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Avian Surveys for the St. Louis River Natural Areas Project: Submitted to Minnesota Land Trust

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PROJECT OVERVIEW

In 2018, researchers from the Natural Resources Research Institute (NRRI) at the University of Minnesota Duluth conducted bird surveys along the St. Louis River Estuary (SLRE) in nine project areas nominated for inclusion in the Duluth Natural Areas Program (DNAP). The DNAP was created in 2002 to manage Duluth's environmentally significant areas to ensure the preservation of services and values, such as habitat diversity and water quality (Duluth Natural Areas Program Guidelines 2002). To assess the importance of the SLRE to birds, we conducted surveys throughout spring migration, the breeding season, and fall migration. In total, we documented 13,953 individuals of 169 species. We summarized bird use of the nine project areas based on abundance and diversity by guild classification within each season. All nine project areas in the nominated tract (i.e. SLRE) meet the conditions for 'Important Bird Congregation Area' based on nomination criteria outlined by DNAP. The western tip of Lake Superior is a well-known corridor for migrating birds, which funnel along the shore, using forests, wetlands, and shoreline habitat, to rest and refuel during both north and southbound migration. This study highlights the importance of the SLRE for breeding birds and as stopover habitat for a wide diversity of migratory birds, including 50 species of conservation concern.

INTRODUCTION

Wetlands are one of the most productive ecosystems in North America; they provide an abundance of habitat and food for diverse ecological communities. More than one third of threatened and endangered species in the United States live only in wetlands (U.S. Environmental Protection Agency 2018). Wetlands provide a wide variety of feeding and nesting resources for breeding birds and migrating birds, which use wetlands as stopover habitat. According to Bancroft (1989), by the 1970s more than 50% of wetlands in the United States had been drained. For this reason, it is important to protect and restore remaining wetlands because of their ecological importance and the diversity of species they sustain.

Bird communities provide many services. Diverse bird communities play a vital role in maintaining both the structure and function of ecosystems by providing numerous ecological services such as seed dispersal and pest control. Furthermore, because birds assimilate environmental variables over space and time, changes in bird communities provide meaningful signals of local ecosystem health and degradation (Gnass Giese et al. 2015). Birds are commonly used as bioindicators because they can be surveyed relatively easily and provide important information about the impacts of conservation and restoration efforts (Butler et al. 2012).

The St. Louis River Estuary (SLRE) is the largest and most biologically productive wetland and aquatic complex in western Lake Superior and supports a high level of bird diversity (The Nature Conservancy 2019). The SLRE provides unique experiences like bird watching and photography for the general public. The Duluth area is renowned for these activities, and they contribute significant ecotourism dollars to region. However, the ecological integrity and habitat quality of the SLRE has been impacted by several historical and ongoing threats including habitat loss, increased sedimentation, development, invasive species, and contaminant exposure from industrial activity. These threats have caused significant impairments to the beneficial use of resources in the SLRE, which led to its designation as a Great Lakes Area of Concern (AOC) under the 1987 Great Lakes Water Quality Agreement (St. Louis River AOC RAP Update 2013). Because progress has been made to decrease the impairments on the beneficial use of the SLRE's resources, current efforts toward delisting are in progress. In an effort to permanently

protect up to 1,300 acres of coastal wetlands and shoreline along nearly 10 miles of the SLRE, the City of Duluth and Minnesota Land Trust (MLT) are working to incorporate integrated public ownership, ecological restoration, and conservation management to nominate this area of land into the Duluth Natural Areas Program (DNAP). This nomination will facilitate a coordinated, holistic, and landscape-scale approach to long-term conservation and management of the SLRE's natural resources.

The avian research team at the Natural Resources Research Institute (NRRI), University of Minnesota Duluth has led four research projects focusing on bird populations in the SLRE since the late 1970s. Each project has had a variety of research objectives, but the overarching goal of each was to document the status of bird populations in the SLRE. This long-term data set provides a historical context for the ecological importance of birds in the SLRE for the past 40 years and also provides data with which to frame restoration outcomes and management guidelines.

The DNAP has developed standards to identify local areas as "Important Bird Congregation Areas." The criteria for this designation are modified from those used to identify Important Bird Areas (IBAs), which are designated globally as locations that provide essential habitat for avian species during some phase of their life cycle. These areas are protected for a variety of reasons including providing important habitat for vulnerable, threatened or endangered species, endemic species, species representative of a biome, or for significant concentrations of birds from a diversity of guilds (e.g. waterfowl, shorebirds, migratory landbirds; Duluth Natural Areas Program Guidelines 2002).The purpose of the IBA program at all scales, from state to global, is to identify sites that provide essential habitat for one or more species of breeding or migratory birds (BirdLife International 2019). The designation of an Important Bird Congregation Area as outlined by the DNAP is modified from the category 4 IBA criteria and is defined as: "sites that are important because they hold large concentrations of birds during one or more seasons; breeding, wintering, or migratory (Duluth Natural Areas Program Guidelines 2002)." We used these criteria as the basis of our survey design and data summaries. The overall objectives of this project were to:

1. Document bird use in nine project areas in the SLRE identified by MLT during three survey periods: spring migration, breeding season, and fall migration;
2. Summarize bird use at each project area for each survey period to determine if they meet the criteria of "Important Bird Congregation Area" as outlined by DNAP;
3. Highlight the use of project areas by species of conservation concern and provide management recommendations to the extent possible; and
4. Summarize the results of four previous bird studies that have been conducted in the area by researchers at NRRI to provide historical context of bird use in the SLRE.

METHODS

Experimental design and procedures

A total of 14 surveys were conducted at each of the 23 survey points located in the nine project areas from April–October 2018 (Fig. 1). Of these 14 surveys, 6 occurred during peak spring migration (April–May), 2 during the breeding season (June), and 6 during peak autumn migration (August–October). A total of 322 surveys were conducted between April and October 2018. Sites were revisited with a minimum of 15 days between surveys during the breeding season and 7 days between surveys during migration periods. All bird observations that occurred within the boundary of each project area were documented on aerial photo field sheets and digitized in ArcMap to allow exploration of the spatial

distribution and habitat use of species observed. The number of survey points within each project area were determined by the area of the sites and site accessibility (Fig. 1).

Figure 1. Red polygons represent project area boundaries located within the SLRE, and the black points represent the survey locations associated with that project area for 2018.

Data collection

Project area polygons were provided by the MLT project officer to ensure all sampling occurred within appropriate project area boundaries. The monitoring protocol followed methods used by Bracey et al. (2016), which have proven to be effective in documenting use by individuals and species within relatively small areas. Due to differences in the seasonal distribution of species, sampling protocols varied between breeding (June) and migration (spring/autumn) surveys as detailed below.

Surveys were designed to obtain a complete count of birds present in each project area during each visit. Surveys consisted of unlimited distance counts at designated locations within each project area; all detected individuals were recorded. The spatial location of each individual was marked on a field sheet that included an aerial photo for reference. Behavior was recorded as either singing, calling, drumming (woodpecker species and Ruffed Grouse), visual observation, or flyover.

Surveys were completed from a fixed-point location within each project area for 10 minutes. For breeding surveys, we used the same fixed-point locations as the migration surveys; however, we extended the point counts to 15 minutes to allow for the incorporation of playbacks. Playbacks were a series of recorded secretive marsh bird calls that were broadcast from an MP3 player with a speaker.

