys for this project focused primarily on identifying or confirming native plant community types for mapping, and we were not specifically searching for rare species. Nevertheless, one rare native tree species was found in two polygons. Butternut (*Juglans cinerea*) trees were found in polygons 57 and 203 near the northeastern end of the park. According to the Minnesota DNR website, butternut was a fairly common forest tree species in the eastern U.S. and Canada until recently. A lethal fungal disease called butternut canker, was first reported in Wisconsin in 1967, and spread into Minnesota. The species was listed as special concern in 1996, with hopes that the fungal disease could be abated. Since then it became clear that the threat from butternut canker could not be abated in the foreseeable future, so butternut was listed in 2013 as an endangered species in Minnesota. We suggest that the butternut trees in Hartley should be evaluated for butternut canker.

CULTURAL COVER TYPES AT HARTLEY PARK

Many areas in Hartley Park are so modified by developments (structures, parking lots), disturbances, or invasion by non-native species that they cannot be considered native plant communities, and so they are not identified in the Minnesota DNR field guide. Since management of these areas is important to Hartley Park, these disturbed areas have been mapped as nine cultural cover types as follows.

Conifer Plantation (C1)

8 Polygons totalling 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 (C2)

1 Polygon of 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 (C3)

5 Polygons totaling 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 (C4)

10 Polygons totaling 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 (C5)

9 Polygons totaling 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.

Open Water (C6)

2 Polygons totaling 2.6 acres

These polygons are small areas of open water in ponds.

Ballpark (C7)

1 Polygon of 8.8 acres

This polygon has the ballpark along Woodland Ave.

Building and Pavement (C8)

1 Polygon of 5 acres

This polygon includes the Hartley Nature Center building, gardens, and parking lot.

Dam and Packed Gravel (C9)

1 Polygon of 2 acres

This polygon consists of the dam and packed gravel near the dam.

CHARACTERIZATION OF HARTLEY VEGETATION

Polygon numbers for all polygons mapped within the project area at Hartley are shown in Map 5 in Appendix 1. A list of all polygons is provided in Appendix 2, where the cover code, Hartley Cover Name, DNR Community Type, and size in acres are provided for each polygon visited in field surveys. Notes about the condition of some polygons are also provided, including notes by Deb Pomroy from 2019 surveys as well as notes by Ethan Perry from 2003 surveys. For native plant communities, each polygon was given two ranks: one for overall quality (Table 1) and one for the abundance of non-native species (Table 2). The quality rankings generally follow guidelines used by the DNR Natural Heritage Program, which differ for the various community types. Abundance of non-native species ranks are focused on abundances of invasive plant species (see list in Appendix 3), and abundance of invasive earthworms in hardwood forest communities, since these earthworms remove the litter layer, disrupt soil horizons, and can change the composition of understory vegetation.

Table 2: Quality rank.

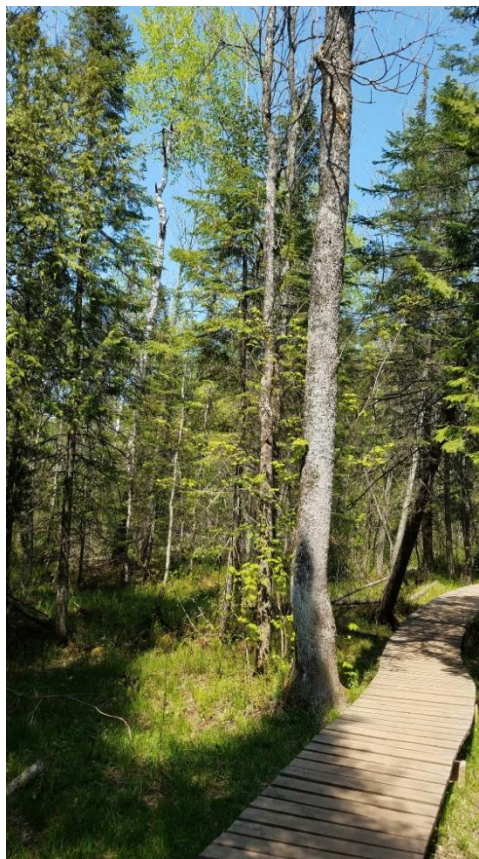
A	Outstanding
B	Very high quality; only slight disturbance
BC	High quality, but significant signs of human disturbance
C	Altered, but with appropriate management, recovery within 50-100 years is expected,
CD	Between C and D
D	Severely degraded; recovery will require active restoration

Table 3: Abundance of non-native species.

1	Few to none
2	Common, but not abundant
3	Abundant

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Appendix 1: Hartley Park Maps

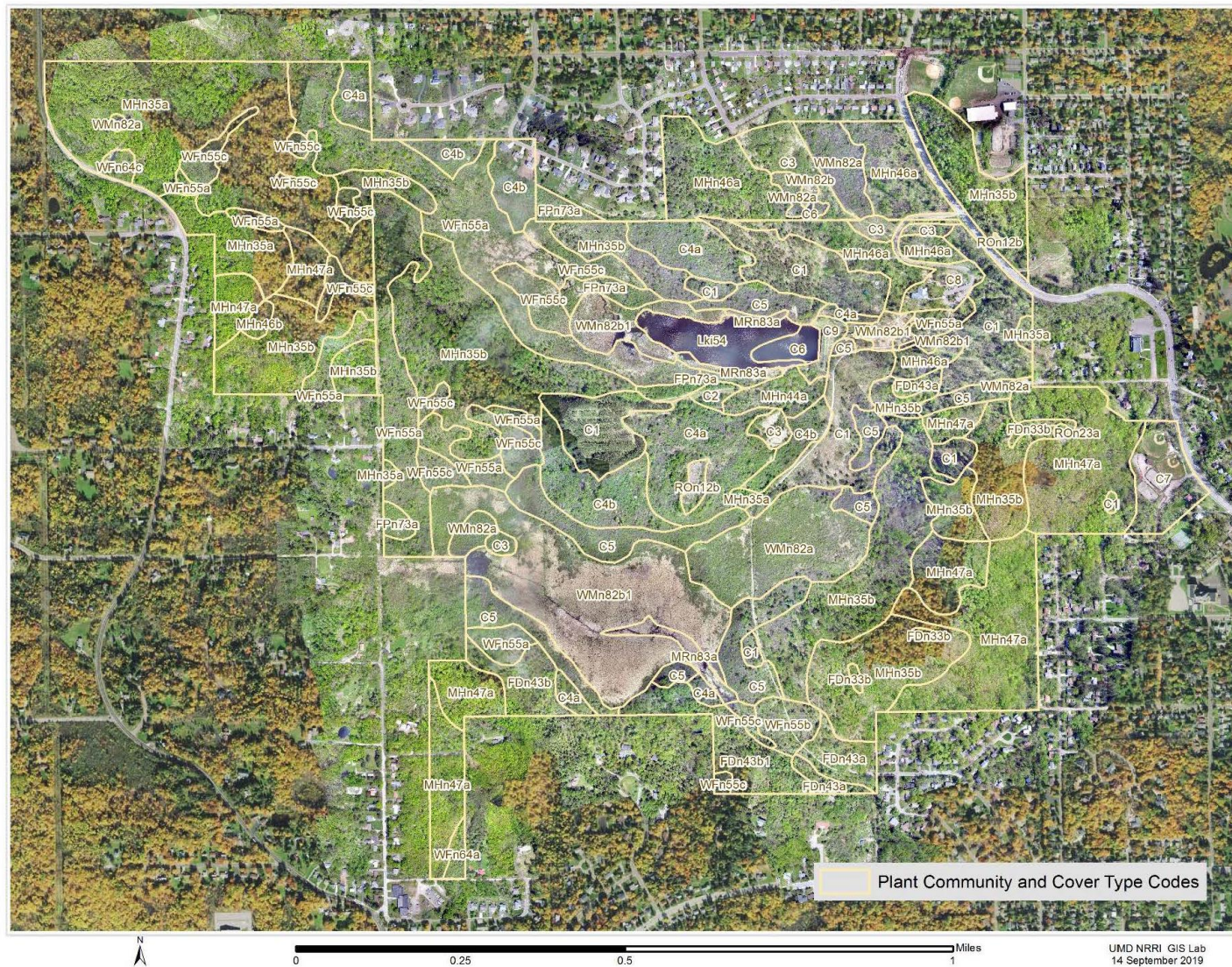
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Hartley Plant Communities and Cover Types

	C1 - Conifer Plantation
	C2 - European Mountain-ash Forest
	C3 - Non-native Grassland
	C4a - Upland Non-native Shrubland
	C4b - Upland Non-native Shrubland
	C5 - Wetland Non-native Shrubland
	C6 - Open Water
	C7 - Ballpark
	C8 - Building and Pavement
	C9 - Dam and Packed Gravel
	FDn33b - Aspen - Birch Woodland
	FDn43a - White Pine - Red Pine Forest
	FDn43b - Aspen - Birch Forest
	FDn43b1 - Aspen - Birch Forest, Balsam Fir Subtype
	FPn73a - Alder Swamp
	Lki54 - Inland Lake Clay/Mud Shore
	MHn35a - Aspen - Birch - Basswood Forest
	MHn35b - Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
	MHn44a - Aspen - Birch - Red Maple Forest
	MHn46a - Aspen - Ash Forest
	MHn46b - Black Ash - Basswood Forest
	MHn47a - Sugar Maple - Basswood - (Bluebead Lily) Forest
	MRn83a - Cattail - Sedge Marsh (Northern)
	ROn12b - Crystalline Bedrock Outcrop (Northern)
	ROn23a - Bedrock Shrubland (Inland)
	WFn55a - Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
	WFn55b - Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral)
	WFn55c - Black Ash - Mountain Maple Swamp (Northern)
	WFn64a - Black Ash - Conifer Swamp (Northeastern)
	WFn64c - Black Ash - Alder Swamp (Northern)
	WMn82a - Willow - Dogwood Shrub Swamp
	WMn82b - Sedge Meadow
	WMn82b1 - Sedge Meadow, Bluejoint Subtype

