MANAGEMENT PLAN FOR THE

St. Louis River Natural Area

OF THE DULUTH NATURAL AREAS PROGRAM

DATE: 1/30/20

Nominated by: City of Duluth Parks & Recreation Division

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List of Acronyms

AOC	Area of Concern
BMP	Best management practice
BUI	Beneficial use impairment
CISMA	Duluth Cooperative Invasive Species Management Area
COGGS	Cyclist of Gitchee Gummee Shores
DNAP	Duluth Natural Areas Program
EAB	Emerald ash borer
IBA	Important Bird Area
LA	Load allocation
MNDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MS4	Municipal separate storm sewer system
NOAA	National Oceanic and Atmospheric Adminstration
NPC	Native plant community
OHV	Off-highway vehicle
PCB	Polychlorinated biphenyl
SLRNA	St. Louis River Natural Area
TMDL	Total maximum daily load
TSS	Total suspended solids
WLA	Wasteload allocation
WDNR	Wisconsin Department of Natural Resources

Introduction

This management plan for the St. Louis River Natural Area (SLRNA) 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 St. Louis River Natural Area was nominated to the program, including significant native plant communities, natural water feature area, important bird congregation area, special species area, and geological landform area.

The 2019 Waabizheshikana (Marten Trail), Mini-Master Plan (final draft), the 2017 Duluth Traverse Mini Master Plan, and the 2017 St. Louis River Estuary National Water Trail Plan are additional guiding documents related to the infrastructure and uses within the St. Louis River 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. Partners involved in stewardship, management, and maintenance of features within the SLRNA include the Duluth Cooperative Invasive Species Management Area (CISMA), Community Action Duluth, Cyclists of Gitchee Gumee Shores (COGGS), Friends of Western Duluth Parks and Trails, and the St. Louis River Alliance. Partners involved in the restoration and remediation of prioritized sites and actions in the St. Louis River Area of Concern (AOC) include Fond du Lac Band of Lake Superior Chippewa, Minnesota Department of Natural Resources (MNDNR), Minnesota Land Trust, Minnesota Pollution Control Agency (MPCA), Wisconsin Department of Natural Resources (WDNR), US Environmental Protection Agency, as well as other local and federal partners.

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 a summary of natural resources in each of the five scientific categories for which the SLRNA was nominated to the DNAP, describes human use of the natural area, and discusses the current status of land ownership for future preservation.

The SLRNA is comprised of approximately 1,119 acres located in nine project sites along the St. Louis River (Figure 1) from Chamber’s Grove on the southwest (most upstream) to Grassy Point on the northeast (most downstream). Selection of the lands for inclusion in the natural area is described in the SLRNA Nomination (City of Duluth, 2019).

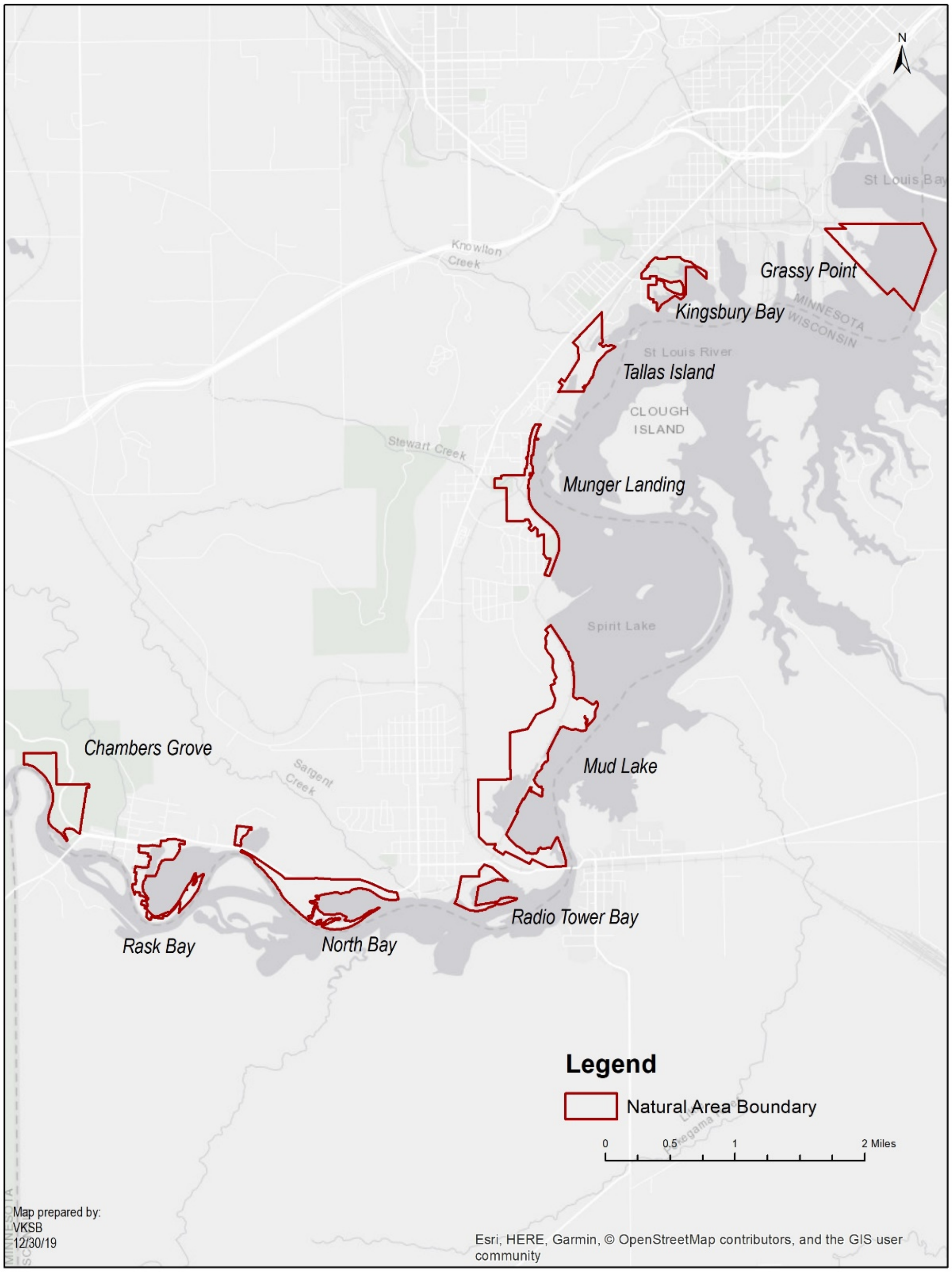

Figure 1: St. Louis River Natural Area Boundary

Note: Inclusion in the natural area is subject to landowner assent and land protection in accordance with the DNAP ordinance.

NATURAL RESOURCES INVENTORY

The significant natural resources for which the St. Louis River Natural Area was nominated include:

- Significant native plant communities (NPCs)
- Natural water features
- Important bird congregation area
- Special species area
- Geological landforms

Please refer to the SLRNA Nomination for descriptions of the ecological resources within each of these categories. The important features of these resources are summarized in Table 1.

Table 1: Summary of Important Features in the St. Louis River Natural Area

DNAP Scientific Category	Important Features
Significant native plant communities	• 17 distinct native plant community types within the natural area comprised of various types of hardwood forest, mixed hardwood-conifer forest, floodplain forest, forested swamps, shrub swamps, wet meadows, and marshes. • 120 acres of Estuary Marsh (Lake Superior) – MRU94a - This coastal wetland community is unique because it only occurs in estuaries and river mouths influenced by the Lake Superior seiche. • 63% of the NPCs have condition rank of B (good) or higher
Natural water features	• St. Louis River Estuary is the largest tributary to Lake Superior in the U.S. and supports globally important coastal wetland ecosystems • Mouths of four designated trout streams, Knowlton Creek, Stewart Creek, Kingsbury Creek, and Keene Creek, are in the SLRNA
Important bird congregation area	• Important congregation area for four bird guilds: waterfowl, shorebirds, waterbirds, and migratory landbirds • 169 species and almost 15,000 individuals surveyed in 2018
Special species area	• One state-listed endangered species, pale sedge (*Carex pallescens*) • Two state-listed special concern species, discoid beggarticks (*Bidens discoidea*) and soapberry (*Shepherdia canadensis*) • 52 sensitive bird species
Geological landforms	• Evidence of the drowned river valley draining to Glacial Lake Duluth is present in the form of backwater bays (e.g., Rask Bay, North Bay, Radio Tower Bay, Kingsbury Bay) • Bedrock geology from the Midcontinent Rift

HUMAN USES

Recreational uses are abundant within the nine project sites of the SLRNA and include hiking, biking, shore fishing, birdwatching, picnicking, and access for paddling. Recreational infrastructure within each project site is inventoried in Table 2. Note: the Tallas Island project area includes the future Spirit Landing Park's passive boat launch and infrastructure.

Table 2: Recreational Infrastructure in the Nine Project Areas of the St. Louis River Natural Area

Recreational Use Facilities	Project Area								
	Chamber's Grove	Rask Bay	North Bay	Radio Tower Bay	Mud Lake	Munger Landing	Tallas Island	Kingsbury Bay	Grassy Point
Hiking trail	X		X				X	X	(X)
Mountain Biking trail	X						X	X	
Accessible trail*	X	(X)	X	(X)	(X)	(X)	X	X	(X)
Picnic area	X					X	(X)	X**	
Shorefishing pier	X		X		(X)	X		(X)	
Trailhead with parking and restrooms	X		(X)		(X)	(X)	(X)	X	
Carry-in boat access (nonmotorized)	X		X		(X)	(X)	(X)	X	X
Public water access (motorized and nonmotorized)						X			

(X) = planned
* Meets Americans with Disabilities Act requirements
** nearby on City property at Indian Point Campground

The 2019 Waabizheshikana (Marten Trail) Mini-Master Plan (LHB, Inc., 2019) details the planned extension of the Waabizheshikana from its current end point at Spring Street (just south of the Tallas Island project site) upstream along the St. Louis River to Chamber's Grove. Once the plan is fully implemented it will connect all of the project sites within the SLRNA with the exception of Grassy point (Figure 2). This plan also includes construction or improvement of existing trailheads along the trail which also serve as access points for the St. Louis River National Water Trail (designation pending). Note, all trails and amenities will not be located on Tallas Island proper, but only along the shoreline.

An accessible hiking trail and carry-in boat access are identified as desired future amenities at Grassy Point in the St. Louis River Corridor Mini-Master Plans (City of Duluth, 2016). The existing boardwalk trail at Grassy Point is in disrepair and is being removed during the extensive habitat restoration work that is happening at the site.

Other existing trails within the SLRNA include:

- Chamber's Grove - Mission Creek mountain biking trails (portions), including the Duluth Traverse; St. Louis River accessible interpretive trail; Mission Creek trails with access to the Superior Hiking Trail (Figure 3)

- North Bay –accessible Boy Scout hiking trail (Figure 4)

The St. Louis River Estuary National Water Trail (designation pending) is a bi-state trail consisting of a series of paddling routes from Fond du Lac Dam downstream to Stryker Bay on the Minnesota side. Trail routes go in and through all of the SLRNA project areas, except Grassy Point. Detailed maps can be found in the water trail master plan (Hoisington, et al. 2017). Recreational infrastructure associated with Waabizheshikana was coordinated with water trail infrastructure needs in the planning process. The National Oceanic and Atmospheric Administration's (NOAA's) St. Louis River Estuary Public Access and Cultural Guidebook provides maps of trails, public access locations, and other areas of interest, as well as descriptions of cutltural resources in the estuary.

Maps of each project area are provided in the SLRNA Nomination . Locations of the amenities associated with Waabizheshikana can be found in the Waabizheshikana (Marten Trail) Mini-Master Plan located on the city of Duluth website.

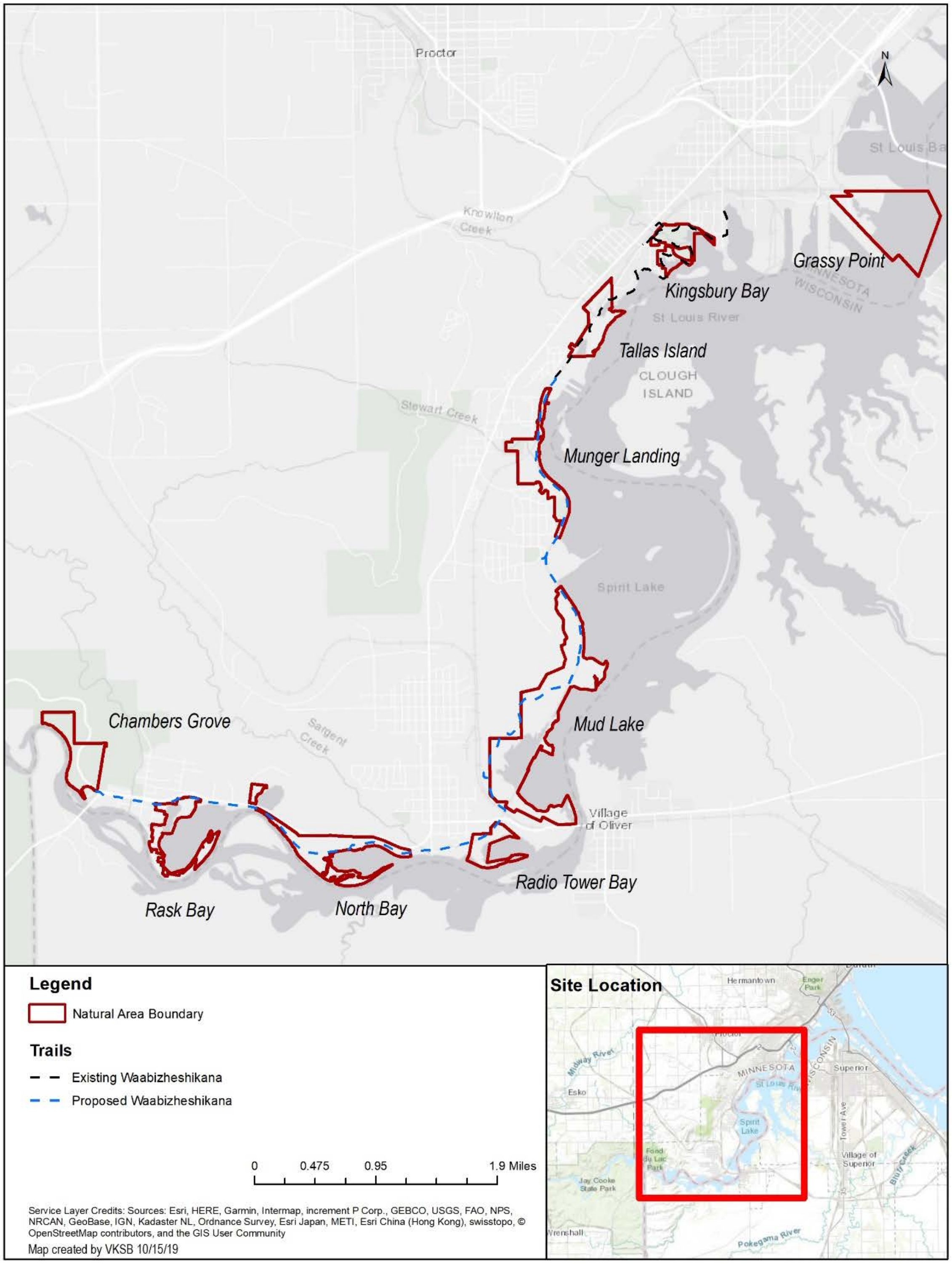

Figure 2: Waabizheshikana Project Limits

Note: Inclusion in the natural area is subject to landowner assent and land protection in accordance with the DNAP ordinance.