This method allowed us to target species that are difficult to detect with passive methods. The broadcast calls consisted of 30 seconds of vocalization followed by 30 seconds of silence for each of six focal species in the following order: Least Bittern, Sora, Virginia Rail, a mixture of American Coot and Common Gallinule, and Pied-billed Grebe. Broadcasts occurred during the middle 5 minutes of the 15-minute survey, with silence during the first and last 5 minutes of the survey.

Surveys were conducted from 0.5 hours before sunrise to 4.5 hours after sunrise during the breeding season and from sunrise until early afternoon during spring and autumn migration, and all were completed during suitable weather conditions (e.g. minimal wind or precipitation). Detailed sampling methodology can be found in Appendix A. We used a two-person survey protocol to insure safety in the field and for additional support in identification and documentation of observations.

Previous data

Data from four previous projects led by the avian research team at NRRI conducted on bird populations in the SLRE were compared with the data collected from the 2018 Minnesota Land Trust surveys. The most recent surveys were conducted from 2010–2011 and 2013–2015 (Bracey et al. 2016). The goal of Bracey et al. (2016) was to provide a contemporary assessment of bird use of the SLRE by comparing bird use in sites planned for restoration and reference sites with reduced degradation. Bracey et al. (2016) also compared their observations to data collected with slightly different methods in the 1970s. The St. Louis River historical bird survey data from the 1970s were obtained using original data sheets from three projects (Niemi et al. 1977, Davis et al. 1978, Niemi et al. 1979).

Although we followed the survey methods Bracey et al. (2016) used in 2010–2015, the frequency with which each project area was surveyed was not consistent with 2018 protocol. Counts from the 1970s used different methods, and the number of surveys conducted were also not consistent with protocol used for this project. Due to the varied effort and inconsistent sampling between projects, previous data will not be directly compared to 2018 data. However, the major objective of all sampling regimes is to count all detectable individuals within the sample area, so observations from all projects will be used to compare the presence or absence of species that are currently, have previously, or continue to use the SLRE. We will not compare the raw data numbers between projects. Species comparisons were limited to those project areas that overlapped two or more projects. Bracey et al. (2016) did not sample three MLT project areas: Chamber's Grove, Tallas Island, and Munger Landing. Mud Lake was the only 1970s survey area that overlapped with MLT project areas.

Guilds, nomination criteria, and species of conservation concern

Species were classified into 16 guilds based on taxonomy and physiological similarities as well as individual species groups of interest. These groups are as follows: gulls and terns, waterfowl, waterbird, wading bird, raptor, shorebird, blackbird, songbird, corvid, pigeon, woodpecker, dove, rail, hummingbird, grouse, and invasive. Grouping individuals based on taxonomy and physiological similarities is useful for illustrating habitat use similarities within these groups. Each species of bird that was observed from 1977–2018 is listed along with their guild classification in Appendix B.

DNAP outlined six guilds in their nomination and benchmark criteria for the designation of Important Bird Congregation Areas. We used 16 more-detailed guild categories that are consistent with previous surveys and provide additional insight into bird community assemblies in the SLRE as stated above. Table 1 shows the guild classification crosswalk along with a brief description of the guild

groupings. According to the DNAP Guidelines, a nominated tract that consists of a limited and defined geographical area qualifies as an Important Bird Congregation Area if one or more of the general thresholds for congregatory species are met during a limited and defined time period of the year on an annually recurring basis. The general thresholds are:

- Exceptional numbers and/or diversity of migratory landbirds;
- 5,000–10,000 raptors;
- 50–500 shorebirds;
- 100–500 wading birds;
- 500–5,000 waterbirds; and
- 1,000–10,000 waterfowl.

Table 1. The 16 guilds categorized into the six guilds highlighted by the DNAP, along with their description.

Guild	DNAP Guild	Description
Blackbird	Migratory Landbird	Landbirds is a catch-all term that refers largely to passerines or perching birds (e.g. warblers, sparrows, woodpeckers) for the purposes of our surveys.
Corvid		
Dove		
Hummingbird		
Songbird		
Woodpecker		
Raptor	Raptor	Raptors are also known as “birds of prey” and consist of species that primarily hunt and feed on vertebrates (e.g. hawks, falcons, eagles).
Shorebird	Shorebird	Shorebirds are birds that live in wet or coastal environments; most species are commonly found along shorelines while foraging for food in mud or sand (e.g. sandpipers, plovers, yellowlegs).
Wading Bird	Wading Bird	Wading birds refer to birds that have long, thin legs to wade through shallow water while foraging; other general characteristics include long necks and specialized bills (e.g. bitterns, herons, cranes).
Waterbird	Waterbird	Waterbirds refer to birds that live on or around water and have special adaptations such as webbed feet, bills and legs adapted to feed in water, and the ability to dive from the surface or the air to catch prey in water (e.g. pelicans, kingfishers, grebes).
Gulls & Terns		
Rail		
Waterfowl	Waterfowl	Waterfowl are a group of species that are highly adapted to living on the surface of the water (e.g. ducks, geese, swans).
Grouse	Not Included	These guilds did not fit into the DNAP guild specifications.
Invasive		
Pigeon		

Species of conservation concern were classified based on state, federal, and national species of concern lists. Species on these lists range from low to high concern. The lists used included Species in Greatest Conservation Need (Minnesota Department of Natural Resources 2016), U.S. Shorebirds of Conservation Concern (U.S. Shorebird Conservation Plan Partnership 2016), Waterbirds of Conservation Concern (Kushlan et al. 2002, North American Waterbird Conservation Plan 2006) Partners in Flight Species of Continental Concern (Rosenberg et al. 2016), USFWS Region 3 Birds of Conservation Concern (BCC) (U.S. Fish and Wildlife Service 2008 (Table 41)), USFWS National BCC (U.S. Fish and Wildlife Service 2008 (Table 48)). A complete list of these species of conservation concern and the lists they are included in can be found in Appendix C. All species from these lists that were observed from 1977 to 2018 were included.

RESULTS AND DISCUSSION

Estuary-wide

A. Current surveys (2018)

a. The 2018 surveys were conducted at nine project areas and included 23 point locations (322 total surveys) during peak spring and fall migration and during the breeding season in 2018. All 16 guilds were observed, with a total of 13,953 individuals and 169 bird species documented (Table 2).

b. A total of 12,152 individuals of 168 species used the SLRE as stopover habitat during spring and fall migration. Of these, 2,091 individuals of 52 species were species of conservation concern. All 52 species of conservation concern that were observed in 2018 were observed at least once during the spring or fall.

c. During the breeding season, 1,801 individuals of 67 species were observed using the SLRE, most likely as breeding habitat. Of these, there were 79 individuals of 10 species of conservation concern observed.

d. Notable observations of species of conservation concern include:
   - 178 American White Pelicans;
   - 5 Baird's Sandpipers;
   - 107 Common Mergansers;
   - 10 Forster's Terns;
   - 30 Greater Yellowlegs;
   - 52 Purple Finches;
   - 216 Rusty Blackbirds; and
   - 72 Veery.