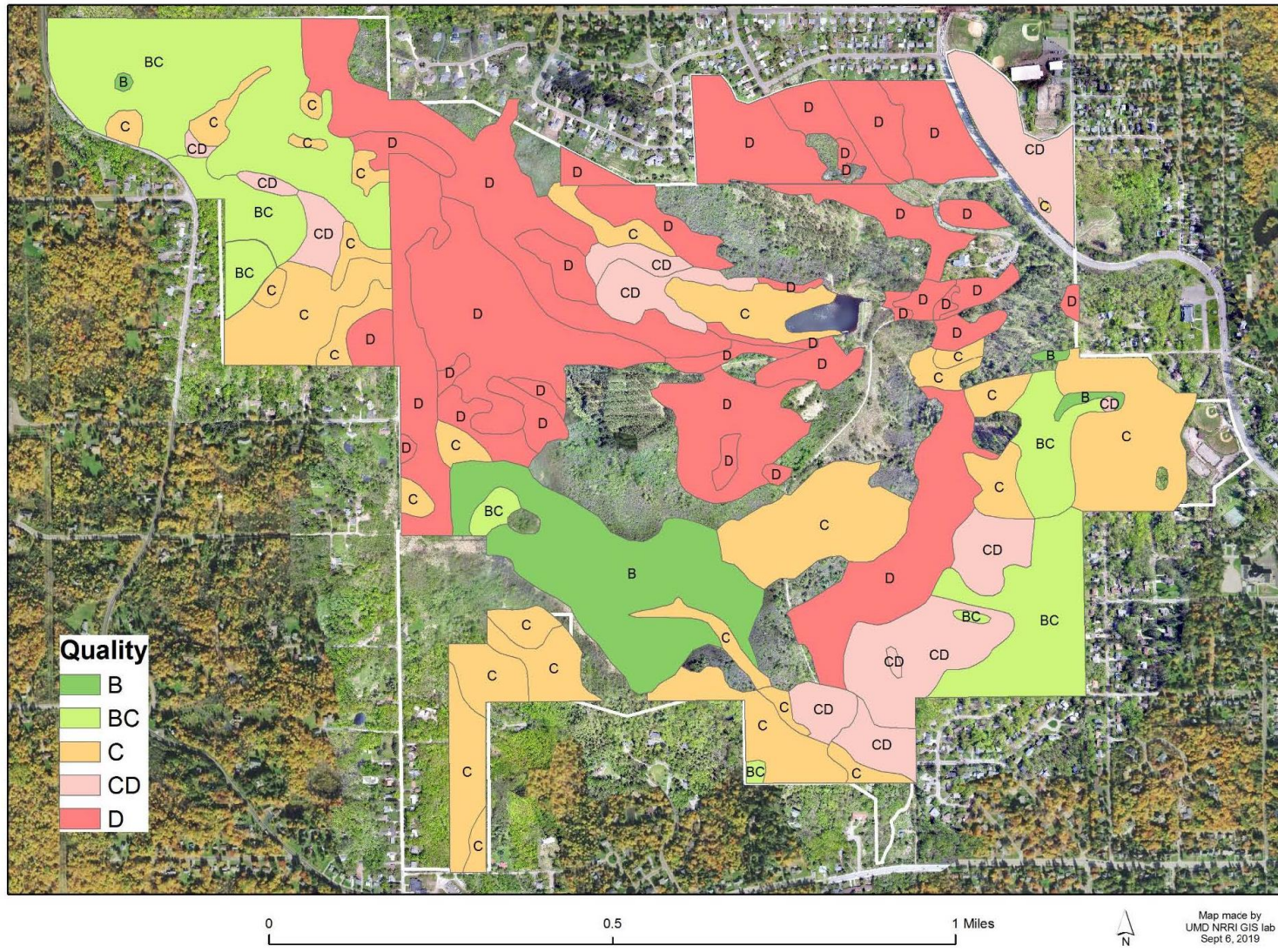
Map 2: Plant Communities and Cover Types, with 2019 spring UAV mosaic and 2017 fall air photo imagery (see legend on page 3)

Hartley Plant Communities and Cover Types



Map 4: DNR Native Plant Community Types Color-coded by Quality Ranks (Cultural and Other cover types were not ranked)

Hartley Native Plant Communities - Quality Rank



Legend for Native Plant Community Quality Ranks

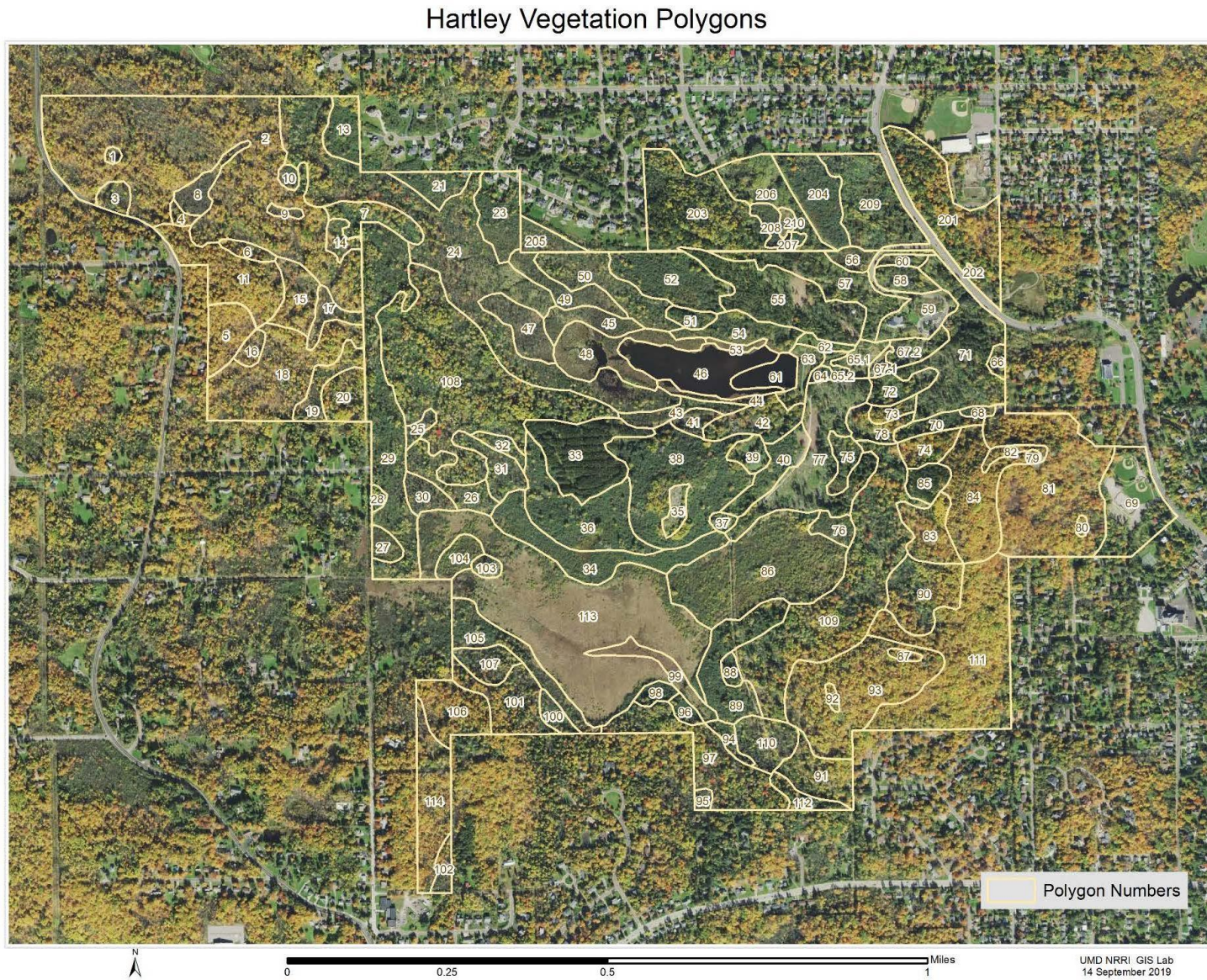
A	Outstanding
B	Very high quality; only slight disturbance
BC	High quality, but significant signs of human disturbance
C	Altered, but recovery within 50-100 years is expected with management
CD	Between C and D
D	Severely degraded; recovery will require active restoration

Map 5: Polygon numbers with 2019 spring UAV mosaic and 2017 fall air photo imagery

Hartley Vegetation Polygons



Map 6: Polygon numbers with 2017 fall air photo imagery



Appendix 2: Descriptions of Hartley Vegetation Polygons

Plant nomenclature follows MN DNR's MNTaxa vascular plant checklist.