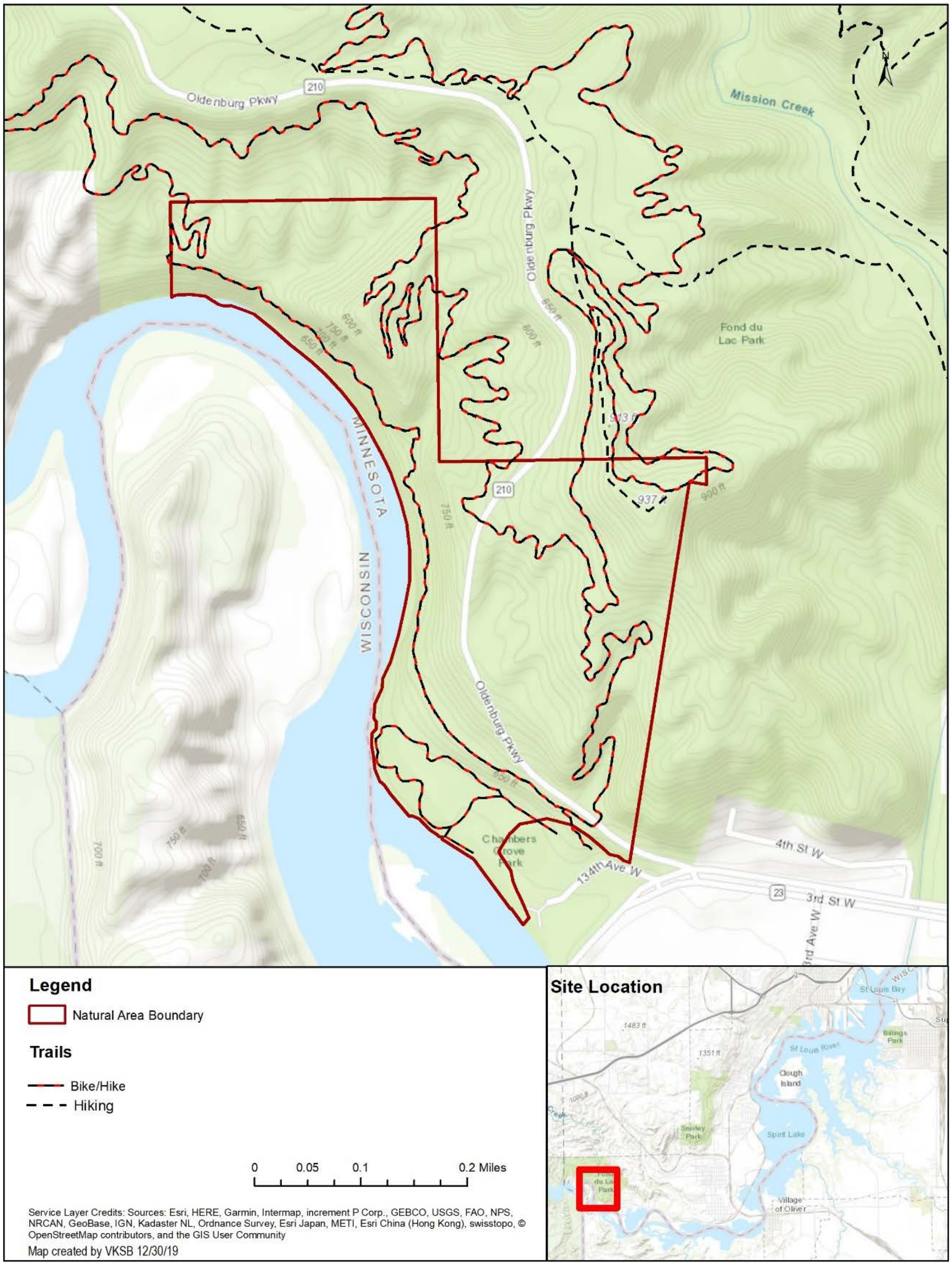

Figure 3: Trails in the Chamber's Grove Project Site

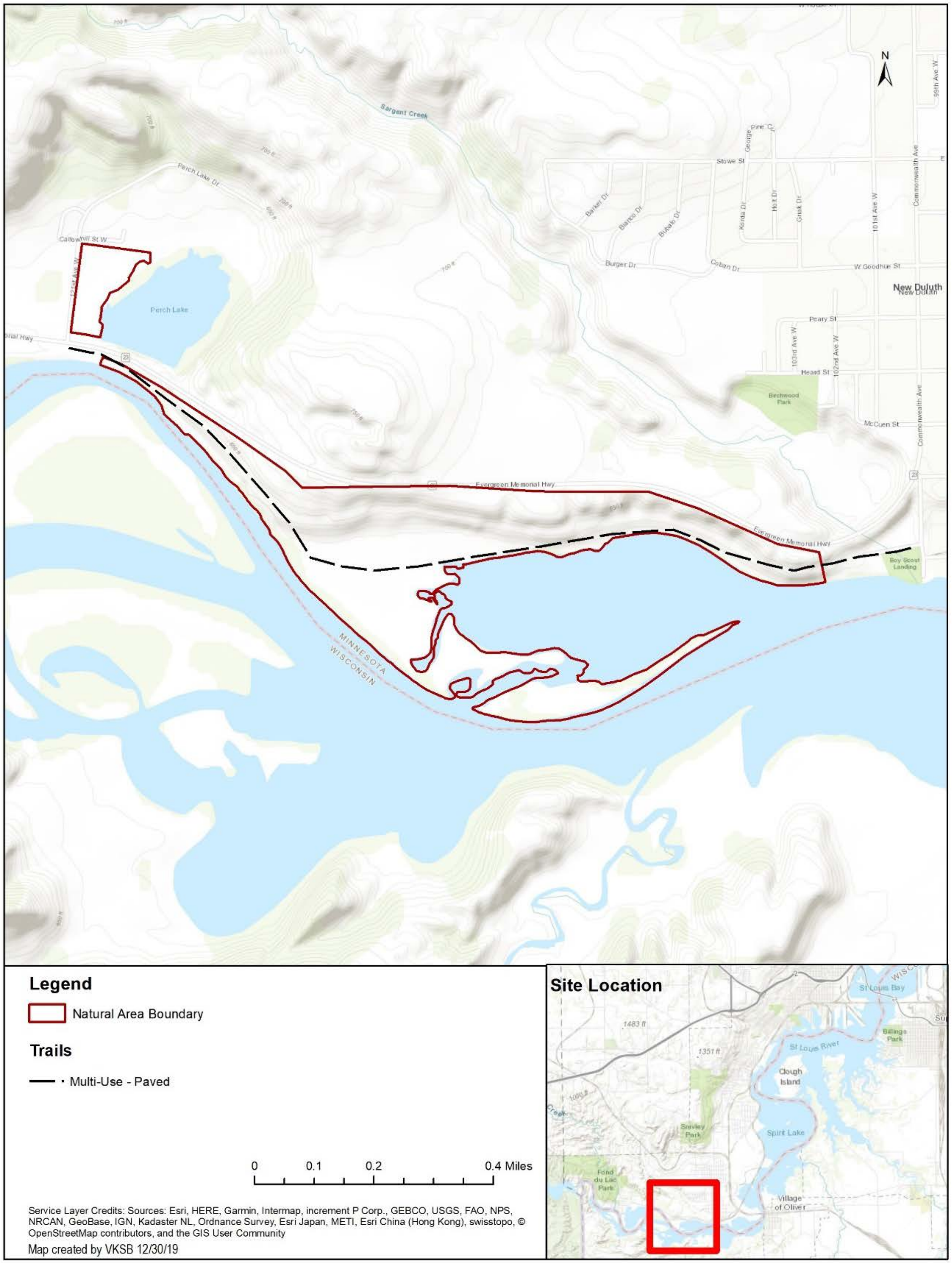

Figure 4: Trails in the North Bay Project Site

Note: Inclusion in the natural area is subject to landowner assent and land protection in accordance with the DNAP ordinance.

LAND OWNERSHIP

As described in the SLRNA Nomination and shown on Figures 4 through 12 of that document, landownership in the SLRNA is 33% City, 30% private, 32% State of Minnesota tax-forfeit, and 5% State of Minnesota. The City of Duluth is working with public and private landowners within the proposed natural area boundary to seek the conveyance of land to the DNAP through gift, sale, or other mechanism. Seven landowners have expressed interest in conveying their parcels to the City. Grant funds are being sought for parcel acquistion. The City is working closely with St. Louis County to acquire the tax forfeit parcels in the SLRNA.

The priority for acquisition of lands not currently under City ownership is as follows:

- Private parcels
- State of Minnesota tax forfeit parcels
- Larger parcels versus smaller parcels
- Higher quality habitat

Until all the parcels in the SLRNA are acquired by or conveyed to the City, the SLRNA boundaries may change slightly and should be reviewed in the next management plan update.

Threats

The threats to the ecological integrity of the special features for which the SLRNA was nominated to the DNAP are described in this section. Threats identified during the 2018 field surveys are described followed by other known threats.

THREATS IDENTIFIED DURING FIELD SURVEYS

Threats within each of the nine project areas of the SLRNA were identified during the 2018 plant and avian field surveys (Table 3). Section 2 of plant survey report (SEH, 2018) provided in Appendix B of the SLRNA Nomination provides a characterization of each project site with identified threats.

Table 3: Threats Identified in the St. Louis River Natural Area Project Areas

Threat	Chambers Grove	Rask Bay	North Bay	Radio Tower Bay	Mud Lake	Munger Landing	Tallas Island	Kingsbury Bay	Grassy Point
Invasive species	X	X	X	X	X	X	X	X	X
Erosion	X		X			X			
Unauthorized Trails	X		X			X			
Off-Highway Vehicle (OHV) Use			X			X			
Substrate issues*					X				
Earthworms								X	
Emerald Ash Borer			X						

* Includes lack of topsoil, compaction from past industrial use, and/or unsuitable substrate due to chemical characteristics (such as nutrient limitation).

Further information on the threats listed in Table 3 is as follows:

- The presence of invasive species was identified and described for each project area during the Summer 2018 plant surveys (SEH, 2018; Appendix B of SLRNA Nomination). Invasive species are discussed further below.

- Erosion is a concern at Chamber's Grove and North Bay on hillslopes affected by the 2012 flood. Erosion control work was conducted by Minnesota Department of Transportation and COGGS on hillslopes below Highway 210 within the Chamber's Grove project site. Additional work was completed in 2016/2017 that appears to have stabilized the slope. Erosion is a concern at North Bay due to runoff from Trunk Highway 23 causing rills to form in the forested communities on the top of slope below the highway in the north end of the project site. In both North Bay and Munger Landing, localized erosion occurs due to OHV use.

- Unauthorized trails and OHV use can be similarly categorized as "human uses". These uses that are not authorized within the natural area. Unauthorized trails are present in the Chamber's Grove project site that may be suitable for soapberry (*Shepherdia canadensis*), a state species of special concern. Their presence could affect habitat sustainability for this special species. OHV use on unauthorized trails is occurring in North Bay and Munger Landing and has been identified as a source of erosion at wetland crossings in North Bay and in localized areas in Munger Landing. Human uses are further discussed below.

- Substrate issues are presumably the cause for the lack of tree canopy growing in areas described as non-native plant communities described as open fields in the Mud Lake project area. These are likely areas that were disturbed by industrial activity. These issues could include lack of topsoil, compaction from past industrial use, and/or unsuitable substrate due to chemical characteristics (such as nutrient limitation).

- Earthworms appear to be negatively affecting an Aspen-Birch-Red Maple Forest (MHn4b) community on the north side of Kingsbury Bay. This community ranks D (poor) for condition with a sparse ground layer. Anecdotal observations from the field included a lack of humus and leaf litter, and earthworm castings on the ground surface.

- Emerald ash borer (EAB) is a concern for the North Bay and Chamber's Grove project sites, as ash trees are an important component of plant communities in these areas. EAB is a beetle inadvertently imported from China that kills ash trees once it infests them. EAB is present in the Duluth area and is a significant threat to ash trees.

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). Effects on human health can occur from certain invasive species, such as wild parsnip (*Pastinaca sativa)* which causes severe chemical burns on skin.

Invasive plants can quickly colonize areas with high levels of disturbance. Therefore, they are a concern wherever regular human use occurs. 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 may be 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. Boats, trailers, and associated gear can also be a source of invasive aquatic species.

The NPC survey conducted in 2018 identified 10 invasive species that are present in infestations of 0.1 acre and greater in at least one project site in the St. Louis River Natural Area (Table 4). The species and locations of these infestations are provided in Figures 4-1 through 4-8 of the SEH (2018) report located in Appendix B of the SLRNA Nomination.

Table 4: Invasive Plant Species in the St. Louis River Natural Area in Infestations of 0.1 acre or Greater

Common Name	Latin Name	Project Sites
Canada thistle	*Cirsium arvense*	Grassy Point
Common buckthorn	*Rhamnus cathartica*	Chamber's Grove; Mud Lake; Tallas Island
False spirea	*Sobaria sorbifolia*	Tallas Island
Lily of the valley	*Convallaria majalis*	Chamber's Grove; North Bay; Munger Landing; Kingsbury Bay
Narrowleaf cattail	*Typha angustifolia*	Radio Tower Bay
Phragmites	*Phragmites australis*	Mud Lake; Munger Landing; Tallas Island; Grassy Point
Purple loosestrife	*Lythrun salicaria*	North Bay; Mud Lake
Reed canary grass	*Phalaris arundinacea*	North Bay; Kingsbury Bay
Siberian peashrub	*Caragana aborescens*	Mud Lake
Wild parsnip	*Pastinaca sativa*	Tallas Island

Human uses

Trails, both terrestrial and aquatic, provide important opportunities for people to connect with nature and improve health and well-being. However, 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 aboard on the effects 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 effects on 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 effects 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 cause 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 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

The use of OHVs is not authorized within City limits. Any use of OHVs on trails within the natural area exacerbates erosion, invasive species colonization, wildlife disturbance and user conflicts.

Boats, trailers, and associated gear provide a vector for transport of aquatic invasive species from one water body to another. Accessing water from non-designated access points can damage shoreline vegetation, disturb wildlife, and cause erosion.

OTHER KNOWN THREATS

Other known threats to the ecological integrity of the features for which the SLRNA was nominated to the DNAP include historic contamination and degradation of habitat in the St. Louis River AOC and water quality impairments in three trout streams and the St. Louis River. It should be noted that while these threats exist, the ecological integrity of the natural area is still intact and improving.