B. Recent surveys (2010–2015)

a. The recent surveys overlapped with six MLT project areas: Grassy Point, Kingsbury Bay, North Bay, Radio Tower Bay, Rask Bay, and Mud Lake (172 total surveys). There were 15 of the 16 guilds with 13,761 individuals and 136 species observed (Table 3).

b. The number of years individual project areas were surveyed varied between two and five years, and the current surveys only have one year of data. Because of these discrepancies, raw data numbers from current and recent surveys should not be compared.

c. Notable important observations of species of conservation concern that were recorded from recent surveys include:
   - 55 American Black Ducks;
   - 3 Black-billed Cuckoos;
   - 121 Canvasbacks;
   - 73 Common Terns;
   - 136 Pied-billed Grebes;
   - 16 Red-necked Grebes; and
   - 16 Sedge Wrens.

C. Historical surveys (1977–1979)

a. Historical surveys overlapped with one MLT project area, Mud Lake. All 16 guilds were observed, with a total of 18,976 individuals of 137 species. Of these, 2,936 individuals and 50 species of species of conservation concern were observed.

b. The methods and amount of effort associated with historical surveys did not match with recent and current surveys, so these data were not used to compare between projects. Notable species of conservation concern that were recorded during this time period were:
   - 10 Black-bellied Plovers;
   - 105 Black Terns;
   - 38 Dunlin;
   - 115 Evening Grosbeaks;
   - 122 Great Blue Herons;
   - 123 Killdeer;
   - 1,117 Lesser Scaup;
   - 72 Purple Martins;
   - 18 Semipalmated Plovers;
   - 215 Semipalmated Sandpipers;
   - 61 Spotted Sandpipers; and
   - 62 Yellow-headed Blackbirds.

D. Combined (1970–2018)

a. Recent (2010–2018)

i. All 16 guilds were observed, with a total of 27,714 individuals of 176 species during recent and current surveys (2018 and 2010–2015).

ii. Notable species of conservation concern that were recorded during these survey years were:
   - 119 Bald Eagles;
   - 69 Horned Grebes;
   - 33 Rough-winged Swallows;
   - 52 Sora; and
   - 161 Trumpeter Swans.

b. All (1970–2018)
   i. All 16 guilds were observed in the SLRE, with a total of 46,690 individuals of 192 species in all nine survey years conducted from 1977–2018. There were a total of 6,313 individuals and 66 species of conservation concern observed.

Project Areas

A. Chamber's Grove

a. **Current Surveys:** A total of 904 individuals, 80 species, and 11 of the 16 guilds were detected in Chamber's Grove from April–October 2018.There were 15 species of conservation concern detected (Table 2).
   i. **Spring**: During spring migration, a total of 550 individuals and 61 species were observed. Guilds with the highest number of observations were 280 waterfowl, 139 songbirds, and 87 waterbirds.
   ii. **Summer**: During the breeding season, a total of 170 individuals and 35 different species were observed. Guilds with the highest number of observations were 97 songbirds, 38 waterfowl, and 13 gulls and terns.
   iii. **Fall**: During fall migration, a total of 184 individuals and 41 different species were observed. Guilds with the highest number of observations were 112 songbirds and 32 corvids.

b. **Recent Surveys:** Surveys were not conducted at this project area from 2010–2015.

c. **Discussion:** This location had a high number of species detected during the summer (breeding) surveys. This high number of species diversity can be contributed to the large number of songbird species observed. Chamber's Grove offers the best woodland habitat adjacent to the SLRE in our study area, which likely contributed to the high songbird diversity.

B. Grassy Point

a. **Current Surveys:** A total of 811 individuals, 61 species, and 12 of the 16 guilds were documented at Grassy Point from April–October 2018. There were 15 species of conservation concern detected in 2018 (Table 2).
   i. **Spring**: A total of 362 individuals and 45 species were observed during spring migration. Guilds with the highest number of observations were 128 waterfowl, 110 blackbirds, and 53 songbirds.
   ii. **Summer**: A total of 183 individuals and 14 species were observed during the summer breeding season. Guilds with the highest number of observations were 60 songbirds, 53 waterfowl, and 47 blackbirds.
   iii. **Fall**: A total of 266 individuals and 29 species were observed during fall migration. Guilds with the highest number of observations were 98 songbirds, 51 waterfowl, and 42 waterbirds.

b. **Recent Surveys:** A total of 1,795 individuals, 84 species, and 14 of the 16 guilds were observed. Grassy Point was surveyed for four years (2010–2011, 2013–2014). There were 22 species of concern detected (Table 3).

c. **Discussion:** This project area had a low number of observed species, and this was consistent for the spring, summer, and fall sampling periods. Additionally, the number of species of

conservation concern between recent surveys declined from 22 to 15. One of the major factors impacting Grassy Point is noise pollution from nearby industrial activity. This certainly had an effect on observers' ability to detect birds, but the effect on birds themselves is unknown.

C. Kingsbury Bay

a. **Current Surveys:** A total of 1,328 individuals, 84 species, and 15 of the 16 guilds were observed in Kingsbury Bay from April–October 2018. There were 17 species of conservation concern detected (Table 2).

i. **Spring:** A total of 491 individuals and 61 species were observed during spring migration. Guilds with the highest number of observations were 163 waterfowl, 152 blackbirds, and 114 songbirds.

ii. **Summer:** A total of 155 individuals and 20 species were observed during the summer breeding season. Guilds with the highest number of observations were 14 waterfowl, 68 blackbirds, and 68 songbirds.

iii. **Fall:** A total of 682 individuals and 57 species were observed during fall migration. Guilds with the highest number of observations were 80 waterfowl, 325 blackbirds, and 215 songbirds.

b. **Recent Surveys:** A total of 1,558 individuals, 76 species, and 15 of the 16 guilds were observed. Kingsbury Bay was surveyed for one year (2015). There were 15 species of conservation concern detected (Table3).

c. **Discussion:** This site had intermediate species richness when considering spring, summer, and fall sampling periods. However, this project area contained the highest number of guilds. This site has diverse habitats including upland forest, cattail marsh, and a shallow marsh area. The diversity of habitat makes this site important for breeding marsh species such as rails and serves as stopover habitat for many species of migrating songbirds. This area is popular with birders because of the accessibility and species diversity.

D. North Bay

a. **Current Surveys:** A total of 103 species, 1,573 individuals, and 14 out of the 16 guilds were observed in North Bay from April–October 2018. There were 22 species of conservation concern detected (Table 2).

i. **Spring**: A total of 798 individuals and 80 species were observed during spring migration. Guilds with the highest number of observations were 335 waterfowl, 80 blackbirds, and 242 songbirds.

ii. **Summer**: A total of 254 individuals and 33 species were observed during the summer breeding season. Guilds with the highest number of observations were 36 waterfowl, 59 blackbirds, and 142 songbirds.

iii. **Fall**: During fall migration, a total of 521 individuals and 63 species were observed. Guilds with the highest number of observations were 196 waterfowl, 24 corvids, and 225 songbirds.

b. **Recent Surveys:** A total of 2,073 individuals, 84 species, and 13 of the 16 guilds were observed. North Bay was surveyed for three years (2013–2015). There were 21 species of conservation concern detected (Table 3).

c. **Discussion:** This project area had a high number of total, spring, and summer species. North Bay also had a high number of guilds. Species of conservation concern detected during the recent surveys and 2018 surveys were similar. This area has several unique features, including wooded marsh and shallow wetlands. These habitats are used by a wide variety of species throughout the year, including many breeding marsh birds and migrating waterfowl. Ash trees are an important component of this site; the future impacts of emerald ash borer (EAB) should be a consideration for management.