Polygon 1

Cover Code: WMN82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 0.3
 Notes (author, survey year): (E. Perry, 2003): Wet meadow with about 30% cover of shrubs about 1 meter tall. Wetland created by berm, but quite healthy and diverse.
 Quality Rank: B
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 2

Cover Code: MHn35a
 Hartley Cover Name: Rich Aspen - Birch Forest
 DNR Community Type: Aspen - Birch - Basswood Forest
 Acres: 50.0
 Notes (author, survey year): (E. Perry, 2003): A few sugar maples are mixed in with the aspen (6-10" dbh), with even more in the understory.
 (D. Pomroy, 2019): A small stream bisects polygon; it's hilly, some steep areas at west end.
 Quality Rank: BC
 Non-native Species: 1
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 3

Cover Code: WFn64c
 Hartley Cover Name: Black Ash - Alder Swamp
 DNR Community Type: Black Ash - Alder Swamp (Northern)
 Acres: 1.4
 Notes (author, survey year): (D. Pomroy, 2019): Creek bisects polygon, with small depression/pool surrounded mainly with black ash. Some of polygon is on hillside.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 4

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 0.6
 Notes (author, survey year):
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 5

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood (Bluebead Lily) Forest
 Acres: 3.7
 Notes (author, survey year): (E. Perry, 2003): Half aspen and half mix of red oak, sugar maple, and basswood. 8-12" dbh. Lots of Carex cf. pennsylvanica, probably due to earthworms.
 Quality Rank: BC
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 6

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 1.1
 Notes (author, survey year): (E. Perry, 2003): Open canopy. Lots of bare ground due to earthworms.
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 7

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood (Bluebead Lily) Forest
 Acres: 3.4
 Notes (author, survey year):
 Quality Rank: D
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 8

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 2.3
 Notes (author, survey year):
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 9

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 0.5
 Notes (author, survey year): (E. Perry, 2003): Very heavy on the bluejoint grass.

Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 10

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 0.7
 Notes (author, survey year):
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 11

Cover Code: MHn35a
 Hartley Cover Name: Rich Aspen - Birch Forest
 DNR Community Type: Aspen - Birch - Basswood Forest
 Acres: 8.4
 Notes (author, survey year): (E. Perry, 2003): Aspen dominated canopy, but succeeding to maple. Heavy earthworm infestation in some spots, but also a highly diverse understory (especially near top of hill), including white baneberry, maidenhair fern, blue cohosh, wild leeks, and dwarf horsetail.
 (D. Pomroy, 2019): Hilly west end; large trees uprooted in blowdown.
 Quality Rank: BC
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 12 Deleted polygon, not included in map.

Polygon 13

Cover Code: C4a
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 3.1
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 14

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 1.3
 Notes (author, survey year): (E. Perry, 2003): Vegetation trampled by deer.
 Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 15

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 3.8
 Notes (author, survey year): (E. Perry, 2003): Aspen not succeeding to maple.
 (D. Pomroy, 2019): Some sugar maples in understory. Invasives are mostly buckthorn (*Rhamnus cathartica*). This area has some hope for improvement if invasives are eradicated soon, and bikes are not allowed here.

Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 16

Cover Code: MHn46b
 Hartley Cover Name: Wet-mesic Hardwood Forest
 DNR Community Type: Black Ash - Basswood Forest
 Acres: 1.1
 Notes (author, survey year): (E. Perry, 2003): This polygon is classified tentatively because Black Ash - Basswood Forest is normally found only south of Duluth. The canopy is fairly open. In addition to the native species listed in the community description there is some bittersweet nightshade and valerian in this polygon.

Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 17

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 1.9
 Notes (author, survey year): (D. Pomroy, 2019): Invasive plants here are buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*Frangula alnus*).

Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 18

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 13.5
 Notes (author, survey year): (E. Perry, 2003): At the east end along the trail is a very scrappy section (rank D) with very low tree canopy cover.

Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 19

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 2.9
 Notes (author, survey year): (E. Perry, 2003);
 (D. Pomroy, 2019):
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 20

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 3.2
 Notes (author, survey year): (D. Pomroy, 2019): Invasives include buckthorn (*Rhamnus cathartica*), and glossy buckthorn (*Frangula alnus*). Non-native honeyberry (*Lonicera caerulea* ssp. *edulis*) found here, may not be invasive.
 Quality Rank: D
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 21

Cover Code: C4b
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 2.6
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 22

Deleted polygon, not included in map.

Polygon 23

Cover Code: C4b
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 5.2
 Notes (author, survey year): (D. Pomroy, 2019): Buckthorn (*Rhamnus cathartica*) dominant in both canopy and understory. Many large diameter buckthorn.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 24

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 33.2

Notes (author, survey year): (E. Perry, 2003): Dominated by balsam poplar and black ash 6-8" dbh. The forest is pretty scrappy, with bittersweet nightshade. Along the creek there is jack-in-the-pulpit and wood nettle.
(D. Pomroy, 2019): Polygon includes some patches of cattail marsh and wet meadow, with many beaver-harvested ash and balsam poplar at SE end.

Quality Rank: CD

Non-native Species: 2

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 25

Cover Code: WFn55c

Hartley Cover Name: Black Ash Swamp

DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)

Acres: 0.9

Notes (author, survey year): (D. Pomroy, 2019): A small inclusion of sedges surrounded by black ash.

Quality Rank: D

Non-native Species: 3

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 26

Cover Code: WFn55a

Hartley Cover Name: Aspen - Black Ash Swamp

DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)

Acres: 3.9

Notes (author, survey year):

Quality Rank: D

Non-native Species: 3

Surveyed by: E. Perry, 2003.

Polygon 27

Cover Code: FPn73a

Hartley Cover Name: Alder Swamp

DNR Community Type: Alder Swamp

Acres: 1.3

Notes (author, survey year): (D. Pomroy, 2019): A few black ash in overstory and understory of dense shrubs

Quality Rank: C

Non-native Species: 2

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 28

Cover Code: MHn35a

Hartley Cover Name: Rich Aspen - Birch Forest

DNR Community Type: Aspen - Birch - Basswood Forest

Acres: 0.5

Notes (author, survey year): (D. Pomroy, 2019): Mature aspen; some aspen is broken off halfway up bole. Includes non-native honeyberry (*Lonicera caerulea* ssp. *edulis*) in SW corner of polygon.

Quality Rank: D

Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 29

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 17.9
 Notes (author, survey year): (E. Perry, 2003): Dominated by aspen, with some black ash. Dense shrub layer of glossy buckthorn and speckled alder, with a bit of hawthorn. Ground layer includes valerian, raspberry, smooth goldenrod, and dewberry.
 (D. Pomroy, 2019): Buckthorn (*Rhamnus cathartica*) seedlings are abundant on forest floor; non-native honeyberry (*Lonicera caerulea* ssp. *edulis* found here.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 30

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 2.1
 Notes (author, survey year): (E. Perry, 2003): Quality varies from BC in the southwest to D in the southeast. There is 70% canopy cover of black ash 6-14" dbh. The shrub layer is sparse in some places and 50% cover in other places. Speckled alder is dominant, with some glossy buckthorn and quite a bit of balsam fir. Ground layer includes ostrich fern, tall meadow rue, rough bedstraw, touch-me-not, marsh marigold, jack-in-the-pulpit, and bittersweet nightshade.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 31

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 3.1
 Notes (author, survey year): (E. Perry, 2003): Lots of bluejoint grass.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 32

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 1.1
 Notes (author, survey year): (D. Pomroy, 2019): Much blowdown, hard to travel. Suggest harvesting blown down trees.

Quality Rank: D
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 33

Cover Code: C1
 Hartley Cover Name: Conifer Plantation
 DNR Community Type: none
 Acres: 9.4
 Notes (author, survey year): (D. Pomroy, 2019): Red pine (*Pinus resinosa*) in canopy, glossy buckthorn in understory.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 34

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 8.7
 Notes (author, survey year): (D. Pomroy, 2019): Dominated by glossy buckthorn (*Frangula alnus*) and buckthorn (*Rhamnus cathartica*).
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 35

Cover Code: ROn12b
 Hartley Cover Name: Bedrock Outcrop
 DNR Community Type: Crystalline Bedrock Outcrop (Northern)
 Acres: 1.3
 Notes (author, survey year): (E. Perry, 2003): This polygon has been disturbed in the past and continues to receive heavy foot traffic, resulting in the near absence of the normally thick layer of lichens and in the dominance of non-native species in the crevices with enough soil to support herbaceous plants. These species include tansy, yarrow, timothy grass, and Canada bluegrass. Native species include ragweed, red-osier dogwood, and sumac.
 (D. Pomroy, 2019): Weedy! Invasives present include non-native honeysuckle (*Lonicera* spp.), glossy buckthorn, buckthorn, and tansy.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 36

Cover Code: C4b
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 10.8
 Notes (author, survey year): (D. Pomroy, 2019): Every vegetation layer is glossy buckthorn (*Frangula alnus*). Buckthorn (*Rhamnus cathartica*) also present.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 37

Cover Code: MHn35a
 Hartley Cover Name: Rich Aspen - Birch Forest
 DNR Community Type: Aspen - Birch - Basswood Forest
 Acres: 0.6
 Notes (author, survey year): (E. Perry, 2003): Canopy of aspen, subcanopy of Preston lilac and buckthorn, bare floor.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003.