Historic Contamination and Degradation of Habitat

The SLRNA is located within the boundary of the St. Louis River AOC was listed by the International Joint Commission as one of 43 Great Lakes AOCs in 1987 because it was identified as an area where "…significant impairment of beneficial uses has occurred as the result of human activities at the local level" (Annex 1 of the Great Lakes Water Quality Protocol of 2012). Historical actions such as unregulated municipal and industrial waste disposal and unchecked landuse practices, including dredging and filling of aquatic habitat and damaging logging practices contributed to the complex set of issues facing the St. Louis River AOC at the time it was listed. By 1992, many of the discharges were eliminated or permitted with appropriate treatment as required by the Clean Water Act. The primary concerns for the AOC that remain are legacy contamination and historical habitat degradation. These sources of impairment led to the designation of nine of 14 possible beneficial use impairments (BUIs) as existing in the AOC.

Today, the St. Louis River AOC Remedial Action Plan (MNDNR and WDNR, 2019) describes the actions necessary to officially "delist" the AOC along with the degree of progress; the plan is updated every year. (For future updates go to the Minnesota Pollution Control Agency's website for the St. Louis River AOC). A number of actions in the Remedial Action Plan are located in the aquatic portions of the river immediately adjacent to the SLRNA (Figure 5), some of which have been completed. The green sites were selected for restoration and/or remediation and remedial decisions are being evaluated for the red sites based on historic habitat degradation and the presence of sediment contamination exceeding allowable thresholds. The required actions in the 2019 Remedial Action Plan for each of these sites are listed in Table 5. Restoration actions in or adjacent to SLRNA project sites have been completed at Chamber's Grove, Radio Tower Bay, and in the Knowlton Creek watershed. Restoration is underway at Kingsbury Bay, Grassy Point, and the wild rice restoration sites and will be started in the next year at the US Steel/Spirit Lake site (Figure 5). Planning for the

Perch Lake and Mud Lake restoration sites is underway. Remediation has been completed at the St. Louis River/Interlake/Duluth Tar Site and is expected to begin at the US Steel/Spirit Lake site in 2020. Work is underway to make remedial decisions at Mud Lake West and Munger Landing.

The MPCA and MNDNR will be implementing institutional controls and long term monitoring and maintenance plans as appropriate to each completed remediation and restoration sites.

The St. Louis River AOC remediation and restoration work is a huge investment by the community and its' implementing partners including: MPCA, WDNR, MNDNR, and Fond du Lac Band of Lake Superior Chippewa. The overarching goal for this area is to transform these remediation and restoration projects into sustainable revitalization of the surrounding community by maximizing, to the extent possible, the positive societal and environmental outcomes. NOAA recognized this goal by designating the estuary as a Habitat Focus Area. Through the SLRNA, the City is providing complimentary work to the AOC by preserving and protecting the terrestrial connection to this amazing aquatic resource. The City's goal is to continue to work with the AOC partners by managing and monitoring the upland and riparian native plant communities along the St. Louis River corridor.

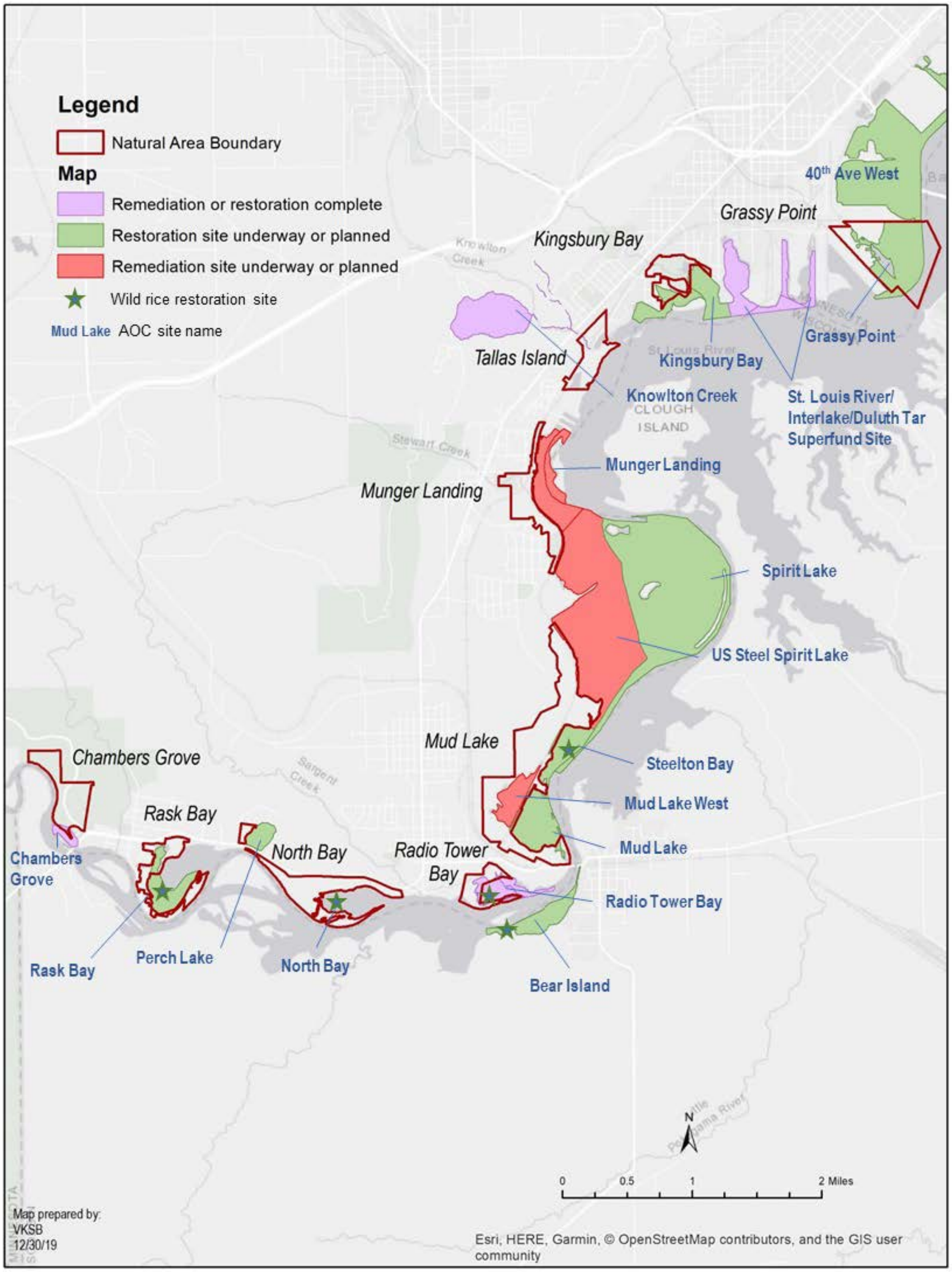

Figure 5: St. Louis River Area of Concern Sites Adjacent to the St. Louis River Natural Area

Note: Inclusion in the natural area is subject to landowner assent and land protection in accordance with the DNAP ordinance.

Table 5: St. Louis River AOC Projects Adjacent to the St. Louis River Natural Area

Note: this table is updated annually as part of the AOC's Remedial Action Plan updates which can be found on the MPCA's St. Louis River AOC website.

Project Name	AOC Action Number	Status	Project Description	Estimated Completion
Perch Lake	9.09	Pre-design	Revitalize biological connection between estuary and Perch Lake and restore optimum bathymetry	2021
Wild Rice Plan and Associated Restoration Sites	9.21	In progress	Develop a plan that identifies the high priority restoration sites and provides a process for restoring those sites. Restoration of 275 acres of wild rice.	2024
Mud Lake	9.08	Pre-design	Remediate contaminated sediments, establish more vital hydrologic connection and restore wetland habitat including wild rice; establish deep water.	2022
Mud Lake West	5.18	Remedial decision	Remediate contaminated sediments.	2020
US Steel/Spirit Lake	9.01	Design	Remediate contaminated sediments and restore emergent wetlands.	2023
Munger Landing	5.09	Pre-design	Remediate contaminated sediments.	2022
Kingsbury Bay	9.06	Construction	Restore wetland complex at the mouth of Kingsbury Creek to pre-1961 condition.	2021
Grassy Point	9.04	Construction	Remove non-native material and restore optimum bathymetry.	2020

Source: St. Louis River AOC 2019 Remedial Action Plan

Water Quality Impairments

Stewart Creek, Kingsbury Creek, Keene Creek, and the St. Louis River have been listed by MPCA as impaired in Minnesota's 2018 Impaired Waters List (MPCA, 2019). Impairments in these waterbodies are summarized in Table 6.

Table 6: Water Quality Impairments of Waterbodies in the St. Louis River Natural Area

Note this table is the TMDL List required by EPA through the Clean Water Act Section 303(d) as of 2018. The website is https://www.pca.state.mn.us/sites/default/files/wq-iw1-58.xlsx.

Waterbody	Impaired Beneficial Use	Pollutant or Stressor
Stewart Creek	Aquatic recreation	E. coli
Keene Creek	Aquatic recreation	E. coli
Kingsbury Creek	Aquatic life	Aquatic macroinvertebrate bioassessment, Fishes bioassessments
St. Louis River - Fond du Lac Dam to Mission Creek and Mission Creek to Oliver Bridge	Aquatic consumption	DDT, dieldrin, mercury in fish tissue, mercury in water column, PCB in fish tissue, PCB in water column,
St. Louis River - Oliver Bridge to Pokegama River	Aquatic consumption	Mercury in fish tissue, PCB in fish tissue
St. Louis River - Pokegama River to Mouth of St. Louis Bay at Blatnik Bridge	Aquatic consumption	DDT, dieldrin, mercury in fish tissue, mercury in water column, PCB in fish tissue, PCB in water column, dioxin (including 2,3,7,8-TCDD), toxaphene

Source: Minnesota's Final 2018 Impaired Waters List

Potential sources of *E. coli* include from humans (e.g., leaking wastewater infrastructure, failing septic systems, homeless population), stormwater runoff, livestock, wildlife, and domestic pets. Storm sewer systems provide a vector for transport of pathogens deposited on the land surface into waterbodies. In addition, bacterial regrowth and naturalized *E. coli* strains in the environment can be a substantial source of *E. coli* to receiving waters, particularly in urban streams.

Total suspended solids (TSS) is the water quality parameter used as a surrogate to assess effects on aquatic macroinvertebrates and fish. Sources of TSS in the Kingsbury Creek watershed include streambank and bluff erosion, unstable gully and ravine tributaries, and overland runoff from urban areas (Tetra Tech, 2018b).

Many of the impairments in the St. Louis River are hypothesized to be the result of legacy contamination from historic industrial operations in the watershed. There were also municipal contributions and natural conditions that contributed to the perceived impairments. Dioxin is a biproduct of industrial processes, but can also be created by natural sources such as forest fires. Polychlorinated biphenyls (PCBs) are a group of manmade chemicals used historically in transformers, and electrical components, as well as paper products such as carbonless copy paper. Mercury is a ubiquitous metal pollutant in Minnesota waters due to atmospheric deposition; however, in the St. Louis River, it is also present from historic discharges. DDT, dieldrin, and toxaphene are insecticides.

Strategies

Strategies for managing native plant communities, special species, non-native or cultural plant communities, natural water features, bird habitat, invasive species, and trails within the SLRNA are described in this section.

NATIVE PLANT COMMUNITIES

The DNAP uses NPCs, defined according to MNDNR's *2005 Field Guide to Native Plant Communities of Minnesota*, 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 St. Louis River 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 St. Louis River Natural Area.

Mesic Hardwood Forest

Aspen – Birch – Basswood Forests (MHn35a), Red Oak – Sugar Maple – Basswood (Bluebead Lily) Forests (MHn35b), Aspen – Birch – Red Maple Forests (MHn44a), White Pine – White Spruce – Paper Birch Forest (MHN44b), Aspen – Birch – Fir Forest (MHn44d), 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 sasparilla (*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 roseaus*), and pennsylvania sedge (*Carex pensylvanica*). 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. 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, with monitoring and response to invasive species colonization following disturbance. 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 (C*onvallaria 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.

Floodplain Forests

Black Ash - Silver Maple Terrace Forest (FFn57a)

Flood plain forests are wet-mesic deciduous forests on silty or sandy alluvium on level sites associated with rivers. They are high enough for only occasional flooding which occurs every 5 to 20 years. Mature forests are naturally dominated by American elm, black ash, and green ash mixed with some bur oak, basswood, and white spruce. This community increasingly includes silver maple as a significant component of the canopy. This plant community is stable and normally driven by individual windthrow or rare flood disturbance. Stand replacing events happen extremely rarely, occurring every 600 years or longer.

Management: The objective for floodplain forest management is the mature growth stage. Natural windfall events will create adequate regeneration. Active forestry is not recommended for this plant community. However, response to EAB may be advised. Individual or small group selection of green and black ash with replanting of silver maple, white spruce, or basswood will keep this plant community intact. Mesic to moist soil conditions can be conducive to exotic species, such as buckthorn, invasion following natural or man made clearing and disturbance. Trail routing and building should consider river terrace soils may be saturated for long periods; appropriate methods should apply. Monitoring for invasive species and response should follow wind throw events and new trail work.

Wet Forests

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

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 in species composition 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 SLRNA 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 EAB 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 EAB 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 EAB 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)

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.

Estuary Marsh

Estuary Marsh (Lake Superior) (MRu94a)

These emergent marshes only occur in estuaries at river mouths along the shore of Lake Superior. Vegetation consists of a variable mixture of species, typically with a dense layer of submerged plants under and between floating-leaved and emergent aquatic plants. Cyclic wind-driven changes in lake level cause changes in local water levels resulting in water levels oscillating up and down similar to tidal effects. These oscillations can reverse the flow of these tributary rivers and function to flush sediment, move nutrients, and change water surface elevations. Water surface elevation changes, normally ranging between 1 to 10 inches, are the primary mechanism limiting dominance of these marsh communities by cattail. Water levels in coastal marshes are also influenced by river flooding from runoff following snowmelt or heavy precipitation. Estuary marsh generally has higher species diversity than cattail marsh.

Management: Estuary marsh is listed by MNDNR as a community of special conservation need with a conservation status rank of “critically imperiled”. Management objectives are to maintain or restore the open and diverse growth forms found in this community. Stabilizing water levels, reducing flow rates, and filling or hardening shoreline promotes invasion by cattail mats reducing the open water, species diversity, and aquatic habitats characteristic of estuary marsh. Land use planning that allows for migration of these communities up and down slope as water levels fluctuate can benefit the long term health of the estuary marsh.

Sparse Vegetated Upland

Dry Sandstone Cliff (Northern) (CTn11e), Wet Sandstone Cliff (Northern) (CTn42d)

Both wet and dry sandstone cliff communities are open communities on moderately acidic cliffs composed of quartz sandstone. Differences in the two communities arise from their moisture level due to their orientation (south- to west-facing, sunny cliffs or shaded northwest- to east-facing). Few records are available on the flora of these communities. Birds-eye primrose (*Primula mistassinica*) and shrubby cinquefoil are present on one known occurrence of CTn42d in Hinckley.