E. Radio Tower Bay

a. **Current Surveys:** A total of 64 species, 802 individuals, and 12 of the 16 guilds were observed in Radio Tower Bay from April–October 2018. A total of 14 species of conservation concern were detected (Table 2).
   i. **Spring**: A total of 379 individuals and 45 species were observed during spring migration. Guilds with the highest number of observations were 104 waterfowl, 87 blackbirds, and 142 songbirds.
   ii. **Summer**: A total of 87 individuals and 22 species were observed during the summer breeding season. Guilds with the highest number of observations were 31 blackbirds and 49 songbirds.
   iii. **Fall**: During fall migration, a total of 336 individuals and 37 different species were observed. Guilds with the highest number of observations were 32 waterfowl, 133 blackbirds, and 139 songbirds.

b. **Recent Surveys:** A total of 487 individuals, 46 species, and 10 of the 16 guilds were observed. Radio Tower Bay was surveyed for two years (2013–2014). There were 14 species of conservation concern detected (Table 3).

c. **Discussion:** This project area had a low number of species detected. This could be due to the fact that there is only one survey location. This site is also close to the road, and birds are harder to detect due to traffic noise. Number of species of conservation concern were identical to the recent data. This site is dominated by cattails; restoration that focuses on opening additional channels to increase structure and diversity of the habitat will likely increase the value of this site for many breeding marsh birds.

F. Rask Bay

a. **Current Surveys:** A total of 96 species, 1,490 individuals, and 12 of the 16 guilds were observed in Rask Bay from April–October 2018. There was a total of 20 species of conservation concern detected (Table 2).
   i. **Spring**: A total of 805 individuals and 69 species were observed during spring migration. Guilds with the highest number of observations were 514 waterfowl, 104 waterbirds, and 88 songbirds.
   ii. **Summer**: A total of 233 individuals and 29 species were observed during the summer breeding season. Guilds with the highest number of observations were 118 waterfowl, 44 blackbirds, and 62 songbirds.

iii. **Fall**: During fall migration, a total of 452 individuals and 54 different species were observed. Guilds with the highest number of observations were 171 waterfowl, 62 blackbirds, and 168 songbirds.

b. **Recent Surveys:** A total of 3,074 individuals, 59 species, and 9 of the 16 guilds were observed. Rask Bay was surveyed for three years (2013–2015). There were 16 species of conservation concern detected (Table 3).

c. **Discussion:** Rask Bay had high numbers of species diversity. Rask Bay saw an increase in species of conservation concern, compared to the recent surveys. This project area also had one of the highest observations of waterbirds during spring migration due to the 71 American White Pelicans using Rask Bay as stopover habitat. This bay is relatively protected, with little human activity, which could account for the higher species diversity and large number of pelicans.

G. Munger Landing

a. **Current Surveys:** A total 1,272 individuals, 94 species detected, and 12 of the 16 guilds were observed in Munger Landing from April–October 2018. There were 20 species of conservation concern detected (Table 2).

i. **Spring:** A total of 704 individuals and 74 species were observed during spring migration. Guilds with the highest number of observations were 329 waterfowl, 105 blackbirds, and 146 songbirds.

ii. **Summer**: A total of 137 individuals and 25 species were observed during the summer breeding season. Guilds with the highest number of observations were 22 waterfowl, 42 blackbirds, and 60 songbirds.

iii. **Fall**: During fall migration, a total of 431 individuals and 58 different species were observed. Guilds with the highest number of observations were 107 waterfowl, 47 corvids, and 186 songbirds.

b. **Recent Surveys:** Surveys were not conducted at this project area from 2010–2015.

c. **Discussion:** This project area, similar to Rask Bay, had high levels of species richness. The habitat surveyed at this site includes a combination of open water, a small marsh, and upland forest that contribute to the high observed species richness at the site. A wide diversity of songbirds was observed in the upland forests throughout the survey periods, and many species of waterfowl used the open and marsh areas during migration.

H. Mud Lake

a. **Current Surveys:** A total of 4,498 individuals, 107 species, and 11 of the 16 guilds were observed in Mud Lake from April–October 2018. There were 32 species of conservation concern detected (Table 2).

i. **Spring:** A total of 2,538 individuals and 76 species were observed during spring migration. Guilds with the highest number of observations were 1,673 waterfowl, 286 blackbirds, and 240 songbirds.

ii. **Summer:** A total of 428 individuals and 35 species were observed during the summer breeding season. Guilds with the highest number of observations were 118 waterfowl, 117 blackbirds, and 145 songbirds.

iii. **Fall:** During fall migration, a total of 1,532 individuals and 80 different species were observed. Guilds with the highest number of observations were 300 waterfowl, 779 blackbirds, and 289 songbirds.

b. **Recent Surveys:** A total of 4,774 individuals, 95 species, and 14 of the 16 guilds were observed. Mud Lake was surveyed for three years (2013–2015). There were 22 species of conservation concern detected (Table 3).

c. **Discussion:** This project area had the highest number of species detected. This area also had the second highest number of spring species and the highest summer and fall species. Interestingly, this project area contained the fewest number of guilds. Similar to Radio Tower Bay, this site is dominated by cattails. Restoration that focuses on opening additional channels to increase structure and diversity of the habitat will be beneficial for multiple species. We suggest this site as a focal site for habitat restoration of Black Tern nesting habitat.

I. Tallas Island

a. **Current Surveys:** A total of 92 species, 1,275 individuals, and 11 of the 16 guilds were observed in Tallas Island from April–October 2018. There were 23 species of conservation concern detected (Table 2).

i. **Spring:** A total of 593 individuals and 66 species were observed during spring migration including. Guilds with the highest number of observations were 203 waterfowl, 73 blackbirds, and 168 songbirds.

ii. **Summer:** A total of 154 individuals and 22 species were observed during the summer breeding season. Guilds with the highest number of observations were 16 waterfowl, 38 blackbirds, and 97 songbirds.

iii. **Fall:** During fall migration, a total of 528 individuals and 57 different species were observed. Guilds with the highest number of observations were 93 waterfowl, 128 blackbirds, and 222 songbirds.

b. **Recent Surveys:** Surveys were not conducted at this project area from 2010–2015.

c. **Discussion:** Similar to Rask Bay and Munger Landing, this project area had high levels of species richness. This project area had a low number of overall guilds. The mudflats are an important and unique feature of this site; this unique habitat was used by several species of migrating shorebirds.

Table 2. Total number of species, individuals, guilds, and species of species of conservation concern detected in each project area from 2018.

Project Area	Species	Individuals	Guilds	Species of conservation concern
Chamber's Grove	80	904	11	15
Grassy Point	61	811	12	15
Kingsbury Bay	84	1,328	15	17
North Bay	103	1,573	14	22
Radio Tower Bay	64	802	12	14
Rask Bay	96	1,490	12	20
Munger Landing	94	1,272	12	20
Mud Lake	107	4,498	11	32
Tallas Island	92	1,275	11	23
Grand Total	**169**	**13,953**	**16**	**52**

Table 3. Total number of species, individuals, guilds, and species of species of conservation concern detected in each project area from 2010–2015.