Polygon 38

Cover Code: C4a
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 16.8
 Notes (author, survey year): (D. Pomroy, 2019): Uprooted aspens are leaning over trail to knob, and pose a hazard to hikers.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 39

Cover Code: C3
 Hartley Cover Name: Non-native Grassland
 DNR Community Type: none
 Acres: 1.6
 Notes (author, survey year): (D. Pomroy, 2019): Nearly 100% cover of reed canary grass (*Phalaris arundinacea*), mixed with Canada thistle (*Cirsium arvense*), tansy, and valerian.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 40

Cover Code: C4b
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 3.9
 Notes (author, survey year): (D. Pomroy, 2019): Dominated by Preston lilac (*Syringa X prestoniae*) and glossy buckthorn (*Frangula alnus*). Small trees planted, may not have survived.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 41

Cover Code: C2
 Hartley Cover Name: European Mountain-ash Forest
 DNR Community Type: none
 Acres: 1.3
 Notes (author, survey year): (D. Pomroy, 2019): There are a few yellow birch in canopy; understory has many European mountain ash seedlings, glossy buckthorn, tansy.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 42

Cover Code: MHn44a
 Hartley Cover Name: Aspen - Birch Forest
 DNR Community Type: Aspen - Birch - Red Maple Forest
 Acres: 4.4
 Notes (author, survey year): (D. Pomroy, 2019): Understory with buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), and Preston lilac (*Syringa X prestoniae*).
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 43

Cover Code: FPn73a
 Hartley Cover Name: Alder Swamp
 DNR Community Type: Alder Swamp
 Acres: 2.3
 Notes (author, survey year): (E. Perry, 2003): Mix of speckled alder and glossy buckthorn.
 (D. Pomroy, 2019): Many seedlings of European mountain ash (*Sorbus aucuparia*) here.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 44

Cover Code: MRn83a
 Hartley Cover Name: Cattail Marsh
 DNR Community Type: Cattail - Sedge Marsh (Northern)
 Acres: 1.1
 Notes (author, survey year): (D. Pomroy, 2019): Invasive narrowleaf cattail (*Typha angustifolia*) is dominant. Purple loosestrife, reed canary grass, and valerian are also present.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 45

Cover Code: FPn73a
 Hartley Cover Name: Alder Swamp
 DNR Community Type: Alder Swamp
 Acres: 3.0
 Notes (author, survey year): (D. Pomroy, 2019): Dense alder, sparse groundcover with deep water, and a mucky mat. Near outlet of creek with beaver channels.
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 46

Cover Code: LKi54
 Hartley Cover Name: Aquatic Vegetation
 DNR Community Type: Inland Lake Clay/Mud Shore
 Acres: 8.6
 Notes (author, survey year): (E. Perry, 2003): Healthy floating mat of pondweed.
 (D. Pomroy, 2019): Coontail (*Ceratophyllum demersum*) is the dominant plant, covers the entire polygon. No aquatic invasive plants seen. Very shallow and peaty or mucky, with several beaver-chewed logs in pond.
 Quality Rank: C
 Non-native Species: 1
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 47

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 3.9
 Notes (author, survey year):
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003.

Polygon 48

Cover Code: WMn82b1
 Hartley Cover Name: Wet Meadow
 DNR Community Type: Sedge Meadow, Bluejoint Subtype
 Acres: 7.0
 Notes (author, survey year): (E. Perry, 2003): Water is deeper in this bluejoint-dominated meadow than normal. There is a mudflat within the polygon that may be classified as Mud Flat (Inland Lake), LKi54b. Spike rushes are common in the mud flat.
 (D. Pomroy, 2019): Floating mat and muck; near beaver dam.
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 49

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 3.5
 Notes (author, survey year): (E. Perry, 2003): Young black ash (3-4" dbh) with some balsam poplar. Ground layer includes sedges, woodland horsetail, toothed wood fern, touch-me-not, yellow avens, smooth goldenrod, dewberry, and red-stemmed aster.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 50

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 6.6
 Notes (author, survey year):
 Quality Rank: D
 Non-native Species: 2
 Surveyed by: E. Perry, 2003.

Polygon 51

Cover Code: C1
 Hartley Cover Name: Conifer Plantation
 DNR Community Type: none
 Acres: 1.2
 Notes (author, survey year): (E. Perry, 2003);
 (D. Pomroy, 2019);
 Surveyed by: E. Perry, 2003.

Polygon 52

Cover Code: C4a
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 7.6
 Notes (author, survey year): (D. Pomroy, 2019): Invasive shrubs are glossy buckthorn (*Frangula alnus*) and buckthorn (*Rhamnus cathartica*).
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 53

Cover Code: MRn83a
 Hartley Cover Name: Cattail Marsh
 DNR Community Type: Cattail - Sedge Marsh (Northern)
 Acres: 0.6
 Notes (author, survey year): (E. Perry, 2003): Heavily dominated by narrow-leaved cattail, with some pondweed in deeper water.
 (D. Pomroy, 2019): Invasive narrowleaf cattail (*Typha angustifolia*) and purple loosestrife (*Lythrum salicaria*) are dominant.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 54

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 4.2

Notes (author, survey year): (D. Pomroy, 2019): Glossy buckthorn (*Frangula alnus*) is dominant in canopy and understory.

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 55

Cover Code: C1

Hartley Cover Name: Conifer Plantation

DNR Community Type: none

Acres: 11.8

Notes (author, survey year): (D. Pomroy, 2019): Red pine canopy with glossy buckthorn understory.

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 56

Cover Code: C3

Hartley Cover Name: Non-native Grassland

DNR Community Type: none

Acres: 1.4

Notes (author, survey year): (D. Pomroy, 2019): Wet meadow with non-native grasses (*Phalaris arundinacea* and *Bromus inermis*) and invasive tansy and Canada thistle dominant.

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 57

Cover Code: MHn46a

Hartley Cover Name: Aspen - Ash Forest

DNR Community Type: Aspen - Ash Forest

Acres: 7.3

Notes (author, survey year): (E. Perry, 2003): An intermittent stream runs through the polygon. Older willows, aspens, and balsam poplars make about 30% canopy cover. The shrub layer includes glossy buckthorn, willow, speckled alder, and young balsam poplar. The ground layer includes reed canary grass, valerian, tansy, and Canada thistle.

(D. Pomroy, 2019): Many invasives dominant; two butternut trees (*Juglans cinerea*), an endangered species in MN, were found here.

Quality Rank: D

Non-native Species: 3

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 58

Cover Code: MHn46a

Hartley Cover Name: Aspen - Ash Forest

DNR Community Type: Aspen - Ash Forest

Acres: 2.2

Notes (author, survey year): (E. Perry, 2003): Older willows, aspens, and balsam poplars make about 50% canopy cover.

(D. Pomroy, 2019): Many invasives are dominant, including glossy buckthorn, buckthorn, and tansy. Many aspen snags, some broken halfway up bole.

Quality Rank: D

Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 59

Cover Code: C8
 Hartley Cover Name: Building and Pavement
 DNR Community Type: none
 Acres: 5.0
 Notes (author, survey year): (D. Pomroy, 2019): Dominant invasives are Amur maple (*Acer ginnala*), tansy, reed canary grass (*Phalaris arundinacea*) and glossy buckthorn. Willow tree should be checked in spring to determine if *Salix nigra* or *Salix X rubens*.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 60

Cover Code: C3
 Hartley Cover Name: Non-native Grassland
 DNR Community Type: none
 Acres: 0.8
 Notes (author, survey year): (D. Pomroy, 2019): An “old field” almost all (90%) tansy (*Tanacetum vulgare*).
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 61

Cover Code: C6
 Hartley Cover Name: Open Water
 DNR Community Type: none
 Acres: 2.5
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 62

Cover Code: C4a
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 0.8
 Notes (author, survey year): (D. Pomroy, 2019): Glossy buckthorn and buckthorn common.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 63

Cover Code: C9
 Hartley Cover Name: Dam and Packed Gravel
 DNR Community Type: none
 Acres: 2.0
 Notes (author, survey year): (D. Pomroy, 2019): Invasives include Preston lilac (*Syringa X prestoniae*), glossy buckthorn, and buckthorn.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 64

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 0.5
 Notes (author, survey year): (D. Pomroy, 2019): Invasives include glossy buckthorn and Preston lilac (*Syringa X prestoniae*). Polygon includes some mixed forest, planted red pine.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 65.1

Cover Code: WMn82b1
 Hartley Cover Name: Wet Meadow
 DNR Community Type: Sedge Meadow, Bluejoint Subtype
 Acres: 1.7
 Notes (author, survey year): (E. Perry, 2003): Quite a bit of reed canary grass and valerian mixed in with the bluejoint grass
 (D. Pomroy, 2019): Basin with stream bisecting polygon. Two species of exotic honeysuckles (*Lonicera* spp.) seen.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 65.2

Cover Code: WMn82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 0.7
 Notes (author, survey year): (D. Pomroy, 2019): Alders, willows, and glossy buckthorn. This polygon split from 65.1 because of dense shrubs with greater than 25% cover.
 Quality Rank: D
 Non-native Species: 2
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 66