Management: These communities are highly restricted in area because they occur only on vertical, or nearly vertical sandstone. The primary location for this NPC is on the exposed rock faces of the abandoned quarry west of Chambers Grove Park. The bedded sandstones along the lower St. Louis River are weak and brittle and unsuitable for climbing or trails. Only hardy plants can survive the conditions and the species tend to be slow growing and long lived. Therefore, the community tends to be stable and the best management for these communities is protecting them from human disturbances such as climbing, unauthorized trails, and other direct impacts. However, trails, or other human use in the near these communities, such as the trails through the quarry, do not now have a detrimental effect. Exotic plant invasion is unlikely because of the extremely harsh growing conditions on the rock.

SPECIAL SPECIES

To protect the three sensitive plant species, locations of the occurences are not available to the public. The City will consider the locations of these populations when planning future human use or land management actions. Unauthorized trails within Chamber's Grove are a threat to habitat for soapberry (*Shepherdia canadensis*). Efforts will be undertaken to close these trails and discourage additional unauthorized trail creation, as described in the Prioitized Actions section below. Additional recommendations may be made for these species following coordination with MNDNR ecologists.

For the 52 sensitive bird species, the strategies that support healthy NPCs and water features will serve to protect the habitat for these species.

CULTURAL OR NON-NATIVE PLANT COMMUNITIES

In general, the DNAP program encourages the establishment of NPCs to the extent possible. Cultural or non-native plant communities exist on approximately 15% of the natural area (City of Duluth, 2019). These are areas with cultural influences on the land cover and include transportation corridors (e.g., railroads, streets), invasive species, restoration areas, and old fields. These areas are included in the natural area because they are limited patches surrounded by NPCs and have the potential to reduce fragmentation; in addition, some have potential to be restored with management actions (such as invasive species control). The plant community survey provides valuable information on possible NPC targets for these areas.

The current focus of plant community restoration within the SLRNA is within Grassy Point, as described in the Prioritized Actions below.

INVASIVE SPECIES

Invasive plant species are present throughout the SLRNA and the City of Duluth. 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

The City will continue to work with partners to control infestations of invasive plant species within the SLRNA and to continually assess available control techniques for invasive species.

Management of New Introductions

Because of the many human uses within the project sites of the SLRNA, management of new introductions of invasive species is vital to long term control or eradication. This must include both education of all natural area users and requirements for use of best management practices (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 managed according to the City's invasive species management plan. A draft plan of past and on-going work is being used until it is incorporated into a comprehensive natural resource management plan. See Prioritized Actions below for description of work anticipated in 2020-2022.

NATURAL WATER FEATURES

Strategies for managing the natural water features of the trout streams and the St. Louis River estuary are described in this section.

Trout Streams

Knowlton Creek, Stewart Creek, Kingsbury Creek, and Keene Creek are class 2A waters under Minnesota Rule 7050.0470. The rule states that the quality of these waters shall be such as to permit the propagation and maintenance of a healthy community of cold water aquatic biota, and their habitats. In addition, these waters shall be suitable for aquatic recreation of all kinds, including bathing. This class of surface waters is also protected as a source of drinking water" (Minnesota Rule 7050.0222), though none of these creeks serve as drinking water sources for the City.

Management of these trout streams and their surrounding landscapes within the SLRNA need 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 fisheries.

Total Maximum Daily Loads (TMDLs) are in draft form for Stewart Creek, Keene Creek, and Kingsbury Creek. As a permtted municipal separate storm sewer system (MS4), the City of Duluth will receive wasteload allocations (WLAs) for their portion of the TMDLs once the they are approved and will be responsible for implementing actions to meet these WLAs. The City will also particiate, along with multiple stakeholders, in addressing the load allocations (LA) for the non-permitted pollutant sources, such as pet waste, channel erosion, failing septic systems, and wildlife.

The overwhelming majority of the watersheds for Stewart, Kingsbury, and Keene Creek are located upstream of the SLRNA project sites in which the creek mouths are located. Therefore, the focus of management efforts will be predominantly outside of the natural area. Stream restoration projects are planned by MNDNR for Kingsbury Creek and Keene Creek in reaches of those streams just upstream of the natural area boundaries.

St. Louis River Estuary

The St. Louis River is a class 2B water under Minnesota Rule 7050.0470. The rule states that the quality these waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water aquatic biota, and their habitats…". These waters shall be suitable for aquatic recreation of all kinds, including bathing. This class of surface water is not protected as a source of drinking water.

Management of the landscapes contributing to the St. Louis River within the SLRNA shall comply with water quality standards appropriate to the class 2B designation, as specified in Minnesota Rule 7050.0222 and to support the health of this ecosystem that is vital to the region and Lake Superior.

TMDLs for toxics have yet to be completed for the St. Louis River impairments.

The shallow sheltered bays of the St. Louis River located adjacent to the SLRNA project areas (i.e., Rask Bay, North Bay, Radio Tower Bay, Mud Lake, Kingsbury Bay, and Grassy Point) are an important habitat type within the estuary. As described above, significant remediation and restoration efforts have been undertaken or are planned for most of these bays as part of the delisting process for the St. Louis River AOC, including restoration of wild rice. The presence of the SLRNA immediately surrounding these bays provides opportunity to further support these efforts through land protection and the recreational amenities identified in Table 2. Management of the SLRNA will consider the vital connection of riparian areas of these bays with the adjacent terrestrial areas to support healthy wetland ecosystems.

BIRD HABITAT

The SLRNA is nesting and stopover habitat for at least 169 species of birds, including 52 species of concern (NRRI, 2018) and is a key reason for designating the SLRNA. Further, as described in the SLRNA Nomination (City of Duluth, 2019), Audubon has designated the estuary, from Chambers Grove downstream to Lake Superior and southeast to Wisconsin Point, as an "Important Bird Area" (IBA), because of its' significance as a migratory corridor for birds.

The City will continue to work with partners to provide for restoration and enhancement of avian habitats within and adjacent to the SLRNA. Implementing the strategies for maintaining or improving NPCs, controlling invasive species, and management of human uses will support vibrant bird habitat in the natural area.

The University of Minnesota Natural Resources Research Institute completed further analysis of the 2018 bird survey data for the SLRNA (original survey data can be found in Appendix C of the SLRNA Nomination) along with other recent and historical survey data to identify bird-habitat associations to help guide restoration and conservation efforts. The analysis, which can be found in Appendix A, indicates the importance of emergent wetland habitats, located throughout the SLRNA, for birds in the estuary. In addition, this work identified the importance of restoration of emergent wetland habitats in the more highly developed areas situated in the lower estuary, such as Grassy Point. Results of this work will be used to inform restoration of the Grassy Point in the Grassy Point Revegtation Project described below.

TRAILS

Trails allow citizens to recreate and experience the benefits of nature within the natural area. The Waabizheshikana (Marten Trail) Mini-Master Plan (City of Duluth, 2019) describes planned extensions of the Waabizheshikana and associated facilities, incuding river access points for the St. Louis River Estuary National Water Trail (designation pending), from Tallas Island to Chamber's Grove.

All trail construction, 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 their partners to maintain the trail system and to educate users on proper BMPs related to trail use (e.g., invasive species and erosion control).

Impact reduction must also include proper trail maintenance, prevention of unauthorized trail segments, and education of users regarding appropriate trail use and BMPs for invasive species control.

Unauthorized "social" trails and water-based landings 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. Water access features and education as part of the proposed National Water Trail will be used to help prevent unauthorized landings.

OHV use is strictly prohibited within city limits. Damage to trails from these vehicles can be severe.

Implementation

Management of natural resources in the SLRNA 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. The prioritized actions with associated timelines and costs, as well as partner responsibilities for implementing this St. Louis River Natural Area Management Plan are described in this section.

PRIORITIZED MANAGEMENT ACTIONS

Four prioritized actions have been identified for the St. Louis River Natural Area. These are summarized in Table 7 and described below.

Funding will be sought from appropriate sources for these projects. Possible sources include: Great Lakes Restoration Initiative, Conservation Partners Legacy Fund, NOAA Coastal Program, and the National Fish and Wildlife Foundation Sustain Our Great Lakes program.

Table 7: Prioritized Actions for the St. Louis River Natural Area

Action	Cost	Responsible Parties	Target Completion Date
Special Plant Species Evaluation	None.	City of Duluth	2020
Invasive Species Control and Re-Planting with Native Species	$165,000	Community Action Duluth or other contractor	2025
Address Unauthorized Trails, Landings, and OHV Use	$7,500	City of Duluth	2022
Grassy Point Revegetation Project	Funds secured	Minnesota Land Trust, MNDNR	2022
Coordination with MPCA and MNDNR on St. Louis River AOC Projects	None	City of Duluth staff	2025
Land Acquisition	To be determine by appraisals	City of Duluth	2025

Special Plant Species Evaluation

The City will coordinate with MNDNR ecologists to identify potential habitat protection and management needs for pale sedge (*Carex pallescens*), discoid beggarticks (*Bidens discoidea*), and soapberry (*Shepherdia canadensis*). No funds are needed for this initial task. The evaluation will be completed in 2020.

Invasive Species Control and Re-Planting with Native Species

The City is working with contractors to control invasive species along the St. Louis River corridor. Figure 6 and Figure 7 show the quality of the NPCs with locations where invasive species have been identified inside and outside the SLRNA. The purple dots are areas noted in the 2018 plant survey where infestations are greater than a tenth of an acre and the blue dots are invasive species locations identified by the public and verified by the Minnesota Department of Agriculture through a computer application called EDDMaps (Early Detection and Distribution Mapping System). A total of 382 acres have been treated since 2015 and trees and shrubs have been planted in some locations as well. Funding is being sought from the Great Lakes Restoration Initiative through the US Environmental Protection Agency as well as other potential sources to continue to control invasives and manage the existings plantings as necessary. This work is planned for 2020-2022 and is estimated to cost $165,000.

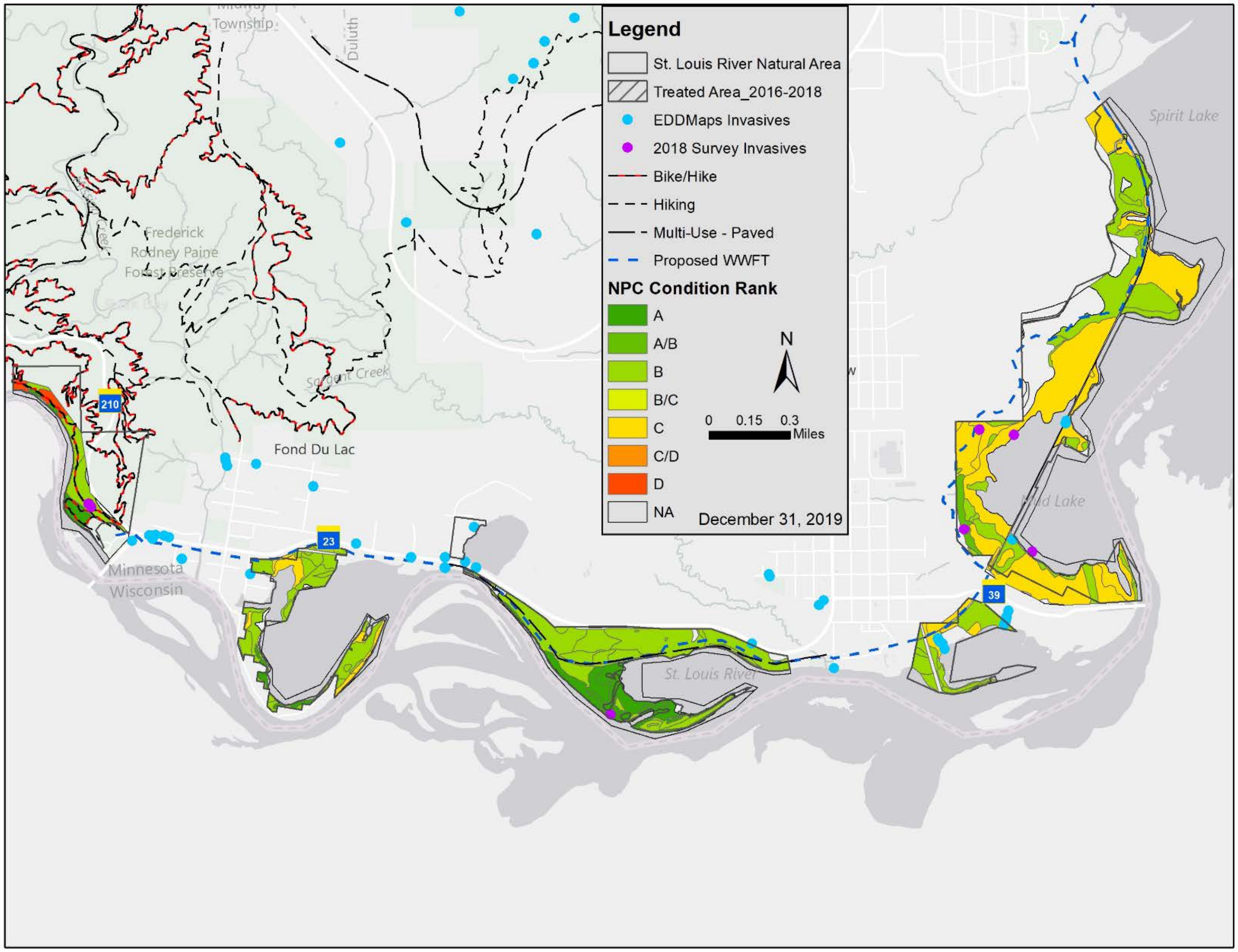

Figure 6: Priority Invasive Species Control Areas for 2020-2021 in the SLRNA

Note: Inclusion in the natural area is subject to landowner assent and land protection in accordance with the DNAP ordinance.