Project Area	Species	Individuals	Guilds	Species of conservation concern
Grassy Point	84	1,795	14	22
Kingsbury Bay	76	1,558	15	15
North Bay	84	2,073	12	21
Radio Tower Bay	46	487	10	14
Rask Bay	59	3,074	9	16
Mud Lake	95	4,774	14	22
Total	**136**	**13,761**	**16**	**36**

Table 4. Total number of species, individuals, guilds, and species of species of conservation concern detected in Mud Lake from 1977–1979.

Project Area	Species	Individuals	Guilds	Species of conservation concern
Mud Lake	137	18,976	16	50

Nomination Criteria

In total, 7,373 migratory landbirds, 158 raptors, 126 shorebirds, 44 wading birds, 948 waterbirds, and 5,184 waterfowl were detected from April–October 2018. The project areas that had the most observations from all guilds in 2018 were Mud Lake, Kingsbury Bay, and Tallas Island (Appendix D). All congregatory bird species have met the DNAP criteria to qualify the SLRE as an Important Bird Congregation Area except for raptors and wading birds (Table 5). Note that the methods used for this project do not reliably survey raptors.

Table 5. Total number of individual bird observations within each DNAP specified guild category. A check mark signifies that the DNAP criteria were met, and an empty cell signifies they were not met. Observations are from 2018 data only.

DNAP Guild	Observations	Criteria Met?
Migratory Landbirds	7,373	✓
Raptors	158	
Shorebirds	126	✓
Wading Birds	44	
Waterbirds	995	✓
Waterfowl	5,184	✓

Migratory Landbirds. A total of 7,373 migratory landbirds of 99 species were observed in 2018. Migratory landbirds were observed in all project areas and had the highest species diversity compared to other guilds. The project areas where migratory landbirds were most abundant, with a range of 2,471–3,500 individuals, were Mud Lake, Kingsbury Bay, and Tallas Island (Appendix E).

Raptors. A total of 158 raptors of 12 species were observed in 2018. Although this guild was observed in all project areas, it was observed in low numbers. The methods used for this project are not appropriate for adequately surveying raptors. Raptor surveys conducted by Hawk Ridge Bird Observatory give a better estimate of raptor movement in the area. For example, the West Skyline Hawk Count conducted from Enger Tower and Thompson Hill from March–May 2018 documented 32,602 raptors of 17 species, all of which used airspace and landforms that provide updraft over the SLRE. From August–November 2018, Hawk Ridge documented 45,089 raptors of 16 species migrating along the north shore of Lake Superior; undoubtedly, most of these birds also occupied airspace over the SLRE. Unlike the methods presented here, surveys utilized by hawk watches are designed specifically to quantify migrating raptors.

Shorebirds. A total of 126 shorebirds of 12 species were observed in 2018. This guild was observed in all project areas. The project areas where shorebirds were most abundant, with a range of 21–25 individuals, were Mud Lake and Tallas Island (Appendix F).

Wading Birds. A total of 44 wading birds of five species were observed in 2018. This guild was observed in all project areas, with the exception of Chamber's Grove. Wading birds accounted for the smallest number of species observations. The project areas where wading birds were most abundant,

with a range of 10–21 individuals, were Mud Lake and North Bay. There were not enough observations of wading birds to create a useful heat map.

Waterbirds. A total of 948 waterbirds of 14 species were observed in 2018. This guild was observed in all project areas. The project areas where waterbirds were most abundant, with a range of 266–360 individuals, were Mud Lake, Rask Bay, Chamber's Grove, and Grassy Point (Appendix G). The reason for the hotspots in Rask Bay and Chamber's Grove were due to the large number of American White Pelicans observed during spring migration.

Waterfowl. A total of 5,184 waterfowl of 22 species were observed in 2018. Waterfowl were observed in all project areas. The project areas where waterfowl were most abundant, with a range of 1,031–1,820 individuals, were Mud Lake, Munger Landing, and Rask Bay (Appendix H).

Guild comparisons of current, recent, and historical surveys

Interpretation of the differences between historical, recent, and current surveys requires consideration of how populations of bird species have changed over the past 40 years, independently of the changes that have occurred in the SLRE. Many waterfowl are still common and widespread in the region and across North America and, in general, waterfowl populations have increased over the past five decades (NABCI 2016). In contrast to many areas of North America that have continued to see reductions in water quality and expansion of agriculture and human populations, the SLRE has improved in water quality with the addition of WLSSD in 1978 along with agriculture being a negligible issue in the region (Bracey et al. 2016). In addition, DDT was banned in the early 1970s, and overall contaminant levels have declined in exposure for aquatic-associated species. However, new and different contaminants are entering the SLRE every year. All of these factors have an effect on population levels for each bird species, and interpretation of these interacting effects is beyond the scope of this report. Another consideration is that the number of sites and years within each survey period vary. For example, the number of years a site could have been potentially surveyed from 2010–2015 is five (no surveys were conducted in 2012), while 2018 only had a single year of data. Similarly, 2018 data summarizes nine project areas, while the recent data (2010–2015) summarizes six project areas, and the historical data (1977–1979) summarizes one project area.

General. Waterfowl, songbirds, and blackbirds were the most abundant guilds in almost all project areas in each season. Guilds that were not well observed (20 or less total observations per guild) in any project area were doves, grouse, hummingbirds, and pigeons.

Blackbirds. This guild was observed in all project areas in 2018, with a total of 2,934 observations. Blackbirds were the least abundant in Chamber's Grove with only 19 total observations, while all other project areas had over 100 observations. Blackbirds were most abundant in Mud Lake with 1,182 observations, but this could be due to the higher amount of survey points. Kingsbury Bay had the second-largest number of blackbirds with 545 observations. This guild was observed most frequently during fall migration. Blackbirds appear to use the SLRE for stopover habitat as well as for roosting. For example, large numbers of Common Grackles and Rusty Blackbirds were noted in flocks early in the morning — typical post-roost behavior. Red-winged Blackbirds commonly breed in the estuary.

Blackbird observations increased from 1,522 observations in historical surveys to 2,934 observations in 2018. Common Grackles had an increase of 63 observations in the 1970s to 1,269 observations in 2018. The Rusty Blackbird also saw an increase in observations. Yellow-headed Blackbirds were observed in the 1970s but were not observed at all in recent or present surveys. Brown-headed Cowbird observations decreased to less than half of what they were in historical data.

Corvids. This guild was observed in all project areas in 2018, with a total of 461 observations. They were the least abundant in Rask Bay, Kingsbury Bay, and Grassy Point, and the most abundant in Tallas Island and Mud Lake. Corvids were observed the most during migration seasons, particularly fall. Corvid observations increased from 167 individuals in historical surveys to 461 individuals in 2018.There were only three species of corvid observed from 1977 to 2018: American Crow, Blue Jay, and Common Raven. Observations of all of these species increased from the first project in the 1970s to 2018.

Gulls & Terns. This guild was observed in all project areas in 2018, with a total of 352 observations. They were the least abundant in Radio Tower Bay, Kingsbury Bay, and Rask Bay, with less than 20 total observations, and the most abundant in Mud Lake and Grassy Point. Gulls and Terns were observed the most during spring migration and had the same amount of observations during breeding and fall migration seasons.