Cover Code: MHn35a
 Hartley Cover Name: Rich Aspen - Birch Forest
 DNR Community Type: Aspen - Birch - Basswood Forest
 Acres: 0.7
 Notes (author, survey year): (E. Perry, 2003): Aspen and birch 8-10" dbh with some maples. Shrub layer is dense with young aspen, choke cherry, red-osier dogwood, round-leaved dogwood, Canada honeysuckle, and some balsam fir. There is also Tartarian honeysuckle and glossy buckthorn. The ground layer includes sensitive fern, swamp red currant, bunchberry, baneberry, shinleaf, interrupted fern, lady fern, valerian, and bittersweet nightshade. There is virtually no leaf litter.
 (D. Pomroy, 2019): Abundant sugar maple seedlings. Very few basswood trees. Invasives include Eurasian honeysuckle, glossy buckthorn, buckthorn, and valerian.
 Quality Rank: D

Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 67.1

Cover Code: WMn82b1
 Hartley Cover Name: Wet Meadow
 DNR Community Type: Sedge Meadow, Bluejoint Subtype
 Acres: 0.6
 Notes (author, survey year): (D. Pomroy, 2019): This polygon split from 67.2 because canopy is more open; this polygon could be combined with adjacent 65.1 into a single polygon. Non-native species of spruce (*Picea*) seedlings were planted here.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 67.2

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 2.3
 Notes (author, survey year): (E. Perry, 2003): 20% tree cover along creek of black ash, willow, and balsam poplar. Dense shrub layer of speckled alder and glossy buckthorn. The ground layer includes valerian, tansy, and forget-me-not. (D. Pomroy, 2019): Stream bisects polygon.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 68

Cover Code: WMn82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 0.5
 Notes (author, survey year): (E. Perry, 2003): Very high quality, but weeds encroach from adjacent mowed trail. Clustered bur-reed (*Sparganium glomeratum*) found here. (D. Pomroy, 2019): Appears to be deeper water than usual, water is more than knee-deep. Dead standing black ash. Some glossy buckthorn present.
 Quality Rank: B
 Non-native Species: 1
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 69

Cover Code: C7
 Hartley Cover Name: Ballpark
 DNR Community Type: none
 Acres: 8.8
 Notes (author, survey year): (D. Pomroy, 2019): Many non-native species, including dame's rocket (*Hesperis matronalis*) abundant in floodplain, tansy (*Tanacetum vulgare*), Japanese

Surveyed by: knotweed (*Fallopia japonica* var. *japonica*), Japanese tree lilac (*Syringa reticulata*), and reed canary grass (*Phalaris arundinacea*).
E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 70

Cover Code: C5
Hartley Cover Name: Wetland Non-native Shrubland
DNR Community Type: none
Acres: 2.0
Notes (author, survey year): (D. Pomroy, 2019): Almost entirely glossy buckthorn.
Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 71

Cover Code: C1
Hartley Cover Name: Conifer Plantation
DNR Community Type: none
Acres: 12.9
Notes (author, survey year): (D. Pomroy, 2019): Red pine is most dominant, jack pine and white pine also present. Thicket of glossy buckthorn, two species of Eurasian honeysuckle, and Preston lilac (*Syringa X prestoniae*) also present.
Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 72

Cover Code: MHn46a
Hartley Cover Name: Aspen - Ash Forest
DNR Community Type: Aspen - Ash Forest
Acres: 2.5
Notes (author, survey year): (E. Perry, 2003): Aspens are about 12" dbh. The dense shrub layer includes choke cherry, red-osier dogwood, elderberry, Canada honeysuckle, beaked hazel, and lots of glossy buckthorn. There is some open dogwood swamp with scattered aspen trees. There is also a vernal pool surrounded by balsam poplar (12" dbh), aspen, black ash, and boxelder. At the east end in some disturbed soil is exotic lilac.
(D. Pomroy, 2019): Exotic Preston lilac (*Syringa X prestoniae*) appears invasive here. Norway spruce (*Abies picea*) cone found here.
Quality Rank: D
Non-native Species: 3
Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 73

Cover Code: FDn43a
Hartley Cover Name: White Pine Forest
DNR Community Type: White Pine - Red Pine Forest
Acres: 1.2
Notes (author, survey year): (E. Perry, 2003): Dominated by paper birch and white pine (about 12" dbh) with some red oak, red maple, sugar maple, quaking aspen and big-toothed aspen. There is an understory of white spruce, balsam fir, beaked hazel, bush honeysuckle, and mountain maple. There is non-native bluegrass and hawkweed in the ground layer.

Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 74

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 2.5
 Notes (author, survey year): (E. Perry, 2003): A mix of red oak, sugar maple, and aspen. A few trees are older, but most are young. There is some buckthorn, and a heavy infestation of earthworms.

Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 75

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 2.0
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 76

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 1.6
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 77

Cover Code: C1
 Hartley Cover Name: Conifer Plantation
 DNR Community Type: none
 Acres: 13.1
 Notes (author, survey year): (D. Pomroy, 2019): Polygon includes root cellar, pollinator garden, and large patch of Preston lilac (*Syringa X prestoniae*) forming tunnel over old Hartley trail. Glossy buckthorn and buckthorn in understory. Invasive goutweed (*Aegopodium podagraria*) near root cellar.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 78

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 2.3

Notes (author, survey year): (E. Perry, 2003): Dominated by paper birch (about 12" dbh) with some red oak, sugar maple, red maple, and big-toothed aspen. An open shrub layer includes beaked hazel, bush honeysuckle, mountain maple, and a bit of white spruce and balsam fir. There is also some common buckthorn. Also a polygon of disturbed soil on top of the hill. Leaf litter is thin (suggesting invasive earthworms).

Quality Rank: C

Non-native Species: 1

Surveyed by: E. Perry, 2003.

Polygon 79

Cover Code: ROn23a

Hartley Cover Name: Bedrock Shrubland

DNR Community Type: Bedrock Shrubland (Inland)

Acres: 0.3

Notes (author, survey year): (E. Perry, 2003): This polygon contains a small Crystalline Bedrock Outcrop in the center and grades into the surrounding Aspen - Birch Woodland. The open center contains rusty woodsia fern and thimbleweed but is dominated by non-native herbaceous species such as tansy and Canada bluegrass. The surrounding shrubland is higher quality, including junberry and sumac, but also the non-native Tartarian honeysuckle. There are a few red oaks and white pines. The open rock outcrop in the center of the polygon is lower quality (D). (D. Pomroy, 2019): Ravine between outcrops mostly oak; many non-native grasses.

Quality Rank: C

Non-native Species: 2

Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 80

Cover Code: C1

Hartley Cover Name: Conifer Plantation

DNR Community Type: none

Acres: 0.3

Notes (author, survey year):

Surveyed by: E. Perry, 2003.

Polygon 81

Cover Code: MHn47a

Hartley Cover Name: Rich Northern Hardwood Forest

DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest

Acres: 21.6

Notes (author, survey year): (E. Perry, 2003): A variable polygon. The highest quality portions (B rank) are below (east and south of) the rock outcrop (polygon 79). In addition, what may be the city's healthiest stand of Canada yew lies north of the outcrop. One stand of red oaks east of the outcrop averages about 20" dbh, but overall the average size is about 12". Sugar maples and red oaks are the dominant trees, with lesser amounts of quaking aspen, paper birch, yellow birch, basswood, and black ash. Common understory species include ironwood, beaked hazel, mountain maple, choke cherry, Canada honeysuckle, and a bit of white spruce and balsam fir. Unusual species include white baneberry, trout lily, and

leatherwood. Past soil disturbance includes old road beds. Yard waste has been dumped along Fairmont Ave. There is lots of exotic bluegrass in the south, which may be due to past grazing. Earthworm damage is variable, with heavier damage often associated with bittersweet nightshade. Along Tischer Creek trees are younger (about 8" dbh), and there are willow trees and some dense glossy buckthorn and exotic lilac. Aspens predominate in the southeast corner. (D. Pomroy, 2019): Erosion along stream. Large white pine tipped. Huge patch of non-native lily-of-the-valley (*Convallaria majalis*) near Fairmont Ave. path.

Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 82

Cover Code: FDn33b
 Hartley Cover Name: Bedrock Woodland
 DNR Community Type: Aspen - Birch Woodland
 Acres: 1.0
 Notes (author, survey year): (E. Perry, 2003): Among the shrubs present is prairie willow (*Salix humilis*). (D. Pomroy, 2019): Rock outcrop on cliff face. A few glossy buckthorn present.
 Quality Rank: B
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 83

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 4.3
 Notes (author, survey year): (E. Perry, 2003): Mixed quaking aspen, red oak, and sugar maple.
 Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 84

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 9.9
 Notes (author, survey year): (E. Perry, 2003): Predominantly red oak with a dense ground layer of bush honeysuckle. There is only a bit of buckthorn.