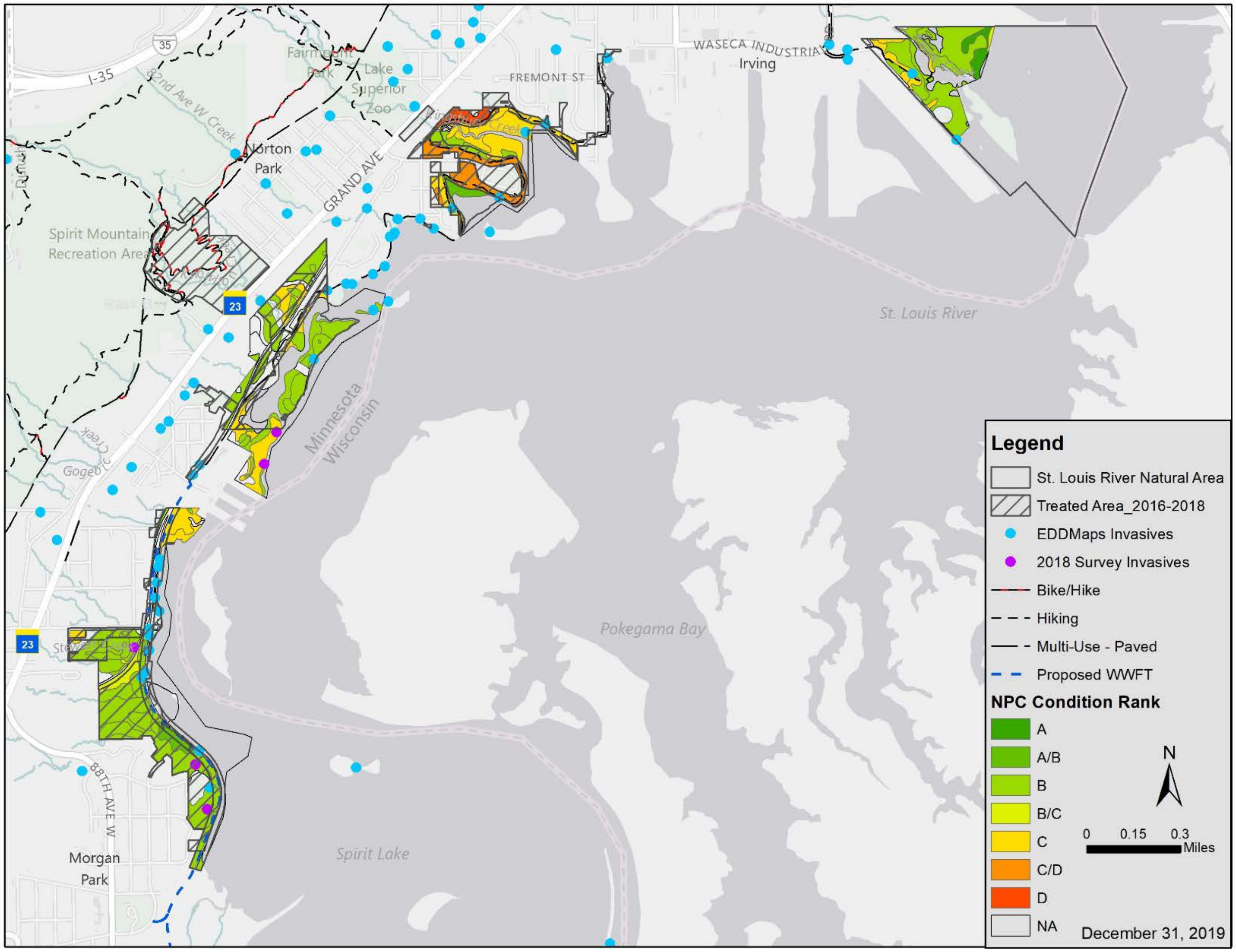

Figure 7: Priority Invasive Species Control Areas for 2020-2021 in the SLRNA

Note: Inclusion in the natural area is subject to landowner assent and land protection in accordance with the DNAP ordinance.

Address Unauthorized Trails, Landings and OHV Use

Unauthorized trails were identified as threats in Chamber's Grove, North Bay, and Munger Landing with OHV use occuring in North Bay and Munger Landing. In addition, the City is aware that unauthorized foot trails and water landings occur. The City will develop an approach for addressing unauthorized trails, landings and OHV within the natural area, with a focus on these three project sites for OHV and trails and review potential concerns along the corridor for water landings. Most likely this work will consist of an information and education campaign along with signage and barricading at select locations. Funds required for this effort are estimated at $7,500. This initial work is expected to begin in 2022 after much of the construction that is underway or planned for the near future has occurred.

Coordination with MPCA and MNDNR on St. Louis River AOC Projects

City staff have been assigned to each of the St. Louis River AOC sites for which designs and construction are not yet complete. Staff are involved in the in-water restoration planning, design, and construction for Grassy Point, Kingsbury Bay, Perch Lake, Mud Lake, US Steel/Spirit Lake, Munger Landing, and wild rice restoration to ensure communication, cooperation and terrestrial issues on City land are represented. This includes recognition of current and future human uses planned for each site, as well as the important ecological values in relation to the adjacent natural area. It is anticipated that the remediation and restoration work will follow the estimated timelines listed in Table 5. No outside funds are required for this effort.

Grassy Point Revegetation Project

This project compliments the St. Louis River AOC in-water restoration project at Grassy Point and Kingsbury Bay. The AOC project is underway and consists of the removal of accumulated sediments, wood waste, and historic wetland fill. The bathymetry will be restored to provide for a sheltered bay habitat. The Grassy Point Revegetation Project, which focuses on the terrestrial areas of Grassy Point, will follow in-water construction to maximize migratory bird habitat value of adjacent wetland and upland areas. The work includes invasive species control (e.g., Phragmites, narrow leaf cattail, buckthorn) followed by revegetation of terrestrial native plants (i.e., grasses, forbs, shrubs trees). Invasive species control in areas proximal to the project is included to reduce the potential for spread and colonization by invasive plant species in the periphery (Figure 7). Minnesota Land Trust is leading this effort with involvement from the City, MNDNR, University of Minnesota Natural Resources Research Institute, CISMA, Community Action Duluth, and US Fish and Wildlife Service. Funding has been secured. Work is anticipated to be complete in 2022.

Land Acquisition

City staff will work to secure funding for acquisition of private and State of Minnesota tax forfeit properties within the SLRNA. Costs for aquisition of these properities will be determined by property appraisals. This effort, which is contigent on landowner assent, is anticipated to be complete in 2025.

RESPONSIBILITIES

Responsibilities for implementation of this SLRNA 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 to implement the plan.

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

Trail User Groups

Implementation of this plan requires cooperation and participation of the user groups responsible for trails management and repair. In particular, partners 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 key messages:
    - 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
- Trail restoration/realignment efforts must be reviewed for compliance with this plan

References

City of Duluth. 2016. St. Louis River Corridor Parks Mini-Master Plans.

City of Duluth. 2019. Nomination of the St. Louis River Natural Area to the Duluth Natural Areas Program. Final. December 30, 2019.

Confluence, et al. 2017. Duluth Traverse Mini Master Plan

Eastern Research Group. 2017. St. Louis River Estuary Public Access and Cultural Guidebook. National Atmospheric and Oceanic Administration (NOAA). Available at: https://coast.noaa.gov/digitalcoast/training/slregb.html

Henning, 2017. Hiking, Mountain Biking, and Equestrian Use in Natural Areas: A Recreation Ecology Literature Review. Metro Parks and Nature, Portland, OR.

Hoisington, et al. 2017. St. Louis River Estuary National Water Trail Master Plan, Duluth, Minnesota and Superior, Wisconsin.

LHB, Inc. 2019. Waabizheshikana (Marten Trail) Mini-Master Plan. November 7, 2019. Final Draft.

MPCA. 2019. Minnesota's 2018 Impaired Waters List. Available at: https://www.pca.state.mn.us/sites/default/files/wq-iw1-58.xlsx

MPCA and WDNR. 2019. St. Louis River Area of Concern 2019 Remedial Action Plan. Available at: https://www.pca.state.mn.us/waste/st-louis-river-area-concern-resources#action-plans-50ff1311

MN Forest Resources Council. 2014. Northeast Landscape Forest Resources Plan.

MN Invasive Species Advisory Council. 2015. Minnesota's Urban and Community Forests Best Management Practices for Preventing the Introduction, Establishment, and Spread of Invasive Species.

MNDNR. 2005. Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research.

MNDNR 2007. Trail Planning, Design, and Development Guidelines,Parks and Trails Division.

Natural Resources Research Institute (NRRI). 2018. St. Louis River Natural Area Project. Nomination Report Important Bird Congregation Area.

SEH, 2018. Native Plant Community and Special Species Verification and Mapping, St. Louis River Natural Area Project. Submitted to Minnesota Land Trust.

Tetra Tech, Inc. 2018a. Draft Duluth Urban Area Streams Total Maximum Daily Load. Prepared for Minnesota Pollution Control Agency. March 2018.

Tetra Tech, Inc. 2018b. St. Louis River Watershed Total Maximum Daily Load Report. Prepared for Minnesota Pollution Control Agency. September 2018.

Appendices

Appendix A: Let the Birds Guide You Final Report

NRRI Technical Report – December 2019

Minnesota Land Trust
Final Report - Let the Birds Guide You

Submitted by:

Alexis Grinde, Nick Walton, Annie Bracey, and Alexis Liljenquist

Date:
December 2019

Report Number:
NRRI/TR-2019/70

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PROJECT OVERVIEW

Identifying environmental and habitat characteristics associated with specific bird communities can help guide conservation and habitat management efforts. The goal of this project was to quantify and characterize bird communities in the St. Louis River Estuary (SLRE) based on bird-habitat associations. Bird communities are commonly described with respect to their associated cover types (i.e., habitat). However, birds often respond to combinations of local cover types and larger-scale landscape features (e.g., forested wetlands in proximity to emergent wetlands), which are not adequately described by a single attribute such as dominant plant species or aquatic habitat type. Therefore, to understand bird species' ecological needs and habitat preferences, we evaluated community assemblages without initially linking the locations sampled for birds with standard habitat categories.

Bird assemblages were first identified using hierarchical cluster analysis, which revealed relationships among locations sampled within the SLRE based solely on bird species composition. This approach identified assemblages of species that tend to co-occur irrespective of traditionally defined habitat types. We used percent perfect indication (PPI) models to identify which species or groups of species were most strongly associated with specific landscape features. We also assessed habitat availability at the landscape-scale (i.e., within a 400m buffer from the shoreline) to identify specific features that are under-represented in the SLRE but likely important to a species or group of species. We also quantified species relative abundance, richness, and diversity throughout the SLRE to identify locations of high use and diversity. Once those locations were identified, we summarized local-scale habitat data define vegetation characteristics at locations with the highest and lowest species richness. Together, these analyses will provide a holistic assessment of the environmental and habitat requirements of migratory and breeding birds at multiple spatial scales. We quantitatively assessed which landscape and habitat characteristics are most likely to be beneficial for birds that use the SLRE and, ultimately, to assist in informing habitat management objectives for current and future projects in the area.

AIMS AND OBJECTIVES

Our first objective was to identify bird community assemblages using bird survey data collected by researchers at Natural Resources Research Institute (NRRI). NRRI has conducted bird surveys throughout the SLRE for a variety of projects since the 1970s. The purpose of these surveys was to document bird use throughout the SLRE, including specific locations identified as targets for current and future habitat restoration (e.g., 21st and 40th Avenues West). These bird data were the basis for our analyses. Our second objective was to quantify spatially explicit environmental variables and habitat characteristics associated with the NRRI bird surveys. Because the SLRE is an important stopover location, where birds rest and forage during migration, it was critical to quantify these associations for migrating birds in addition to breeding birds. To identify which environmental and habitat variables were associated with current bird use, we used data from a variety of regional and local sources, which are described in detail in the Methods section.

The overall aim of this study was to identify how species assemblages relate to specific landscape features and cover types. By combining NRRI's bird surveys with environmental and cover type variables, we were able to quantify current habitat availability and provide management guidelines for restoring habitat that is lacking for the bird communities described, guilds, as well as for individual species of interest. For example, we specify use by species of greatest conservation need (SGCN), defined by the Minnesota Department of Natural Resources (MNDNR) as species whose populations are rare, declining, or vulnerable to decline and below levels desirable to ensure their long-term health and stability (MNDNR 2006). Management recommendations include restoration efforts that promote the long-term maintenance of hemi-marsh condition (ratio of open water to emergent vegetation), planting of native perennial vegetation to provide food and cover for a variety of bird species, and using islands to increase mudflat availability for migrating shorebirds. Based on our findings, additional recommendations are provided at the close of this report. Our results will inform restoration goals aimed at maximizing bird biodiversity, benefiting species of conservation concern and to guide current and future restoration efforts in the SLRE.

METHODS

Study Sites and Data Sources

A total of 107 bird survey point-count locations occurring within the SLRE were included in our analyses. These locations spanned from the Duluth-Superior harbor to up-river locations near Chambers Grove (Fig. 1). The spatial extent of these surveys provided an adequate representation of current bird use in the SLRE. Surveys occurred along a gradient of human disturbance, from highly developed (e.g., Minnesota Slip) to primarily forested (e.g., Pokegama River). There were a variety of land cover types surrounding the point-count locations, with many having a mix of emergent wetlands, forested wetlands, shrub/scrub, upland forest, and developed land.

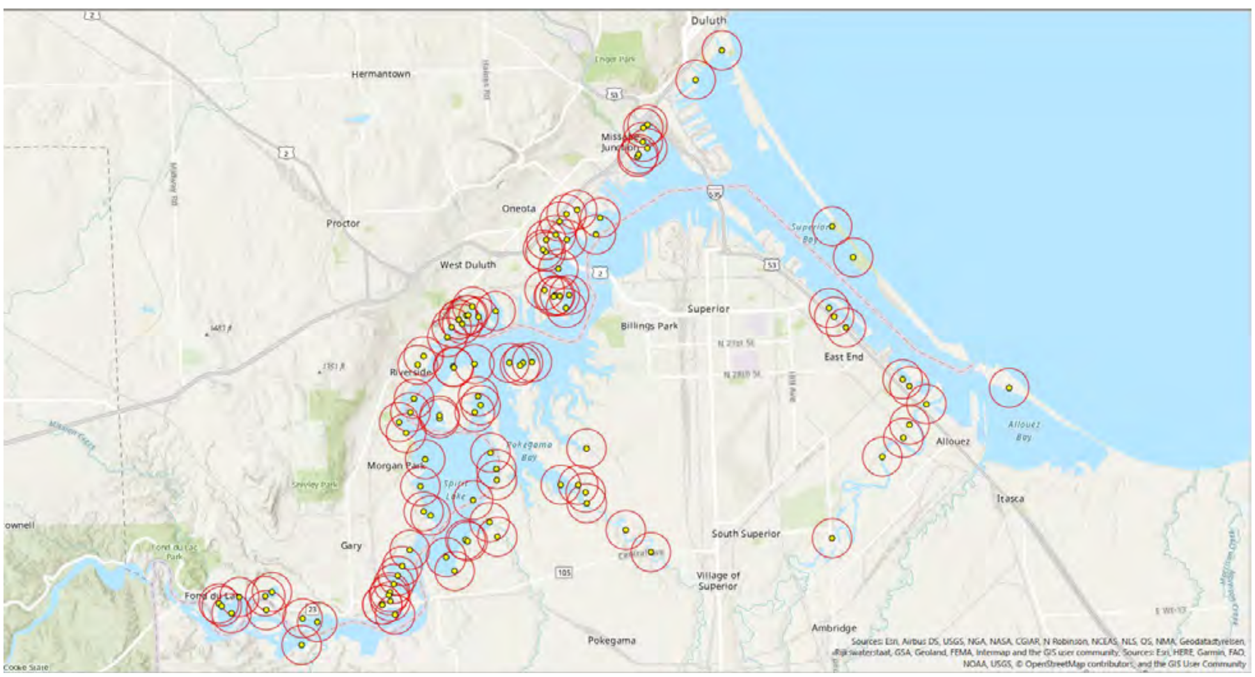

Figure 1. Map of bird point-count locations within the St. Louis River Estuary (*n* = 107). The red circle around each point-count location represents a 500m buffer from which we extracted environmental variables.

Bird Data

We included only current bird survey data collected by NRRI researchers (2011–2018). We restricted our analyses to include only these years because they are most representative of current conditions in the SLRE, and therefore will be most useful for informing current restoration and management efforts. Additionally, many of the bird surveys conducted prior to 2011 either used different sampling methodologies, did not have enough metadata to determine spatial extent or effort, or had no existing land cover or habitat data available.