Gull and tern observations decreased from 971 individuals in the historical surveys to 352 individuals in 2018. Major decreased species observations from 1977–2018 contributing to this decline are from Black Terns, Common Terns, Bonaparte's Gulls, and Herring Gulls. Black Terns historically nested in the SLRE, but currently there is no suitable nesting habitat for this species. Common Terns have moved their breeding colony to Interstate Island, a small island in the Duluth-Superior harbor that does not overlap with any of the project areas. A large population of Ring-billed Gulls and some Herring Gulls have also moved to Interstate Island to nest. Bonaparte's Gulls breed much farther north in Canada and only migrate through the SLRE. The cause for the low number of migrating Bonaparte's Gull observations is unknown.

Invasive. The only invasive species observed in the SLRE during all surveys from 1977–2018 was the European Starling. Starlings were only observed in three project areas in 2018: North Bay, Kingsbury Bay, and Grassy Point. Kingsbury Bay had the most invasive individuals with 26 observations, Grassy Point had 18, and North Bay had 7 observations. Starlings were observed the most during breeding and fall migration seasons. There were only 6 starlings observed in recent surveys, and 32 starlings were observed in Mud Lake in historical surveys. European Starlings are locally abundant in the estuary near WLSSD but otherwise are not a major issue.

Rail. Rails were only observed in five project areas in 2018, with a total of 47 observations. Mud Lake had the most observations (33), and North Bay had the second-most observations (10) in 2018. Rails were observed the most during spring migration, but observations did not change much between the three seasons. There were only two species of rails observed: Virginia Rail and Sora. These species can be difficult to detect.

Raptor. Raptors were not well documented because of the observation methods used in historical, recent, and current surveys.

Shorebird. This guild was observed in all project areas in 2018, with a total of 126 observations. Tallas Island and Mud Lake had the most observations, and all other project areas had less than ten observations. Shorebirds were primarily observed during spring and fall migration. The majority of shorebird species observed breed much farther north in the tundra, which is why most were observed during migration. There were three shorebirds observed that breed in this region: Killdeer, Spotted Sandpiper, and Wilson's Snipe. Two Spotted Sandpipers were observed during the breeding season. The total number of observations of shorebird individuals and species from 1977 to 2018 have declined from 606 observations (17 species) in historical surveys, 33 (5 species) in recent surveys, and 126 (12 species) in present surveys. There was a total of 18 species of shorebirds documented, and only one species (Baird's Sandpiper) was not observed in historical surveys. Species of shorebirds that had an increase in observations from historical to present surveys were Greater Yellowlegs, Lesser Yellowlegs, and Baird's Sandpiper. Species of shorebirds that had a decrease in observation from historical to current surveys were Dunlin, Black-bellied Plover, Killdeer, Semipalmated Sandpiper, Spotted Sandpiper, and Wilson's Phalarope. It is not known why shorebird use of the SLRE has declined in the past 40 years. Shorebird stopover sites are ephemeral by nature: most species prefer very shallow water and/or mudflats. When these conditions are present, large numbers of shorebirds can appear practically overnight during spring and fall migration, and when they disappear, shorebirds will follow suit.

Songbird. Overall, this guild was abundant in all project areas in 2018, with a total of 3,766 observations. They were the least abundant in Grassy Point and Rask Bay and the most abundant in Mud Lake and North Bay. Songbirds were observed the most during fall migration, but they were observed in high abundances during all seasons. Of the 16 guilds, the songbird guild had the most observations during the breeding season. Songbirds were more abundant in project areas with adjacent upland forests such as North Bay and Chamber's Grove.

Songbird observations remained relatively constant from historical surveys, with 3,289 individuals, to present surveys, with 3,766 individuals. There was a decrease in observations in recent surveys, with 1,750 individuals. Some of the songbirds consistently observed the most often throughout all project years were the Common Yellowthroat, Song Sparrow, Swamp Sparrow, and Tree Swallow. Yellow Warblers, Yellow-rumped Warblers, Cedar Waxwings, and American Goldfinches all had an increase in observations from 1977 to 2018.

Wading Bird. This guild was observed in notable numbers in three project areas in 2018: Mud Lake, North Bay, and Munger Landing. They were either not observed or only had one or two observations in the other project areas. Wading birds were observed the most in fall and spring migration. Only one was observed during the breeding season.

Wading bird observations decreased from 190 individuals in historical surveys to 44 individuals in 2018. This guild only contains five species (Great Blue Heron, Green Heron, American Bittern, Least Bittern, and Sandhill Crane), all of which declined in observations from 1977 to 2018 except for the Sandhill Crane, which increased.

Waterbird. This guild was observed in all project areas in 2018, with a total of 596 observations. They were the least abundant in Radio Tower Bay and Kingsbury Bay and the most abundant in Rask Bay and Mud Lake. Waterbirds were observed the most during spring migration. Only 15 individuals were observed during the breeding season.

The total number of observations of individual waterbirds from 1977 to 2018 declined from 5,356 observations in historical surveys to 596 observations in current surveys. Species of waterbirds that had an increase in observations from historical to present surveys were American White Pelicans, Double-crested Cormorant, Pied-billed Grebe, and Horned Grebe. All of these species are consistent with increasing regional trend estimates except for the Pied-billed and Horned Grebe, which have decreasing regional trend estimates (Sauer et al. 2017). The American Coot had a decrease in observations from historical to present surveys. Regional trend estimates for this species are declining (Sauer et al. 2017).

Waterfowl. This guild was observed in all project areas in 2018, with a total of 5,184 observations. They were the least abundant in Radio Tower Bay and Grassy Point and the most abundant in Mud Lake and Rask Bay. Waterfowl were observed the most during spring and fall migration.

The total number of observations of waterfowl individuals from 1977 to 2018 have declined slightly, with 6,682 observations in historical surveys, 7,328 in recent surveys, and 5,184 in current surveys. Species of waterfowl that had an increase in observations from historical to present surveys were Hooded Merganser, Common Merganser, Greater Scaup, Northern Shoveler, Trumpeter Swan, Bufflehead, and Canada Goose. Species that had a decrease in observations from historical to current surveys were Common Goldeneye, Lesser Scaup, Mallard, Ring-necked Duck, Tundra Swan, and Wood Duck. There were 428 Redheads observed in the recent surveys, and less than 20 were observed in historical and present surveys.

Woodpecker. This guild was observed in all project areas in 2018, with a total of 193 observations. They were the least abundant in Grassy Point, Rask Bay, and Radio Tower Bay and the most abundant in Mud Lake and Munger Landing. Woodpeckers were observed the most during spring and fall migration. Woodpecker observations increased from 55 individuals in historical observations to 193 individuals in 2018. Even from 2010–2015, when six project areas were surveyed, only 41 individuals were observed. All species of woodpeckers increased in observations from 1977 to 2018 including Downy, Hairy, and Pileated Woodpeckers, Northern Flickers, and Yellow-bellied Sapsuckers.

Species of Conservation Concern

There are many reasons a species may be present or absent from a given location, and although changes or differences in species composition can be quantified, they are not always easy to interpret (Philippi et al. 1998). The presence of a species at a given site or set of sites implies these locations provide a similar set of conditions that allows a species to exist and potentially persist (Borcard et al. 2011, Bracey et al. 2016). However, if a species is absent, it is difficult or impossible to discern why it is not present. There are many reasons why a species may be absent or undetected, including: 1) poor site condition, 2) lack of detection, in which the species was present but not observed, and 3) factors outside the sampled area, such as an overall declining population and a retraction of the species range (Bracey et al. 2016).