Quality Rank: BC
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 85

Cover Code: C1
 Hartley Cover Name: Conifer Plantation
 DNR Community Type: none
 Acres: 2.1
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 86

Cover Code: WMn82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 19.7
 Notes (author, survey year): (D. Pomroy, 2019): Many small streams through muck; includes glossy buckthorn.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 87

Cover Code: FDn33b
 Hartley Cover Name: Bedrock Woodland
 DNR Community Type: Aspen - Birch Woodland
 Acres: 0.5
 Notes (author, survey year): (E. Perry, 2003): Stunted red oak with small aspen and a few white spruce. Dense beaked hazel and bush honeysuckle and lots of bluejoint grass.
 (D. Pomroy, 2019): Small outcrops, more than 40% cover of trees.
 Quality Rank: BC
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 88

Cover Code: C1
 Hartley Cover Name: Conifer Plantation
 DNR Community Type: none
 Acres: 0.8
 Notes (author, survey year): (D. Pomroy, 2019): Jack pine mixed with some birch and aspen.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 89

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 7.3
 Notes (author, survey year): (D. Pomroy, 2019): Glossy buckthorn, alder, willow, and buckthorn.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 90

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 6.7
 Notes (author, survey year): (E. Perry, 2003): Quaking aspen (8-10" dbh) with some red oak hear the hill in the east. Young sugar maple and basswood show that the forest is succeeding to northern hardwoods. Dense shrub layer of beaked hazel, red-osier dogwood, and glossy buckthorn.
 Quality Rank: CD
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 91

Cover Code: FDn43a
 Hartley Cover Name: White Pine Forest
 DNR Community Type: White Pine - Red Pine Forest
 Acres: 4.8
 Notes (author, survey year): (E. Perry, 2003): This polygon is actually a transition between the true pine forest of polygon 112 and the mesic hardwood to the north. The total forest canopy is fairly open (about 70% due to aspen treefalls), and white pine makes up about 25% (12-18" dbh). Other trees include red maple, paper birch, quaking aspen, white cedar, red oak, sugar maple, and balsam fir. The polygon also grades into the wetland forest in the west, where it includes black ash and yellow birch. The dense shrub layer (about 50% cover) includes beaked hazel, Canada honeysuckle, mountain maple, and young aspen. The ground layer includes bush honeysuckle, bracken, large-leaved aster, baneberry, nodding trillium, sarsaparilla, and Canada mayflower.
 (D. Pomroy, 2019): Several red pine broken halfway up bole. Invasives include Japanese knotweed (*Fallopia japonica* var. *japonica*), goutweed (*Aegopodium podagraria*), and lily-of-the-valley (*Convallaria majalis*).
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 92

Cover Code: FDn33b
 Hartley Cover Name: Bedrock Woodland
 DNR Community Type: Aspen - Birch Woodland
 Acres: 0.4
 Notes (author, survey year): (E. Perry, 2003): Lots of bluejoint grass.
 (D. Pomroy, 2019): Stunted trees, exposed bedrock in a few places. Invasive shrubs include glossy buckthorn and Eurasian honeysuckle.
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 93

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 16.6
 Notes (author, survey year): (E. Perry, 2003): Lots of non-native bluegrass.
 (D. Pomroy, 2019): Exposed bedrock with stunted trees on upper reaches; trees broken off halfway up bole. Invasives include buckthorn and glossy buckthorn.
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 94

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 1.1
 Notes (author, survey year): (E. Perry, 2003): This polygon was difficult to classify because of its heavy component of balsam fir, along with the dominant black ash. Wood nettle along the creek.
 (D. Pomroy, 2019): Stream runs through polygon. Invasives include glossy buckthorn and buckthorn.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 95

Cover Code: WFn55c
 Hartley Cover Name: Black Ash Swamp
 DNR Community Type: Black Ash - Mountain Maple Swamp (Northern)
 Acres: 0.6
 Notes (author, survey year):
 Quality Rank: BC
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 96

Cover Code: C4a
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 0.9
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 97

Cover Code: FDn43b1
 Hartley Cover Name: Mixed Hardwood - Conifer Forest
 DNR Community Type: Aspen - Birch Forest, Balsam Fir Subtype

Acres: 10.3
 Notes (author, survey year): (E. Perry, 2003): This is a typical mixed white spruce, balsam fir, quaking aspen, paper birch forest - with some red maple, sugar maple, yellow birch, black ash, white cedar and white pine mixed in. There are fewer conifers in the western part.
 (D. Pomroy, 2019): Invasives include abundant honeyberry (*Lonicera caerulea* ssp. *edulis*), as well as glossy buckthorn and buckthorn.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 98

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 1.1
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 99

Cover Code: MRn83a
 Hartley Cover Name: Cattail Marsh
 DNR Community Type: Cattail - Sedge Marsh (Northern)
 Acres: 2.8
 Notes (author, survey year):
 Quality Rank: C
 Non-native Species: ?
 Surveyed by: E. Perry, 2003.

Polygon 100

Cover Code: C4a
 Hartley Cover Name: Upland Non-native Shrubland
 DNR Community Type: none
 Acres: 1.3
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 101

Cover Code: FDn43b
 Hartley Cover Name: Mixed Hardwood - Conifer Forest
 DNR Community Type: Aspen - Birch Forest
 Acres: 6.0
 Notes (author, survey year): (E. Perry, 2003): Like polygon 97, but more dominated by quaking aspen.
 Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 102

Cover Code: WFn64a
 Hartley Cover Name: Black Ash - Conifer Swamp
 DNR Community Type: Black Ash - Conifer Swamp (Northeastern)
 Acres: 1.3
 Notes (author, survey year): (E. Perry, 2003): Young (4-6" dbh), but very nice quality. This polygon is the single example of this type at Hartley; it has an uneven floor, with dry hummocks rising above pools of water (covering approximately half the area). Black ash and white cedar are co-dominant, with a few yellow birches mixed in. The sparse shrub layer includes speckled alder, along with young black ash and balsam fir. The herbaceous layer on the hummocks includes goldthread, oak fern, bluebead lily, and Canada mayflower. There is a bit of bittersweet nightshade.
 (D. Pomroy, 2019): Invasives include buckthorn and glossy buckthorn.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 103

Cover Code: C3
 Hartley Cover Name: Non-native Grassland
 DNR Community Type: none
 Acres: 0.8
 Notes (author, survey year): (D. Pomroy, 2019): Appears similar to an old field. Invasives include buckthorn, glossy buckthorn, tansy, and valerian.
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 104

Cover Code: WMn82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 2.1
 Notes (author, survey year): (E. Perry, 2003): This portion of the wet meadow has grown up with shrubs.
 Quality Rank: BC
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 105

Cover Code: C5
 Hartley Cover Name: Wetland Non-native Shrubland
 DNR Community Type: none
 Acres: 5.7
 Notes (author, survey year):
 Surveyed by: E. Perry, 2003.

Polygon 106

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest

Acres: 5.4
 Notes (author, survey year): (E. Perry, 2003): Dominated by sugar maple and paper birch ranging from 4 to 10" dbh.
 (D. Pomroy, 2019): Birch snags, uprooted aspen and birch. Invasives include buckthorn and glossy buckthorn.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 107

Cover Code: WFn55a
 Hartley Cover Name: Aspen - Black Ash Swamp
 DNR Community Type: Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)
 Acres: 2.7
 Notes (author, survey year): (E. Perry, 2003): Dominated by black ash, paper birch, and quaking aspen (3-12" dbh), with quite a bit of white spruce and balsam fir mixed in.
 Quality Rank: C
 Non-native Species: 1
 Surveyed by: E. Perry, 2003.

Polygon 108

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 31.4
 Notes (author, survey year): (E. Perry, 2003): Understory is disturbed, but white baneberry was found.
 (D. Pomroy, 2019): Subcanopy of glossy buckthorn; other invasives include buckthorn, honeyberry (*Lonicera caerulea* ssp. *edulis*), and Eurasian honeysuckle (*Lonicera* sp.) Many aspen are broken halfway up bole. Evidence of fire on tree trunks.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 109

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 24.8
 Notes (author, survey year): (E. Perry, 2003): Very dense glossy buckthorn in many areas, but also beaked hazel and choke cherry. At the south end a few white pines are mixed in with the 10-12" dbh aspens and birches.
 (D. Pomroy, 2019): White pines ovetopping aspen and birch in some areas.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 110

Cover Code: WFn55b
 Hartley Cover Name: Black Ash - Hardwood Swamp
 DNR Community Type: Black Ash - Yellow Birch - Red Maple - Basswood Swamp (Eastcentral)
 Acres: 4.1
 Notes (author, survey year): (E. Perry, 2003): Quaking aspen (averaging 12" dbh) and black ash (averaging 4-6" dbh) are dominant, with some white pine, balsam fir, and white spruce mixed in. Dense glossy buckthorn, choke cherry, beaked hazel, round-leaved dogwood, and red-osier dogwood. There is valerian in the understory.
 (D. Pomroy, 2019): An abundance of invasives, including buckthorn, glossy buckthorn, Amur maple (*Acer ginnala*), Eurasian honeysuckle (*Lonicera* sp.).

Quality Rank: CD
 Non-native Species: 3
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 111

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 22.7
 Notes (author, survey year): (E. Perry, 2003): Red oak 12-18" dbh is dominant, along with quaking aspen, paper birch, basswood, and sugar maple (especially young sugar maple). There is a subcanopy of ironwood, along with beaked hazel and mountain maple. Ground layer includes a bit of spikenard.
 (D. Pomroy, 2019): Steep slopes; invasives include glossy buckthorn and buckthorn.

Quality Rank: BC
 Non-native Species: 1
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 112

Cover Code: FDn43a
 Hartley Cover Name: White Pine Forest
 DNR Community Type: White Pine - Red Pine Forest
 Acres: 1.7
 Notes (author, survey year): (E. Perry, 2003): Large white pines make up about 30% canopy cover, while white cedar, quaking aspen, paper birch, yellow birch, and balsam fir makes up the rest. Canada yew grows in the gorge along the creek, but in general the shrub and herbaceous layers are sparse. A rock outcrop contains a lot of glossy buckthorn. There is also a vernal pool.
 (D. Pomroy, 2019): Invasives include glossy buckthorn, buckthorn, Canada thistle (*Cirsium arvense*), and tansy.

Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 113

Cover Code: WMn82b1
 Hartley Cover Name: Wet Meadow
 DNR Community Type: Sedge Meadow, Bluejoint Subtype
 Acres: 42.6
 Notes (author, survey year): (E. Perry, 2003): Dominated by bluejoint grass, but there is a diversity of sedges and wildflowers, including joe-pye-weed and common skullcap. Considering that this was once a vegetable field, the quality of this meadow is shocking. Perhaps flooding by beavers in the past helped restore it. Surprisingly, there is none of the non-native reed canary grass.
 (D. Pomroy, 2019): Dominated by bluejoint grass, with scattered willows.
 Quality Rank: B
 Non-native Species: 1
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 114

Cover Code: MHn47a
 Hartley Cover Name: Rich Northern Hardwood Forest
 DNR Community Type: Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 7.4
 Notes (author, survey year): (E. Perry, 2003): The forest is relatively young (4-10" dbh) and dominated by red oak, basswood, and sugar maple, with some yellow birch and black ash. There is an inclusion of *Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest*. The forest is pretty scrappy in places, with quite a bit of aspen in the understory, some dumping of rubble, soil movement of some sort, and heavy earthworm infestation. There is some white baneberry in addition to wild leeks, lady fern, and thimbleberry. Shrubs are sparse.
 (D. Pomroy, 2019): Some sugar maple and aspen trees are broken halfway up bole; and a large aspen is uprooted and leaning down. Invasives include buckthorn, glossy buckthorn, Japanese barberry (*Berberis thunbergii*), and lily-of-the-valley (*Convallaria majalis*).
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: E. Perry, 2003; D. Pomroy & R. Barnes, 2019.

Polygon 201

Cover Code: MHn35b
 Hartley Cover Name: Northern Hardwood Forest
 DNR Community Type: Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest
 Acres: 12.8
 Notes (author, survey year): (D. Pomroy, 2019): Polygon on east side of Woodland Ave. with highest point locally. Predominantly sugar maple with basswood and a few overtopping red pine. Invasives include glossy buckthorn, buckthorn, valerian, and tansy. Includes small rhyolite outcrop.
 Quality Rank: CD
 Non-native Species: 2
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 202

Cover Code: ROn12b
 Hartley Cover Name: Bedrock Outcrop
 DNR Community Type: Crystalline Bedrock Outcrop (Northern)
 Acres: 0.1
 Notes (author, survey year): (D. Pomroy, 2019): Large rhyolite outcrop.
 Quality Rank: C
 Non-native Species: 2
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 203

Cover Code: MHn46a
 Hartley Cover Name: Aspen - Ash Forest
 DNR Community Type: Aspen - Ash Forest
 Acres: 13.6
 Notes (author, survey year): (D. Pomroy, 2019): Mostly trembling aspen, paper birch, and balsam poplar, with some willows, box elder, and one butternut (*Juglans cinerea*), an endangered species in MN. The area has mudholes with standing water. A few red pine and norway spruce at high spot along old road look to be planted in rows. Invasives include glossy buckthorn, buckthorn, tansy, and valerian. High density of non-natives.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 204

Cover Code: WMn82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 6.0
 Notes (author, survey year): (D. Pomroy, 2019): Drainage ditch extends south from Northfield St. along west side of polygon, with an underground pipeline. Standing water in much of this area. Dense cover, dominated by glossy buckthorn (*Frangula alnus*) with willows and speckled alder; likely once an alder swamp.
 Quality Rank: D
 Non-native Species: 3
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 205

Cover Code: FPn73a
 Hartley Cover Name: Alder Swamp
 DNR Community Type: Alder Swamp
 Acres: 2.0
 Notes (author, survey year): (D. Pomroy, 2019): Dominated by alder and glossy buckthorn, with a few black ash. Very weedy with glossy buckthorn, buckthorn, honeyberry (*Lonicera caerulea* ssp. *edulis*), and reed canary grass; this could almost be called a non-native dominated shrubland.
 Quality Rank: D

Non-native Species: 3
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 206

Cover Code: C3
 Hartley Cover Name: Non-native Grassland
 DNR Community Type: none
 Acres: 5.7
 Notes (author, survey year): (D. Pomroy, 2019): Large invasive Japanese knotweed (*Fallopia japonica* var. *japonica*) found near north edge of this polygon.
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 207

Cover Code: C6
 Hartley Cover Name: Open Water
 DNR Community Type: none
 Acres: 0.1
 Notes (author, survey year):
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 208

Cover Code: WMn82a
 Hartley Cover Name: Willow Swamp
 DNR Community Type: Willow - Dogwood Shrub Swamp
 Acres: 1.7
 Notes (author, survey year): (D. Pomroy, 2019): Observed from distance
 Quality Rank: ?
 Non-native Species: ?
 Surveyed by: Not surveyed; interpreted from imagery.

Polygon 209

Cover Code: MHn46a
 Hartley Cover Name: Aspen - Ash Forest
 DNR Community Type: Aspen - Ash Forest
 Acres: 9.2
 Notes (author, survey year): (D. Pomroy, 2019): Many broken or blown down trees.
 Quality Rank: D
 Non-native Species: 2
 Surveyed by: D. Pomroy & R. Barnes, 2019.

Polygon 210

Cover Code: WMn82b
 Hartley Cover Name: Wet Meadow
 DNR Community Type: Sedge Meadow
 Acres: 0.6
 Notes (author, survey year):
 Quality Rank: ?
 Non-native Species: ?
 Surveyed by: Not surveyed; interpreted from imagery.

Appendix 3: Non-native plants noted in 2019 (sorted by frequency)

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

Scientific name	Common name	# polygons
<i>Verbascum thapsis</i>	common mullein	2
<i>Acer platanoides</i>	Norway maple	1
<i>Hemerocallis fulva</i>	orange daylily	1
<i>Sorbaria sorbifolia</i>	false spiraea	1
<i>Syringa reticulata</i>	Amur lilac	1



Appendix C

History of Eastern White Pine (*Pinus strobus*) at Hartley Park, Duluth



History of eastern white pine (*Pinus strobus*) at Hartley Park, Duluth

Andrew David, University of Minnesota

September 2019

The eastern white pine in Hartley Park are of unknown origin and were planted by the Hartley family, or at their direction. The exact reasons for planting these trees is unknown to us but the timeframe of the planting suggests the Hartley family was concerned about the loss of the original forest and recognized the ecological and economic values that a healthy forest would provide.

These trees tell an interesting story about forest history since the mid-1850s. This history weaves tales of early logging, forest reclamation, soil stabilization, European nurseries, exotic diseases and forest genetics research into a rich tapestry that is the experience of the land.

Loggers came to the north shore of Lake Superior in search of tall pines, particularly eastern white pine (*Pinus strobus*), and the area around Duluth provided an ample supply. In a short time, the loss of forest cover resulted in erosion and river siltation leading to the recognition that intact forests provide more than building materials. Planting seedlings was deemed to be an excellent way to re-establish the forest but there was little nursery capacity for growing tree seedlings in North America. Instead, seed was collected here and sent to Europe where the seedlings were grown before being shipped back to North America to be planted as the next generation of forests. Unfortunately, at about the same time that Europe's nurseries were growing these seedlings, white pine blister rust, a fungal disease from Eurasia, was moving westward into Europe. Eastern white pine seedlings are incredibly susceptible to white pine blister rust and the seedlings grown in European nurseries became infected before they were shipped to North America. Once the seedlings were planted here the non-native disease spread quickly attacking wild seedlings, uninfected planted seedlings and smaller trees often killing them in 3-5 years. Older trees, left over from logging operations, were susceptible too but tended to lose branches to the disease or took much longer to die.

Often there is hope in the face of uncertainty and with eastern white pine an occasional planted or wild tree would appear uninfected. Forest researchers began to look for these 'resistant trees' in the hope that they were immune to the disease or had a higher level of resistance than an average tree. In the short run, seed from these resistant trees could be planted to increase the level of disease resistance locally. In the long run, these trees could be used in a breeding program with other resistant trees to create seedlings with resistance greater than their parents. From the 1940s through the 1970s Dr. Robert Patton at the University of Wisconsin, Madison had a research program devoted to improving the rust resistance of eastern white pine in the upper Great Lakes region. In the course of his travels he surveyed the eastern white pine at

Hartley Park and made several selections. One of them, P327, became his most famous selection. When he retired, he donated his selections and research results to the U.S.D.A. Forest Service, Oconto River Seed Orchard near Langlade, Wisconsin. As the demand for improved rust resistant eastern white pine seed increased additional seed orchards were established by industry, county and state organizations in Minnesota and Wisconsin. These seed orchards contain grafts of several genotypes originally selected from Hartley Park including P327.

In the years since Dr. Patton's pioneering work researchers have discovered trees that have higher levels of resistance than P327 but have not found an eastern white pine that is immune to white pine blister rust. Despite this P327 is still relevant as it is often the benchmark, or control, by which other trees are measured and it continues to be a part of seed orchards and breeding programs in the upper Great Lakes region.