We used point-count surveys to determine bird use in the SLRE. These surveys are a tally of birds detected by sight and sound at a fixed location during a specified period of time by a trained observer. Bird surveys were conducted during spring (April – early May) and fall (August – November) migration as well as during the breeding season (May 25 – July 10). We combined data collected by NRRI researchers from three sources: 1) Minnesota Pollution Control Agency St. Louis River AOC R2R Support Project: Ecological Monitoring and Assessment (Bracey et al. 2016); 2) Minnesota Land Trust Avian Surveys for the St. Louis River Natural Areas Project (Liljenquist et al. 2019); and 3) the Great Lakes Coastal Wetland Monitoring Program (CWM; https://www.greatlakeswetlands.org/Home.vbhtml). See Bracey et al. (2016) for detailed information about how bird surveys were conducted for both migration and breeding season counts.

Landscape and Local Vegetation Data

We quantified landscape- and local-scale variables from the following sources: 1) The National Oceanic and Atmospheric Administration (NOAA) C-CAP Regional Land Cover; 2) the U.S. Fish & Wildlife Service (USFWS) National Wetland Inventory; and 3) The St. Louis River Estuary Vegetation Database (Danz et al. 2017). Large-scale environmental variables (NOAA C-CAP and USFWS National Wetland Inventory) were quantified within a 200m and 500m circular buffer placed around the center of each bird survey location. We chose 200m and 500m buffers because this adequately captured the scales at which birds select resources and observations were made. The local habitat variables (Danz et al. 2017) were restricted to vegetation surveys conducted within a 200m buffer around each bird survey location, a spatial extent that appropriately described the wetland habitat within each survey location and that is also useful for restoration projects.

Patch Analyst (Rempel et al. 2012) in ArcGIS (ESRI 2019) was used to extract NOAA C-CAP land cover and USFWS National Wetland Inventory wetland classes within each 500m buffer around point-count locations. Extracted area values were converted to percent area per buffer. Land cover and wetland classes used in the analyses are listed in Appendix A. The same process was used to extract land cover occurring within the SLRE from Allouez Bay to Chamber’s Grove. We chose to delineate this spatial extent of the river because it encompasses the wetland areas most likely to be chosen for restoration. Land cover and wetland classes were extracted from a 400m buffer (200m on land and 200m in the river) along the shoreline of the SLRE on both the MN and WI sides (Fig. 2).

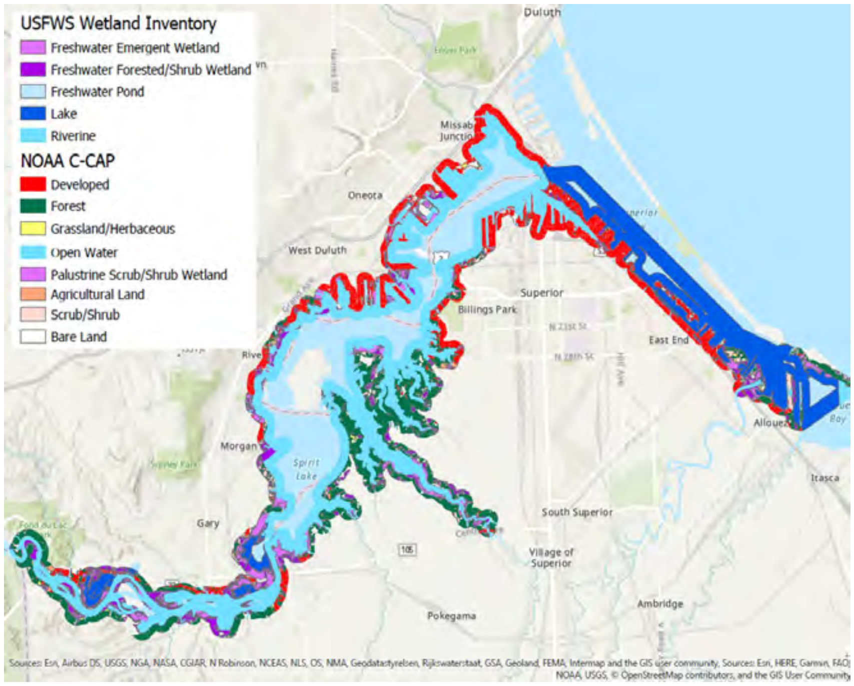

Figure 2. Map of land cover and wetland cover types from USFWS Wetland Inventory and NOAA C-CAP data. Calculations of cover types were restricted to a 400m buffer along the shoreline of the SLRE, from Allouez Bay to Chambers Grove.

We restricted local vegetation variables (Danz et al. 2017) to those that fell within a 200m buffer around each point-count location. Because of the magnitude of the 2012 flooding, we used the following rules to select local vegetation data that aligned best (temporally) with the bird data: 1) if a bird survey year was < 2012: select closest year before 2012; 2) if a bird survey year was ≥ 2012: select closest year after 2011; if no data matching were found in 2 or 3: select closest year ignoring 2012; and 4) select a sample at random if more than one is available from the selected year. Descriptions of local vegetation variables included in the summaries can be found in Appendix B.

Analytical Methods

For all analyses, unknown bird observations and flyovers were excluded. A total of 36,540 individual birds of 169 species were detected for all surveys and seasons combined. The number of bird surveys conducted and species detected varied by season (Table 1). All analyses were conducted independently by season using R version 3.6.1 (R Core Team 2019).

Table 1. The number of individual birds of known species detected during each season (spring migration, breeding season, fall migration) is provided along with the number of species detected, number of point-count surveys conducted, number of point-count locations, and years in which surveys were conducted.

Season	Number of Individuals	Number of Species	Number of Surveys Conducted	Number of Point-Count Locations	Years Surveyed
Spring Migration	8,725	134	174	40	2014 – 2015, 2018
Breeding Season	13,102	120	400	91	2011 – 2019
Fall Migration	14,713	130	312	52	2013 –2015, 2018

Guilds and community metrics

Each bird species was categorized within three different group types based on broad taxonomic groups (11), family (43), and foraging behavior (12; Appendix C). Information for categorizing species was obtained primarily from Cornell Lab of Ornithology (2019). Bird communities were summarized for each site by season using three metrics: species richness, Shannon–Wiener index of diversity, and Shannon evenness to assess bird use among sites and between seasons. We used t-tests to compare differences in environmental variables (cover types) within 200m and 500m buffers of sites with highest and lowest species richness.

To identify local-scale vegetation characteristics associated with diverse bird communities, we used linear regression models to assess the relationship between bird species richness and five vegetation metrics; vegetation species abundance (restricted to species with at least 10 detections), exotic cover, native species richness, water depth, and weighted mean C (Appendix B; refer to Danz et al. 2017 for additional details). Single vegetation metric (e.g., vegetation species abundance) models were fit, and best models were identified using both forward and backward stepwise AIC model selection (Burnham and Anderson 2003), using R package MASS (Venables and Ripley 2002).

Hierarchical cluster analysis

We calculated relative abundance (RA) for each species by aggregating individual counts at each point-count location, summing observations for each species detected and dividing by the number of surveys conducted at each site by season. We then used R package vegan (Oksanen et al. 2019) to identify site clusters. Environmental variables at the 200m and 500m scales were summarized to characterize clusters of sites. Percent Perfect Indicator analysis (see details below) was applied to clusters to identify bird species representative of associated bird communities.

PPI

We used Percent Perfect Indicator (PPI) models to determine associations between environmental variables and bird RA by season (Dufrêne and Legendre 1997). This modeling approach identifies the proportion of a given species detected in a given land cover type (e.g., developed) or wetland type (e.g., freshwater emergent) relative to the proportion of sites in that cover type or wetland type that were occupied by the species. This value can be used as an indicator for how important a landscape characteristic is to a given species (i.e., how strongly the species is associated with given characteristic).

Within each 200m and 500m buffer around point-count locations we calculated percent dominant habitats, after excluding the riverine category, as it comprised 43% of sites and was not useful in these analyses. The C-CAP categories Forested Wetland and Emergent Wetland were also removed because their definitions overlapped with the Wetland Inventory categories of Emergent Wetland and Forested Shrub Wetland. Any land cover type or wetland type categories that were dominant in less than 1% of sites were excluded. We also limited calculations of PPI to species that were detected in at least 10 sites. In addition to species RA, we also calculated PPI values for guilds to identify general patterns in cover type associations for similar species. The *P*-value for PPI indicates whether a species or group of species is a significant indicator of a given land cover type or wetland type. Non-significant values are still informative, as they identify which cover type or wetland type is most frequently used by a given species. PPI models were fit using R package labdsv (Roberts 2019).

RESULTS AND DISCUSSION

Overall

Spring migration: A total of 8,725 individuals of 134 species were observed over three survey years (2015, 2016, and 2018) during 174 point counts (*n*= 40) in the SLRE during spring migration (Table 1). The most common species included Lesser Scaup (1,187), Red-winged Blackbird (1,061), Canada Goose (751), Ring-necked Duck (661), and Mallard (486). Annual relative abundance for each species observed during spring migration can be found in Appendix D.

Breeding season: A total of 13,102 individuals of 120 species were observed over nine survey years (2011–2019) during 400 point counts (*n*= 91) in the SLRE during the breeding season (Table 1). The most common species detected during the breeding season included Red-winged Blackbird (3,043), Canada Goose (2,050), Ring-billed Gull (1,261), Yellow Warbler (795), and Song Sparrow (646). Annual relative abundance for species observed during the breeding season can be found in Appendix E.

Fall migration: A total of 14,713 individuals of 130 species were observed over four survey years (2013, 2014, 2015, and 2018) during 312 point counts (*n*= 52) in the SLRE during fall migration (Table 1). The most common species included Canada Goose (3,996), American Coot (2,298), Mallard (2,104), Common Grackle (1,093), and European Starling (652). Annual relative abundance for each species observed during fall migration can be found in Appendix F.

Land Cover Types

To determine the availability of different land cover types within the SLRE, we calculated the percentages of each land cover type from the NOAA C-CAP and USFWS Wetlands Inventory datasets (Appendix A). Because of differences in land use between MN and WI, we calculated percentages both independently for each state and with states combined (Fig. 2; Tables 2 and 3).

Table 2. Percent area of NOAA C-CAP land cover types found within a 400m buffer along the shoreline of the St. Louis River Estuary (SLRE). Values are provided separately ("Independent") for shoreline occurring in Minnesota (MN) and Wisconsin (WI), as well as in reference to availability within the entire SLRE (confined to 400m buffer around shoreline). See Appendix A for a description of land classifications. "Independent" values were calculated by dividing the land cover area by the total wetland area in the state. "Relative to SLRE" values were calculated by dividing the land cover area by the combined 400m buffer area in the SLRE.

	Independent (%)		**Relative to entire SLRE (%)**		
C-Cap Land Classification	***WI***	***MN***	***WI***	***MN***	***Total***
Developed	13.7	22.0	8.8	7.9	16.7
Agricultural Land	0.2	0.3	0.1	0.1	0.3
Grassland/Herbaceous	0.3	0.4	0.2	0.2	0.4
Forest	19.7	5.2	12.7	1.9	14.5
Scrub/Shrub	3.5	3.4	2.3	1.2	3.5
Palustrine Forested Wetland	4.3	2.0	2.8	0.7	3.5
Palustrine Scrub/Shrub Wetland	4.3	9.6	2.8	3.5	6.2
Palustrine Emergent Wetland	2.7	4.6	1.8	1.7	3.4
Bare Land	0.2	1.0	0.1	0.4	0.5
Open Water	51.0	51.6	32.7	18.5	51.2
Totals	100.0	100.0	64.1	35.9	100.0

Table 3. Percentages of USFWS Wetland Inventory wetland cover type found along the shoreline of the St. Louis River Estuary (SLRE). Values are provided separately ("Independent") for shoreline occurring in Minnesota (MN) and Wisconsin (WI), as well as in reference to availability of total wetland area and availability within the entire SLRE (confined to 400m buffer around shoreline). See Appendix A for a description of land classifications. "Independent" values were calculated by dividing the land cover area by the total wetland area in the state. "Relative to SLRE" values were calculated by dividing the land cover area by the combined 400 m buffer area in the SLRE.

	Independent (%)		**Relative to entire SLRE (%)**		
Wetland Inventory Land Classification	***WI***	***MN***	***WI***	***MN***	***Total***
Lake	31.7	22.3	11.7	5.3	17.0
Riverine	49.5	54.9	18.3	13.0	31.3
Freshwater Emergent Wetland	9.6	13.1	3.6	3.1	6.7
Freshwater Forested/Shrub Wetland	8.7	8.3	3.2	2.0	5.2
Freshwater Pond	0.6	1.4	0.2	0.3	0.5
Total	100.0	100.0	37.0	23.7	60.7

Land cover type summary: Based on the wetlands inventory data, there are approximately 3,100 hectares of 'wetland habitat' in the SLRE, including lands classified as riverine and lakes. Approximately 1,900 hectares are located in WI and 1,200 hectares are in MN. The three most abundant land cover types in the SLRE, after excluding riverine and lake, are developed, forest, and emergent wetland, respectively. As shown in Figure 2, the majority of developed land is located in the lower SLRE, in both MN and WI, while the majority of forested land is south of Billings Park in the Superior Municipal Forest, WI.

Minnesota: The three main land cover types in MN, excluding riverine and lake, are developed (covered by varying amounts of constructed materials), forest (dominated by trees generally greater than 5 meters tall and greater than 20% of total vegetation cover), and scrub/shrub wetland (dominated by woody vegetation less than 5 meters in height and total vegetation cover > 20%). Lands classified as wetlands comprise 66% of the 400m buffer area. Relative to size, there is more scrub/shrub and emergent wetland habitat (dominated by persistent emergent vascular plants, emergent mosses or lichens and total vegetation cover > 20%) located in MN than in WI.

Wisconsin: The three main land cover types in WI, excluding riverine and lake, are developed, forest, and emergent wetland. Lands classified as wetlands comprise 58% of the 400m buffer area. Compared to MN, there is more forested land in WI along the shore of the SLRE.

Discussion: An important takeaway from this summary is that while emergent wetland is a relatively common cover type, it primarily occurs in small patches throughout the SLRE. For example, less than 15% of the survey sites had more than 30% emergent cover at the 200m scale, and only two sites had more than 30% emergent wetland cover at the 500m scale. In general, increasing the amount and quality of emergent wetland habitat in the SLRE would be beneficial for bird communities. Long-term conservation efforts should focus on protecting the existing emergent wetland habitat and identifying restoration activities that enhance the connectivity between the small patches to provide quality habitat.

Guilds and community metrics

Bird community metrics (species richness, Shannon–Wiener index of diversity and Shannon evenness) were summarized by site and season for all bird guilds and groups, the full set of figures can be found in Appendix G. The results for the overall bird community metrics (i.e., all species; Fig. 3a) show that high diversity locations differ between seasons (spring migration, breeding, and fall migration), but in general, diversity and richness are higher in up-river sites compared to those in the lower part of the estuary and are highest near the Riverside the Spirit Lake areas (Table 4). Maps focusing on SGCNs (Fig. 3b) show a similar pattern (Table 5).