Black Tern. Black Terns are small, graceful waterbirds that breed in freshwater wetlands, backwater marshes, and shallow lakes. Black Tern populations in Minnesota have experienced a large and statistically significant decline since 1966, declining an average of 5.8% per year for a loss of nearly 96% of the state population over 53 years. For this reason, Black Terns are designated as a Species in Greatest Conservation Need by the Minnesota Department of Natural Resources, and Audubon Minnesota has designated it a Target Conservation Species. The main cause of population declines in Minnesota appears to be habitat loss. However, habitat degradation from growth of dense invasive plants such as *Phragmities*, purple loosestrife, and hybrid cattail in the breeding areas may also be significantly impacting breeding success. In the SLRE, 105 Black Terns were observed from 1977–1979 in the breeding months in Mud Lake, but none have been observed breeding in subsequent survey years. Wetland restoration and introduction of suitable nesting platforms may provide the necessary habitat requirements for Black Tern to return to the area.

Yellow-headed Blackbird. Yellow-headed Blackbirds are wetland specialists that require deep water marshes that support diverse stands of emergent vegetation interspersed with equal areas of open water. Similar to the Black Terns, there was a total of 62 Yellow-headed Blackbirds observed from 1977 to 1978 at the Mud Lake project area only, with no observations in following survey years. The Yellow-headed Blackbird is listed as a Species of Greatest Conservation Need (Minnesota Department of Natural Resources 2016).

Purple Martin. This species has been assigned a Continental Concern Score of 10/20 by Partners in Flight and is officially listed as a Special Concern species in Minnesota and designated a Species in Greatest Conservation Need by the Minnesota Department of Natural Resources (MNBBA 2019). Purple Martins have shown a significant population decline in Minnesota from 1966–2015, with an annual decline of 6.64% (Sauer et al. 2017). There were 72 Purple Martins observed in the Mud Lake project area in the 1970s and then no observations in any project areas in subsequent survey years. Historically, the majority of this species was found in riparian areas with dead snags that had woodpecker holes suitable for nesting cavities (Brown and Tarof 2013). Nesting cavities are more commonly found in mature forests that have not been recently cut, but due to logging habits and more frequent blowdowns, these forests are becoming more difficult to find. Purple Martins are also in competition for nest cavities with European Starlings and House Sparrows and are commonly forced by these species to leave nest sites. Wetlands in the SLRE could provide foraging habitat for this aerial insectivore; we suggest using Purple Martin houses along the river to provide nesting habitat to re-establish this species.

Rusty Blackbird. Rusty Blackbirds are one of the most rapidly declining songbirds in North America, yet the reasons for this trend remain unclear. One untested hypothesis is that factors such as loss of habitat during stopover may be contributing to this decline. However, stopover ecology of Rusty Blackbirds is poorly understood on the continental scale and has not been studied in Minnesota. There were 216 Rusty Blackbird observations in 2018, primarily during the fall survey period, suggesting the SLRE provides important stopover habitat for this imperiled species. Detailed studies should be conducted in the SLRE to assess habitat use during stopover.

Common Tern. This species was assigned a Continental Concern Score of 11/20 by Partners in Flight and designated a species of Low Concern by the North American Waterbird Conservation Plan. In Minnesota, the Common Tern is officially classified as a Threatened Species and is designated a Species of Greatest Conservation Need by the Minnesota Department of Natural Resources (MNBBA 2019). Common Tern breed on Interstate Island in the Duluth-Superior harbor and use the SLRE for foraging throughout the breeding season. There were 18 Common Tern observed from 1977–1979, 48 were observed from 2014–2015, and only one was observed in 2018. This species faces a multitude of habitat-related threats including issues associated with legacy contaminants, rising lake levels, intense storms during the breeding season, and encroaching vegetation on the breeding colony. Continued active management on Interstate Island along with active habitat restoration of Interstate Island and the SLRE will help increase habitat availability and food resources for Common Tern during the breeding season.

CONCLUSION

The SLRE qualifies as an Important Bird Congregation Area based on the criteria outlined by the DNAP. The SLRE provides important habitat and resources to a multitude of species. The designation of the SLRE as an Important Bird Congregation Area will ensure protection of a unique wetland complex that has had its ecological integrity compromised by a host of threats including habitat loss, development, and industrial activities. Conservation and restoration of wetlands within the SLRE is necessary to mitigate further loss or degradation of habitat within the estuary. There are several wetland specialist species that were at one time common in the area, including Black Tern and Yellow-headed Blackbirds; continuing restoration efforts to facilitate reintroduction of these species is recommended. Overall, the conservation of the SLRE's natural resources will not only promote long-term conservation of biodiversity but also improve recreational opportunities for residents and tourists.

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Appendix A. Minnesota Land Trust Support Project: St. Louis River Estuary Natural Areas Acquisition and Conservation: Migration and Breeding Bird Distribution and Abundance Standard Operating Procedures.

Survey Protocol Summary

Spring/Fall Migration:

- Each point at each site needs to be surveyed for 10 minutes. If it is not possible to count all birds within 10 minutes, stay until all birds have been counted and write survey duration on accompanying field sheet.
- All birds seen or heard should be placed on the maps in the location in which it was observed. Observation type (e.g. singing, observed, flyover) should also be recorded.
- A field sheet will be provided with each map and should be filled out completely during each visit. This will contain site level information (e.g. date, survey duration, location, observer, temperature, etc.).

Breeding Season:

- Breeding season surveys will be extended to 15-minute surveys and include use of playbacks.

Sites to be sampled	Area (acres)	No. of survey points	Number of Surveys		
			Spring	*Breeding*	*Fall*
Chamber's Grove	48	3	6	2	6
Grassy Point	49	1	6	2	6
Kingsbury Bay	75	2	6	2	6
North Bay	164	4	6	2	6
Radio Tower Bay	40	1	6	2	6
Rask Bay	72	2	6	2	6
Munger Landing	122	3	6	2	6
Mud Lake	366	5	6	2	6
Tallas Island	104	2	6	2	6

Minnesota Land Trust: Bird Survey Standard Operating Procedures

1. Samples: Bird surveys will be conducted 14 times at each survey point.
   a. Surveys will be conducted:
      i. Six times during spring migration (April–May).
      ii. Two times during the breeding season (June).
      iii. Six times during fall migration (August–October).
   b. Sites will be revisited with a minimum of:
      i. Fifteen days between surveys during the breeding season.
      ii. Seven days between surveys during migration periods.

2. Survey weather:
   a. Because the majority of observations will be visual, wind strength is less likely to affect the quality of the survey. However, it is optimal to conduct surveys when the wind strength is less than six on the wind scale (i.e. wind < 15 mph or < 20 kmh) for identifying birds aurally.
   b. Surveys should only be conducted when there is little or no precipitation.
      i. If the precipitation is heavier than a drizzle, you should discontinue the survey. Moderate to heavy rain will decrease bird vocalization and other activity levels.

c. Wind and precipitation during breeding season surveys could affect your ability to detect territorial vocalizing males; therefore, it is more important that survey conditions are optimal.
d. The decision to discontinue a survey due to weather conditions is made at the discretion of the field crew leader.
e. If survey is conducted during questionable weather conditions, be sure to provide comments on the data sheet, such as why the survey was continued.

3. Sample periods:
   a. Be sure to get accurate sunrise and sunset times for your location.
   b. All breeding season surveys are morning surveys: sampling can begin from 0.5hrs before sunrise to 4.5hrs after sunrise.
   c. Surveys during migration can begin at sunrise and continue into the afternoon.
   d. Surveyors will survey each point within a given location until all birds present have been counted (approximately 10 minutes at each point within a site).