Appendix D

Potential Costs to Address Hartley Pond and Tischer Creek



Technical Memorandum

To: Gini Breidenbach, Minnesota Land Trust
From: Jessica Olson, PE
Subject: Hartley Pond – Tischer Creek Draft Feasibility Study and Alternative Cost Estimates
Date: September 23, 2019
Project: Potential Costs to Address Hartley Pond and Tischer Creek, for the Hartley Natural Area Management Plan
c: Project Files

Introduction

In July 2019, Minnesota Land Trust contacted Barr Engineering to request assistance in developing estimated costs associated with a Feasibility Study and three potential future configurations of Hartley Pond and Tischer Creek, as called for in the 2014 Hartley Park Master Plan (Plan). The purpose of these cost estimates is to support the development of the Hartley Natural Area Management Plan for the City of Duluth Natural Areas Program. This document will become part of the Hartley Natural Area Management Plan and will be included the review process associated with that plan.

The cost estimates presented in this document will be used to seek funding for the Feasibility Study and for improvements to Tischer Creek and Hartley Pond. The alternatives presented are intended to represent a range of potential options that could be considered for concept planning purposes only. The Plan indicates that a feasibility study of restoration alternatives must be conducted, reviewed, and approved by the Parks and Recreation Commission before any commitments are made or funds expended on any study recommendations. The Plan states the following:

“The primary goal of the water resource recommendations is to preserve and increase the historical, recreational, ecological, educational and aesthetic value of Tischer Creek and Hartley Pond.” It also states that the City will “commission an objective, scientific feasibility study to assess the preservation of Hartley Pond and the restoration of Tischer Creek.” Additionally, “Results of the study will be open to public review and approval of the Parks Commission before any steps are taken to implement the study’s recommendations.” (Hartley Park Master Plan, p. 33, 2014)

The Plan also notes that, “There is currently a dam at the eastern edge of Hartley Pond. Tischer Creek is a DNR designated trout stream that flows through the Park, but nearly one mile of fish habitat is compromised by warm water flowing over the dam.” (Hartley Park Master Plan, p. 15, 2014) and that one of the threats to the Park’s ecological importance and recreation value is, “The dam on Tischer Creek, which impairs riparian and fish habitat on nearly one mile of Tischer Creek, a DNR-designated trout stream.” (Hartley Park Master Plan, p. 20, 2014)

Evaluation of the potential alternatives for Hartley Pond and Tischer Creek must include potential water quality and habitat improvements of the cold water trout stream, as well as recreational values of the pond and stream. In addition, it is essential that each alternative is analyzed to determine impacts to homes, property and infrastructure along Tischer Creek, downstream of Hartley Pond. A reduction in retention area upstream of the dam and/or alteration of the outflow structure of the pond could significantly impact the flooding risk downstream of Hartley Pond. It is imperative that the feasibility study consider these possible human safety impacts and define the process of selecting a preferred alternative.

Stream and Pond Alternatives

Alternatives included in this memo represent a range of possibilities for the site and should be used for high-level conceptual planning purposes only. Costs will change with further design. The estimated accuracy range for the alternative costs presented here (Class 4 per ASTM E 2516-11) are -20% to +30%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The accuracy range is not intended to include costs for future scope changes. Operation and Maintenance costs are not included. Engineering costs are assumed to be 15% of the construction costs. Permitting costs, including costs related to any potential wetland mitigation, are not included in estimates. Uncertainties include (but are not limited to): pond/stream bathymetry, sediment/soil characteristics and contaminant level, wetland impacts, and groundwater interaction. Assumptions for each alternative are noted in the descriptions below.

Alternative A – Remove dam and establish new stream channel - \$870K to \$1.4M

This alternative includes removing the existing dam (earthen structure and concrete weir) and accumulated sediment from the pond area. A new channel would be excavated through the former ponded area and the surrounding area would be graded to allow for floodplain connectivity. The new channel would tie in with the existing creek upstream and downstream of the pond. All disturbed ground would be stabilized with seeding and plantings, as well as erosion control blanket. It is assumed that excavated material can be re-used on site or disposed of at a nearby city-owned property.

Alternative B – Install a cool-water intake and discharge from Hartley Pond - \$320K to \$525K

This alternative includes removing accumulated sediment from the creek and/or pond to a depth that allows for placement and maintenance of a cold-water inlet structure. Cool water would flow in to a deep-water intake pipe upstream of the dam, then be routed via pipe to Tischer Creek, downstream of the existing dam structure. All disturbed ground would be stabilized with seeding and plantings, as well as erosion control blanket. This concept-level cost includes an assumption that approximately 8,000 cubic yards of material will be dredged and trucked to a nearby City-owned property, and that no contaminants are present in the dredged material.

Alternative C – Divert Tischer Creek around Hartley Pond - \$720K to \$1.2M

This alternative includes constructing an earthen berm along the pond's edge (and/or through a portion of the pond) and excavating a new channel adjacent to the berm that would tie in with the existing creek upstream and downstream of the pond. The area surrounding the channel would be graded to allow for floodplain connectivity. Removal of accumulated sediment from the pond area could be a component of this alternative, but is not included in the cost estimate assumptions. A high-flow overflow at the upstream end of the new channel into the pond could also be a component of this alternative. All disturbed ground would be stabilized with seeding and plantings, as well as erosion control blanket. It is assumed that excavated material can be re-used on site or disposed of at a nearby city-owned property.

Alternative D – Convert Hartley Dam into rock arch rapids and install cold-water intake/discharge from Hartley Pond - \$515K to \$770K

This alternative includes placing a series of rock arch rapids to replace the dam structure. The alternative assumes maintaining the existing dam in its current location and incorporating it into the new rapids. Accumulated sediment would be removed from the pond area; this concept-level cost assumes a removal of 8,000 cubic yards, which could be significantly higher or lower, depending on the bathymetry of the pond. The rock arch rapids could be shaped and sized as needed to meet design goals and objectives. This cost estimate assumes a 330-ft long rapids. The new rapids would tie in with the existing creek downstream of the pond. A cold-water intake would be incorporated to help reduce temperatures in Tischer Creek downstream of the dam. All disturbed ground would be stabilized with seeding and plantings, as well as erosion control blanket.

Feasibility Study

The Feasibility Study will include several components to determine the most appropriate course of action to address preservation and restoration goals and objectives, as developed by the City of Duluth and its partners. Estimated total cost for the feasibility study is \$79,000. Total cost for feasibility study would be reduced if number of alternatives is reduced. Components will include:

Project Evaluation - \$16,000

- Develop goals and objective statements for MNDNR and City review
- Kickoff meeting with project partners
- Review existing pond, stream and park data
 - Review available GIS information including LiDAR data
 - Review existing dam plans, reports, etc.
 - Review SWCD plans for cold-water tributary to Tischer Creek
 - Review information provided by partners (Hartley Nature Center, Lake Superior Coldwater Coalition, Isaak Walton League, etc.) – get key stakeholders to the table
 - Review existing stream flow and water quality data
- Address data gaps, including development of stream temperature and flow monitoring plan, if needed
- Field work/stream site visits/pond and creek monitoring

Temperature and flow monitoring
Aquatic biota survey
Groundwater monitoring
Sediment characterization for dredging

Alternatives Assessment - \$14,000

Identify Alternative A and C channel configuration options (through pond and adjacent to pond)
Identify Alternative B and D cool-water discharge options from Hartley Pond
Identify pond depth and volume options for all alternatives
Develop concept plans for all alternatives
Prepare sketches for channel configurations
Prepare cross-sections and profiles of existing and proposed alternatives
Review preliminary alternative sketches, cross-sections and profiles with City staff and project partners
Refine cost estimates for project construction
Meet with City staff (and partners?) to discuss alternatives

Impact Assessment of Proposed Hartley Pond Changes - \$6,500

Obtain updated floodplain maps and models, as available
H&H models of existing and proposed conditions
Model results review, including upstream and downstream impacts

Water Quality Assessment of Proposed Hartley Pond changes - \$4,500

Perform watershed runoff modeling
Model pond water quality
Evaluate water quality impacts on pond and stream
Water quality impacts
Water temperature impacts downstream and in-pond

Wetland Impacts Evaluation - \$3,500

Collect base data (GIS air photos, soil survey, NWI maps) for field wetland delineation
Define regulatory review of delineation and mitigation needs

Other Evaluations - \$10,000

Cultural resources reconnaissance survey
Contact state, federal, and local entities (including but not limited to MPCA, MNDNR and USACE) to determine permit requirements for project
Perform Phase One environmental study, including core samples of existing pond sediment, to identify potential soil contamination issues, as well as reuse/disposal options for dredged pond sediment

Feasibility Report - \$17,500

Draft report for review by City and applicable City commissioners
Revise report based upon City/commissioner comments
2nd draft based on additional City staff comments

Public Meetings - \$7,000

Attend 3 public meetings during Project Evaluation
Attend 2 public meetings during Impact Assessment

To: Gini Breidenbach, Minnesota Land Trust
From: Jessica Olson, PE
Subject: Hartley Pond – Tischer Creek Draft Feasibility Study and Alternative Cost Estimates
Date: September 23, 2019
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Attend 1 public meeting to present Feasibility Report

The following tasks are not included in the study costs and would be completed as part of the design phase, as relevant for the selected alternative:

Rosgen Level II Channel Evaluation - \$5,000
Wetland Delineation - \$2,000
Permitting Assistance - \$3,000