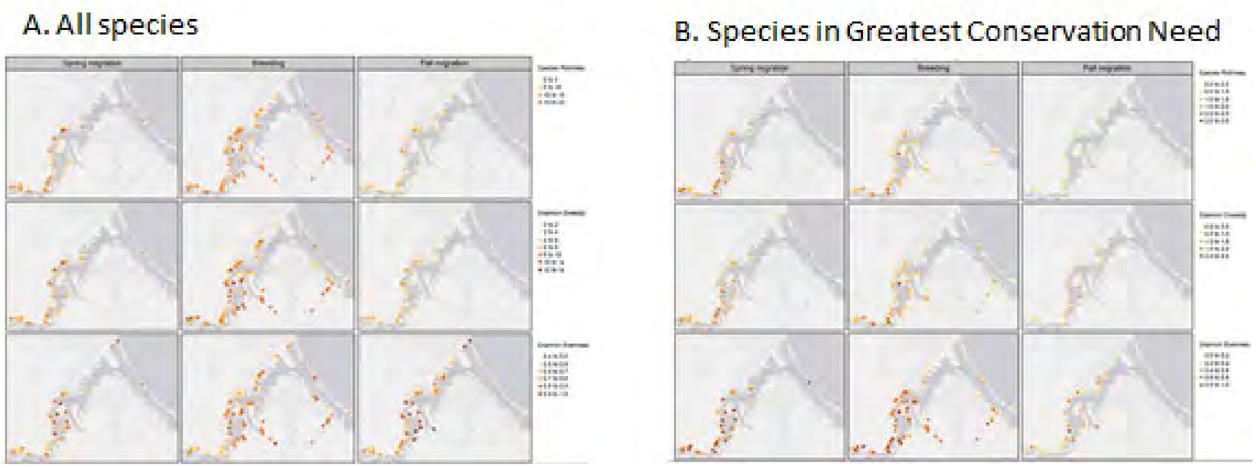

Figure 3. Maps of community metrics by season in the SLRE. A. shows the community metrics for all species observed each season, and B. shows community metrics for those designated as Species in Greatest Conservation Need by the Minnesota Department of Natural Resources.

Table 4. List of bird survey point-count locations within the St. Louis River Estuary (SLRE) where the highest and lowest mean species richness (SR) were detected during each season (spring migration, breeding, fall migration). We restricted sites to include the five highest and lowest values.

Season	Site	High SR		Site	Low SR
Spring migration	Grassy Point 2	16.33		Slip C 1	4.33
	Kingsbury Bay KB.2	15.20		Minnesota Slip 1	4.25
	Mud Lake ML.1	14.67		Clough Island 2	4.00
	Rask Bay RB.1	14.50		Spirit Lake West 3	3.00
	North Bay NB.1	13.83		Clough Island 1	2.00
Breeding	Clough Island 1	16.00		7073 4 (Kingsbury Bay)	6.50
	North Bay 1	15.80		7049 2 (21st Ave W)	6.17
	Kingsbury Bay 2	15.50		Minnesota Slip 1	5.60
	Perch Lake 1	14.67		7073 1 (Kingsbury Bay)	4.50
	Tallas Island TI.1	14.67		7074 1 (Grassy Point)	4.00
Fall migration	Kingsbury Bay KB.2	13.33		40th Avenue West 2	2.00
	Sargent Creek Floodplain SF.1	11.83		Spirit Lake West 3	1.83
	Spirit Lake SL.2	11.00		Spirit Lake East 2	1.67
	North Bay NB.1	10.67		Slip C 1	1.56
	Mud Lake ML.1	10.33		Spirit Lake East 1	1.20
	Mud Lake ML.1	10.33		Spirit Lake East 1	1.20

Table 5. List of bird survey point-count locations within the St. Louis River Estuary (SLRE) where the highest and lowest mean species richness (SR) were detected for species of greatest conservation need (SGCN), during each season (fall migration, breeding, spring migration). We restricted sites to include the five highest and lowest values. When sites had equal SR values, both were included; therefore, some seasons have more than five sites listed.

Season	Site	High SR	Site	Low SR
Spring migration	Rask Bay 2	3.00	Slip C 1	0.67
	Mud Lake ML.1	2.33	Spirit Lake East 1	0.67
	Spirit Lake SL.3	2.20	Sargent Creek Floodplain SF.2	0.60
	Mud Lake ML.2	2.00	Spirit Lake East 2	0.33
	Radio Tower Bay 1	2.00	Minnesota Slip 1	0.25
	Rask Bay RB.2	2.00		
	Spirit Lake West 1	2.00		
Breeding	7064 2 (Mud Lake)	2.50	1191 1 (Wisconsin Point Bay)	0.25
	Radio Tower Bay 1	2.33	7048 1 (40th Ave West)	0.25
	North Bay 1	2.20	Minnesota Slip 1	0.20
	Clough Island 1	2.00	1194 1 (inlet near Barker's Island)	0.17
	Kingsbury Bay 2	2.00	7049 2 (21st Ave West)	0.17
			7049 1 (21st Ave West)	0.13
Fall migration	Spirit Lake SL.2	1.17	Perch Lake 1	0.18
	Rask Bay RB.2	0.83	Grassy Point GP.1	0.17
	Spirit Lake SL.3	0.83	Kingsbury Bay 1	0.17
	40th Avenue West 3	0.80	Kingsbury Bay 2	0.17
	Little Pokegama Bay 2	0.75	Little Pokegama Bay 1	0.14

Based on linear regression models, there were no significant vegetation characteristics associated with species richness during any season, which may be a consequence of inadequate sample sizes for some metrics each season and high within group variability. However, the best model for the breeding season was nearly significant (p = 0.07) and showed that breeding bird species richness was positively correlated with native richness of plant communities. Some of the sites with the lowest species richness did not contain any vegetation (e.g., Minnesota Slip), and therefore there are no values to compare. Although we were unable to identify specific differences in local-scale vegetation metrics and species richness based on sites with highest and lowest species richness, we summarize the local-scale vegetation metrics for the sites identified in Table 4, including most abundant species of plants observed at sites where data are available, though note the small sample sizes (Appendix H). Although local-scale vegetation metrics were not significantly associated with species richness, landscape-scale environmental variables summarized for the sites with highest and lowest diversity show differences by season (Appendix I). During spring migration, species richness was significantly higher at sites with emergent wetland at the 500m scale and at sites with forested shrub wetlands, at both scales (Appendix I). During the breeding season, the amount of developed land is significantly lower in sites with highest species richness, at both spatial scales (Appendix I). During fall migration, the amount of emergent wetland was significantly greater in sites with highest species richness (Appendix I). These results suggest that breeding birds in the SLRE are more sensitive to human development than are birds during migration, which makes sense given migrating birds are using the habitat for short-term needs associated with rest and foraging, while migrating birds tend to use sites that are more sheltered and surrounded with vegetation (Appendix I).

Discussion: The results of these analyses suggest that pursuing opportunities for wetland restoration in the highly developed areas (i.e., those in the lower SLRE, closer to Lake Superior) would likely benefit birds. An expected outcome would be an overall increase in bird richness and diversity throughout the year and an increase in breeding and stop-over habitat use by SGCNs. A coordinated long-term monitoring program that temporally and spatially tracks changes in both bird and plant communities is recommended for the SLRE. This type of monitoring program will allow us to assess and make specific recommendations regarding plant community composition that will aid habitat restoration teams in identifying, targeting, and mitigating issues associated with biodiversity loss related to habitat quality in a timely manner. At a local scale, restoration plans should focus on the vegetation characteristics that benefit both breeding and migratory bird communities. Specifically, we recommend that restoration plans promote diverse native plant communities and account for ecological processes that will promote resiliency after disturbance.

Hierarchical cluster analysis

Hierarchical cluster analysis illustrated relationships among survey points conducted in each season based on bird associations alone (i.e., ignoring the assigned habitat categories). The relationships between the bird communities and site characteristics paint a complex picture of bird community composition within the SLRE. The relative abundance of species by cluster and results of the PPI for the clusters can be found in Appendix J.

Spring migration: Spring bird communities split the sites into three groups. At the 200m scale, the first group, "Spring A," had a relatively high proportion of emergent and shrub wetland, and high proportion of developed land at the 500m scale. Based on the results of the PPI analysis, the bird species that were characteristic of this group included Tree Swallow, Swamp Sparrow, Hooded Merganser, Blue Jay, American Robin, and Belted Kingfisher (Appendix J). The second group, "Spring B," had a high proportion of the lake cover type at the 200m and 500m scales. Species characteristic of this cluster included Ring-necked Duck and Redhead (Appendix J). Both species are surface divers and were likely responding to the deeper areas associated with the lake cover type. The third group, "Spring C," was a mix of cover types at both scales (Fig. 4), and the only characteristic species for this cluster was Common Tern (Appendix J).

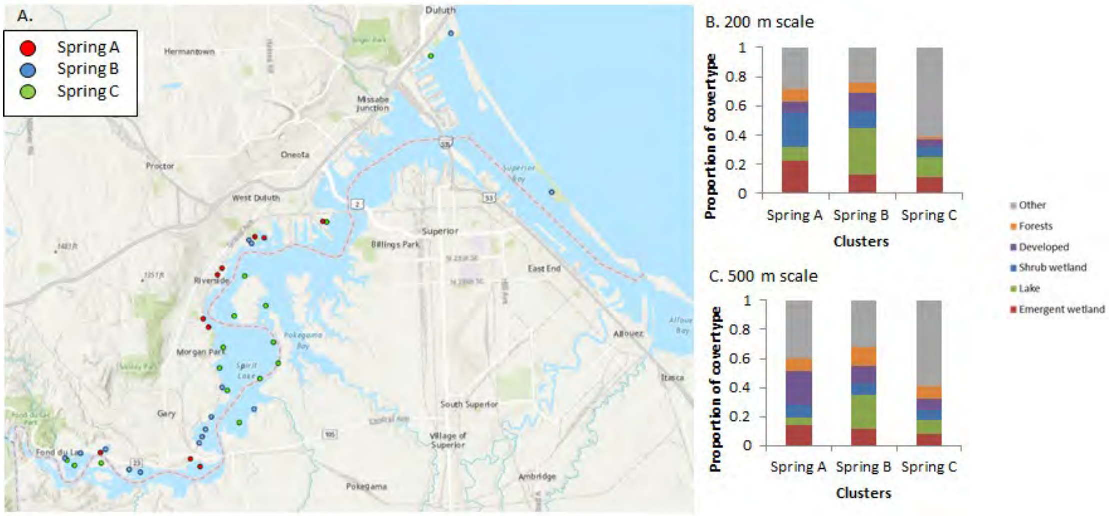

Figure 4. Site groupings based on the results of hierarchical cluster analysis for spring migration. **A.)** map of sites by cluster and summary of cover type variables of sites at the **B.)** 200m and **C.)** 500m scales.

Breeding season: The breeding season bird communities split the sites into four groups; the clusters had a similar proportion of emergent wetland, shrub wetland, and forest cover at the 200m scale (Fig. 5). Breeding group A had a relatively high proportion of developed cover, and characteristic species were those well-adapted to humans and included Ring-billed Gull, Mallard, and European Starling (Fig. 5; Appendix J). Sites in breeding group B had a mix of cover types at the 200m scale, but distinctive features were a high proportion of forests at the 500m scale. There were several characteristic species including European Starlings, Veery, Red-eyed Vireo, Ovenbird, Black-capped Chickadee, White-throated Sparrow, Chestnut-sided Warbler, Northern Flicker, and Black-throated Green Warbler (Appendix J). All characteristic species for this cluster breed in forest habitats with the exception of European Starling. Breeding groups C and D had a mix of land cover types, but sites in breeding group D had a higher proportion of lake cover (Fig. 5). There were no species that were characteristic of Breeding C, but there was high relative abundance of many wetland breeding species such as Yellow Warbler, Common Yellowthroat, Swamp Sparrow, and Marsh Wren. Importantly, this cluster had the highest relative abundance of both Virginia Rail and Sora. Breeding group D also had several wetland-associated species, including Swamp Sparrow and Marsh Wren. Red-winged Blackbird, Canada Goose, and Common Grackle were characteristic species of Breeding D. The results of breeding groups C and D show that these are the sites that are important for breeding wetland birds. The combination of “wetland” habitats including lake, emergent wetland, and scrub-shrub wetlands for these sites are, on average, at least 50% of the 200m scale (Fig. 5).

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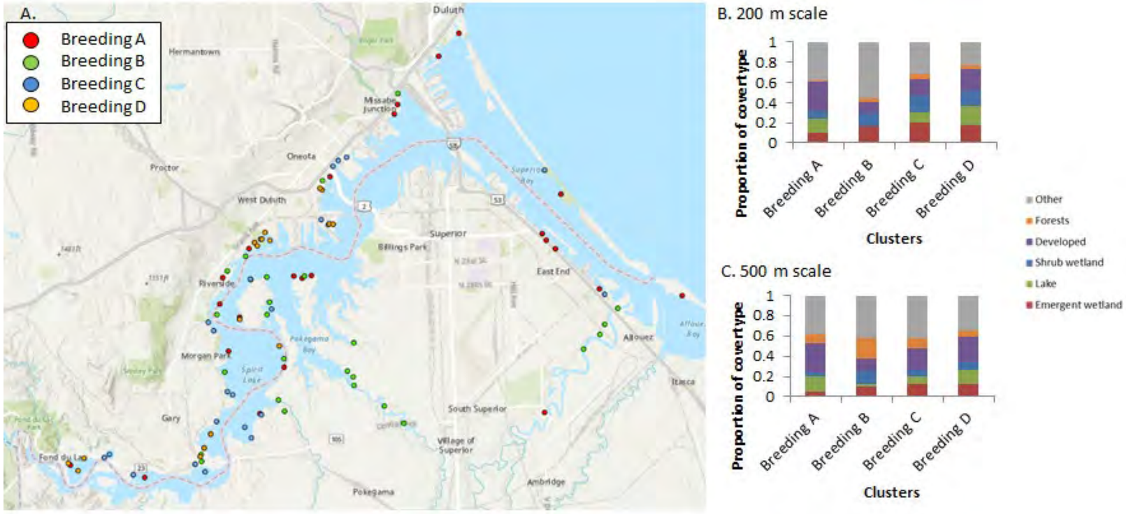

Figure 5. Site groupings based on the results of hierarchical cluster analysis for the breeding season. **A.)** map of sites by cluster and summary of cover type variables of sites at the **B.)** 200m and **C.)** 500m scales.

Fall migration: The fall migration bird communities clustered sites into three groups. Sites in fall group A had a mix of cover types at the 200m scale and a high proportion of developed and lake cover types at the 500m scale (Fig. 6). Sites in the fall group B sites had relatively little lake cover at the 200m scale and high percentage of forest at the 500m scales (Fig. 6). Sites in the fall group C cluster had a high proportion of lake and developed at the 200m scale (Fig. 6). There were no species that had significant associations for the fall migration clusters (Appendix J), although there were patterns in overall relative abundances between groups. For example, Fall A had many species that are tolerant to development such as Canada Goose, Mallard, and Common Grackle. Importantly, this group had the highest relative abundance of Rusty Blackbirds. Fall group B had a mix of waterfowl such as Canada Goose, Mallard, and American Coot, along with wetland species such as Red-Winged Blackbird, and forest species such as Black-capped Chickadees. Fall Group C had several waterfowl species with relatively high abundances such as American Coot, Ring-necked Duck, and Bufflehead (Appendix J).

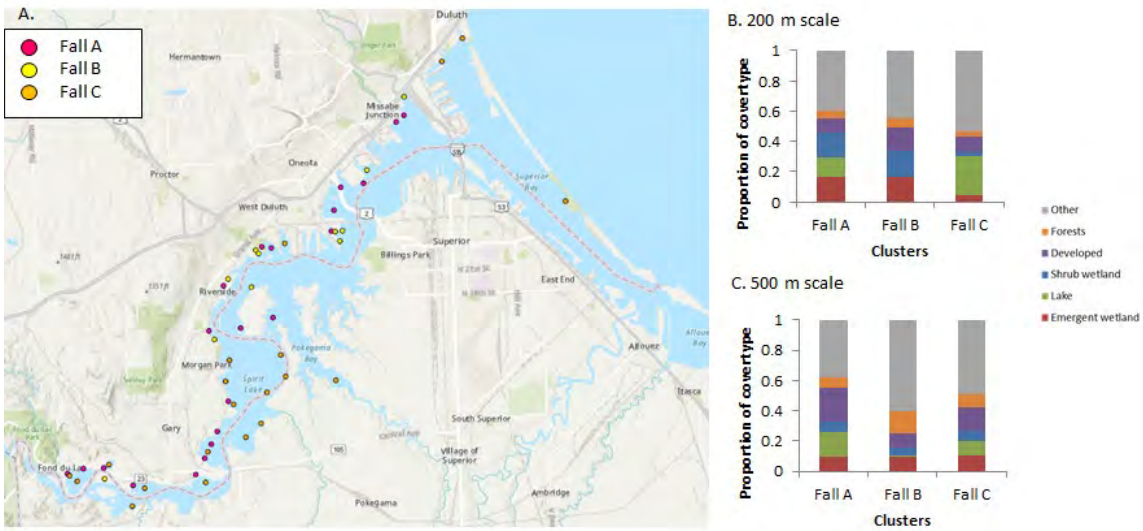

Figure 6. Site groupings based on the results of hierarchical cluster analysis for fall migration. **A.)** map of sites by cluster groupings and summary of cover type variables of clustered sites at the **B.)** 200m and **C.)** 500m scales.

Discussion: The overall results of these analyses show that birds use a combination of scrub-shrub, emergent, and lake habitats, i.e., there are no groups that have a dominant "emergent wetland," "scrub-shrub wetland," or "lake" characteristics. The goal of restoration priorities should be to provide a minimum of 50% of "wetland-associated" cover types to support breeding wetland species. This guideline will also benefit migrating birds.

PPI

Species-specific. The results of the species PPI analysis showed 25 species had significant associations with cover type variables at the 200m and 500m scales (Appendix K). Red-winged Blackbird was the only species that had a significant result during spring migration and was associated with shrub wetlands at the 200m scale. Fourteen (14) species had significant associations with cover type variables at the 200m scale, and 17 species had significant associations at the 500m scale. This result is likely due to the fact that species respond to different scales, particularly during the breeding season, and scale of importance is generally associated with territory size, foraging behavior, and nesting requirements. During fall migration, four species — American Goldfinch, Common Yellowthroat, Hairy Woodpecker, and Red-eyed Vireo — were significantly associated with forested shrub wetland at the 200m scale. These results show the importance of a variety of habitat types in the SLRE used by birds throughout the year.

There were no significant habitat associations for these wetland-obligate bird species including American Coot, Marsh Wren, Pied-billed Grebe, Sora, Swamp Sparrow, and Virginia Rail (Fig. 7). However, the results of the PPI show the relative importance of different habitat types for each species.

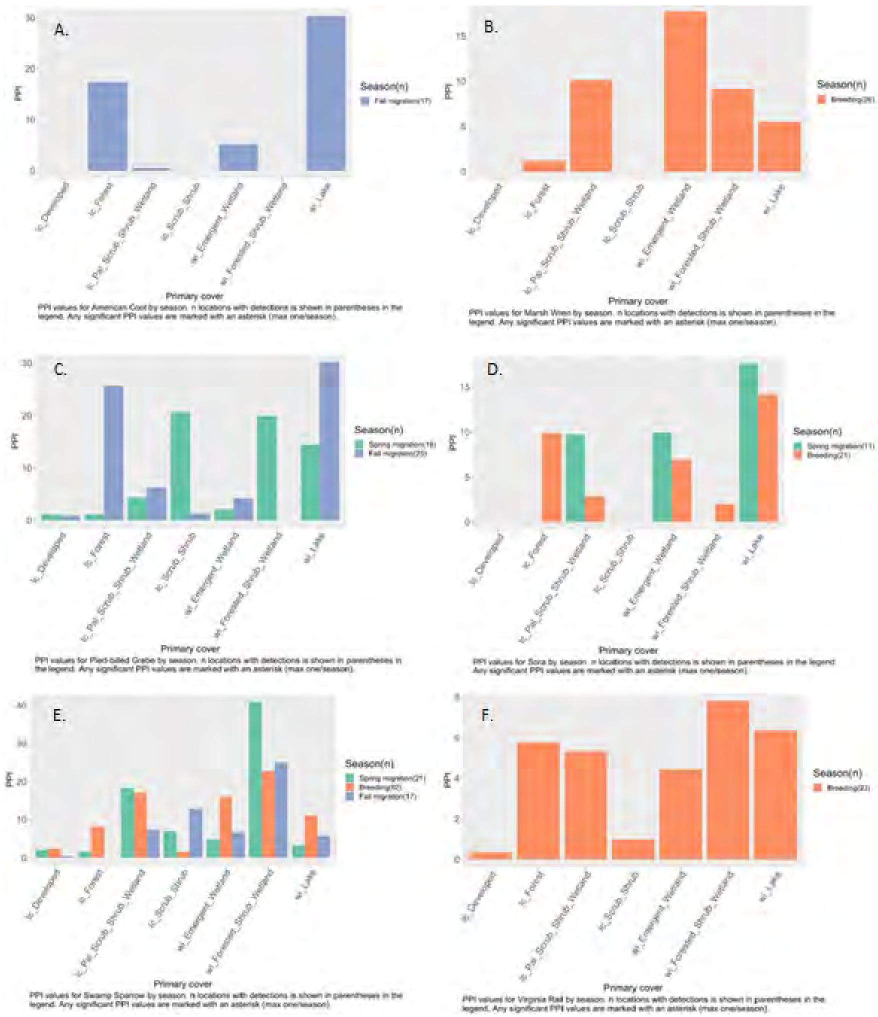

Figure 7. PPI results of cover type associations for wetland obligate bird species including **A.)** American Coot, **B.)** Marsh Wren, **C.)** Pied-billed Grebe, **D.)** Sora, **E.)** Swamp Sparrow, and **F.)** Virginia Rail.

Guilds. The results of the PPI analysis showed significant associations for 5 guilds during spring migration, 13 guilds during the breeding season, and 4 guilds during fall migration (Appendices L–N).

Forested shrub wetlands was significantly associated with several guilds. For example, groups that characterize sandpipers (probing, Scolopacidae, shorebirds) were significantly associated with forested shrub wetlands at the 200m scale during spring migration and during the breeding season. Additionally, aerial foragers, kingfishers, and swallows were associated with forested shrub wetlands at the 200m scale during the breeding season. Warblers and bark foragers were significantly associated with forest cover type during the breeding season at the 200m and 500m scales, respectively. During fall migration, forested shrub wetlands were significantly associated with finches and cormorants at the 200m scale and soaring foragers at the 500m scale. Importantly, emergent wetland at the 500m scale was significantly associated with rails during fall migration.

SUMMARY AND MANAGEMENT RECOMMENDATIONS

- The SLRE is critical to birds throughout the year. A consistent, dedicated, long-term bird monitoring program in the SLRE is essential for long-term conservation of biodiversity. We recommend a monitoring program that focuses on bird use in the SLRE throughout the year (spring migration, breeding, and fall migration). The monitoring program should also include an overlapping and coordinated fine-scale vegetation component that allows for classifying native plant communities at the bird survey sites. Annual drone imagery that facilitates monitoring the amount and locations of emergent wetland at the landscape scale would be important for documenting changes in wetland quality over time. Specifically, changes in the availability of emergent wetland habitat from a combination of shrub encroachment, water level changes, and the spread of invasive plant species needs to be monitored.
- Results of cluster and PPI analyses show the importance of having a variety of habitat types in the SLRE, which are used by birds throughout the year. Many bird species and guilds rely on "shrub- scrub" wetlands, maintaining these cover types is recommended.
- Birds that are considered "wetland obligate" species are present but not widespread in the estuary, despite the fact that there is habitat available. While wetland obligate species such as Virginia Rail are often observed in the SLRE, they are found in low densities, thus making site-specific habitat recommendations challenging.
- Our results suggest that pursuing opportunities for wetland restoration in the highly developed areas (i.e., those that are closer to Lake Superior) would likely benefit birds, and an expected outcome would be an overall increase in bird richness and diversity throughout the year and an increase in available breeding and stop-over habitat for SGCN. Based on sites with highest species richness and cluster analyses, increasing the amount and quality of emergent wetland habitat in the SLRE would be beneficial for several bird communities. The goal of restoration priorities should be to provide a minimum of 50% "wetland-associated" cover types to support breeding wetland species. This guideline will also benefit migrating birds.
- Long-term conservation efforts should focus on protecting the existing emergent wetland habitat and identifying restoration activities that enhance connectivity between the small patches that are providing quality habitat.

REFERENCES

Bracey, A., J. Chatterton, and G. Niemi. 2016. St. Louis River AOC R2R Support Projects: Ecological Monitoring and Assessment (CR#6403). Final Report submitted to the Minnesota Pollution Control Agency, Duluth, MN. 64 p. https://conservancy.umn.edu/handle/11299/188455

Burnham, K.P., and D.R. Anderson. 2003. Model selection and multimodel inference. A practical Information-Theoretic Approach, 2nd Ed. Springer, New York.

Cornell Lab of Ornithology. 2019. All about birds. Retrieved December 2019 from https://www.allaboutbirds.org/guide/browse/taxonomy#

Danz, N.P., N.B. Dahlberg, and S. Schooler. 2017. The St. Louis River Estuary vegetation database. Lake Superior Research Institute Technical Report 2017-1, University of Wisconsin-Superior, Superior, WI. 8 p.

Dufrêne, M., and P. Legendre. 1997. Species assemblages and indicator species: The need for a flexible asymmetrical approach. Ecological Monographs 67:345–366.

ESRI 2019. ArcGIS Desktop: Release 10.7.1. Redlands, CA: Environmental Systems Research Institute.

Liljenquist, A., A. Bracey, and A. Grinde. 2019. Avian surveys for the St. Louis River Natural Areas Project: Submitted to Minnesota Land Trust. Natural Resources Research Institute, University of Minnesota Duluth, Technical Summary Report NRRI/TSR-2019/09. 39 p.

MNDNR. 2006. Tomorrow's habitat for the wild and rare: An action plan for Minnesota wildlife. Minnesota Department of Natural Resources, Division of Ecological Services.

Oksanen, J., F. Guillame Blanchet, M. Friendly, R. Kindt, P. Legendre, D. McGlinn, P.R. Minchin, R.B. O'Hara, G.L. Simpson, P. Solymos, M. Henry, H. Stevens, E. Szoecs, and H. Wagner. 2019. Vegan: Community Ecology Package. R package version 2.5-6. https://CRAN.R-project.or/package=vegan

R Core Team. 2019. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rempel, R.S., D. Kaukinen, and A.P. Carr. 2012. Patch Analyst and Patch Grid. Ontario Ministry of Natural Resources, Centre for Northern Forest Ecosystem Research, Thunder Bay. http://www.cnfer.on.ca/SEP/patchanalyst/

Roberts, D.W. 2019. labdsv: Ordination and Multivariate Analysis for Ecology.R package version 2.0-1. https://cran.r-project.org/package=labdsv.

Venables, W.N., and B.D. Ripley. 2002. Modern Applied Statistics with S, 4th Ed. Springer, New York.

LIST OF APPENDICES

Appendices are attached to this document as individual PDF files. Following are descriptions for each appendix. Click on the appendix title to open that appendix:

Appendix A. List of landscape-scale variables included in analyses to identify bird-habitat associations. These variables were calculated within a 200m and 500m buffer around each bird survey point count location. A brief description of each classification is provided for each dataset. A link to additional metadata for each source can be found in the footnotes.

Appendix B. List of local-scale (within wetland) plant community variables included in analyses to identify bird-habitat associations. These variables were calculated within a 200m buffer around each bird survey point count location. A brief description of each classification is provided for each dataset. A link to additional metadata for each source can be found in the footnotes.

Appendix C. List of species detected during point-count surveys in the St. Louis River Estuary. The four-letter alpha code is provided for each species as well as common and scientific name, group it was included in for analysis, family group, foraging behavior, and whether it was identified as a species of greatest conservation need (SGCN) by the Minnesota Department of Natural Resources (DNR). The footnote has a link to the Minnesota DNR listed species that provides additional information about each species.

Appendix D. Relative abundance of each species detected per year during spring migration.

Appendix E. Relative abundance of each species detected by year during the breeding season.

Appendix F. Relative abundance of each species detected by year during fall migration.

Appendix G. Bird community species richness, species diversity, and species evenness maps of the St. Louis River Estuary for spring migration, breeding season, and fall migration.

Appendix H. List of local-scale vegetation metrics included in the species richness linear regression models. The sites with highest and lowest species richness (SR), provided in Table 6, are summarized here. Detailed descriptions of the vegetation metrics can be found in Appendix B and in Danz et al. (2017). The average value of each metric and range of values is provided with the sample size (n). For plot_obs, the most common species are listed, note the sample size of plot_obs is particularly low for all seasons.

Appendix I. Comparison of environmental variables within 200 and 500m buffers around bird survey locations for sites with highest and lowest species richness (see Table 6 for list of sites). Within each season (Breeding, Fall migration, Spring migration), mean percent cover and range are provided. T-test Results are provided by buffer distance and significant values ($p \leq 0.05$) and in bold.

Appendix J. Species relative abundance and results of the Percent Perfect Indicator analyses based on the results of the heirarchical cluster analysis.

Appendix K. Percent Perfect Indication (PPI) values for species relative to cover type and season (spring, breeding, and fall). Values are listed at the 200m and 500m scales. Significant values are denoted in bold with an asterisk and the number of locations with detections is included in parentheses.

Appendix L. Percent Perfect Indication (PPI) values for groups of species (behavior, family, general) relative to cover type and season (Spring, Breeding, and Fall). Values are listed at the 200m and 500m scales. Significant values are denoted in bold with an asterisk and the number of locations with detections is included in parentheses.

Appendix M. Percent Perfect Indication (PPI) values for groups of species (behavior, family, general) relative to season (spring, breeding, and fall) and cover type at the 200m scale.

Appendix N. Percent Perfect Indication (PPI) values for groups of species (behavior, family, general) relative to season (spring, breeding, and fall) and cover type at the 500m scale.

DULUTH NATURAL AREAS PROGRAM