4. Sites and sample points:
   a. Each site can contain from 1–5 bird sample points.
   b. Sample points:
      i. Points will be located near the most convenient access point.
      ii. The location of each point will be marked using a GPS unit prior to the first sampling period (March 2018). These locations will not change during the project unless a safety or accessibility issue arises during the project.
      iii. Points will be saved in the GPS unit as a waypoint as well as in an Excel database.
      iv. Once point locations have been established, proceed to the provided point location to conduct surveys.
      v. All points must be marked on the field maps, and notes such as how to access each point must be recorded.

5. Record site data:
   a. Before beginning the survey, fill out the following:
      i. Date: Format of MM/DD/YY (e.g. 06/04/18).
      ii. Point ID: Each point has an associated ID (e.g. Site 1 pt.1).
      iii. Observer: Observer first initial and last name (J. Doe).
      iv. Time (start): Record in 24-hour format (e.g. 4:30am is 0430).
      v. Temperature: Record in ° Celsius.
      vi. Wind (code): Wind scale codes (see chart below).
      vii. Sky (code): Assign and record the appropriate sky cover code (see chart below).
      viii. Noise (code): Assign and record the appropriate background noise code (see chart below).
      ix. Weather: Circle the appropriate description: dry, damp/haze/fog, drizzle, or rain.
      x. Site description/notes: Any additional information that you think will be important to record about the survey location. Observations that could affect counts (e.g. ice covering the bay, boat activity in the area) or any other information that may be of interest (e.g. other animals using the area, e.g. beaver or otter).

WIND SCALE
0 no wind
1 leaves barely move
2 leaves, small twigs move
3 leaves, twigs in constant motion
4 small branches move
5 large branches, small trees sway
6 large branches in continuous motion
7 whole trees in motion

NOISE CODES
0 No appreciable effect (owl calling)
1 Slightly affecting sampling (distant traffic, dog barking, car passing)
2 Moderately affecting sampling (distant traffic, 2–5 cars passing)
3 Seriously affecting sampling (continuous traffic nearby, 6–10 cars passing)
4 Profoundly affecting sampling (continuous traffic passing, construction noise)

SKY CODES
0 clear (<10%)
1 scattered (10–50%)
2 broken (60–90%)
3 overcast (>90%)
4 fog
5 light mist
6 water dripping off vegetation
7 rain during last 5 minutes of census
8 rain during last 7 minutes of census
9 rain during entire census

6. Conduct the survey:
    a. Each survey point will be visited for approximately 10 minutes, or until all observations have been recorded.
        i. Using a spotting scope and binoculars, make a preliminary scan of the survey location to identify all individuals present. This is important, as some species may leave the area due to your presence.
    b. We will use unlimited-distance counts to complete a thorough inventory of bird use, counting all species identified by both visual and aural surveys.
    c. All bird observations will be identified to specific locations on aerial photo field sheets; accuracy will be approximately 25 m in open water and 10 m near or on shore.
        i. Record the four-letter alpha code for each species observed at the corresponding spatial location on the aerial map provided for each point.
        ii. Each individual bird observed must be recorded, whether you are able to identify it or not. Individuals which cannot be positively identified should be recorded as unidentified (e.g. unidentified sparrow (USPA), unidentified passerine (UPBD). (See http://www.birdpop.org/alphacodes.htm for alpha codes.) The inability to identify every individual bird is expected. However, not recording individuals because you are unable to identify them is not acceptable, as this can greatly affect survey results.
    d. Record the behavior of the individual. Notation is listed below and on each data sheet. For instance, if it was singing, circle the alpha code; if it was calling, underline it. “Observed” means

you saw the bird and it wasn't doing anything else such as calling, singing, or drumming. NOTE: record the "highest" level of observation. For instance, if a bird is first observed calling and later sings, record that observation as singing. This is most important to record during the breeding season when territorial males are singing.

i. The order of observations is as follows (highest to lowest):
   a. Two males simultaneous singing;
   b. Singing/woodpecker drumming;
   c. Calling;
   d. Observed (sight only).

Observation Type	Example
Singing	NAWA
Calling	NAWA
Observed	NAWA
Drumming	$PIWO_D$
Two males singing simultaneously	NAWA NAWA

e. For surveys conducted during the breeding season (June), record the breeding evidence code by using a subscript after the alpha code. To find evidence codes, along with descriptions, see http://www.mnbba.org/pdf/BreedingEvidenceCodes_Tips.pdf. Record the "highest" level of breeding evidence. For instance, if a bird is first observed doing a distraction display and later you see it occupying a nest, record it as occupied nest. This is a definite breeding observation, whereas a distraction display is a probable breeding observation.

i. Examples:

$TRES_{ON}$ Observed an occupied nest cavity of a Tree Swallow (adult seen entering/exiting)	$MOWA_{NB}$ Observed a Mourning Warbler building a nest	$RWBL_{FY}$ Observed a Red-winged Blackbird carrying food for young

f. If a bird moves to a different location during the survey, only record the location where the bird was originally detected within the site. If a bird is initially not using the site but moves in during the survey, it should be recorded.

g. If a bird is detected at multiple points, record it on the data sheet for each of the points where it is observed. The location where the bird was first detected is where the observation should be recorded. At all other locations where the bird was observed, record the bird and use a superscript asterisk. In the site description/notes section, write that this bird is a duplicate seen at point X. When entering the data, do not enter birds that have an asterisk denoting a duplicate observation.

i. Observations of large groups of birds (single species) should be recorded with the number of individuals in front of the species code. For example, a group of 80 Double-crested Cormorants observed on the water would be recorded as:

80 DCCO

h. Aerial foragers that are foraging should be recorded. A bird that is aerial foraging is using the airspace above the territory for foraging, catching insects in the air, using the airspace for fishing (terns), etc. It is different from a flyover in that a bird flying over the territory is traveling, not foraging.

7. Breeding Season Surveys:
   a. During the two breeding season surveys, surveys will last 15 minutes and will be broken down in the following way:
      i. 0–5 minutes: passive listening (0:00 to 5:00)
      ii. 5–10 minutes: broadcast (5:00 to 10:00)
      iii. 10–15 minutes: passive listening (10:00 to 15:00)
   b. Equipment must be capable of broadcasting at an 80 dB level with minimal distortion. A decibel meter should be used at the beginning of the first survey each day to determine that speakers are projecting at 80dB at 1m distance from the speaker.
   c. Hold speaker above the level of vegetation and broadcast in the direction of the site you are surveying.
   d. Broadcast order:
      i. 30 seconds LEAST BITTERN (LEBI)
      ii. 30 seconds silence
      iii. 30 seconds SORA (SORA)
      iv. 30 seconds silence
      v. 30 seconds VIRGINIA RAIL (VIRA)
      vi. 30 seconds silence
      vii. 30 seconds COMMON MOORHEN(COMO)
      viii. 30 seconds silence
      ix. 30 seconds PIED-BILLED GREBE (PBGR)
      x. 30 seconds silence

8. Data Management:
   a. Crews will check over data sheets after each survey, checking that all fields have been filled in properly and for readability.
   b. Data sheets will be maintained at the Natural Resources Research Institute in Duluth, Minnesota. Results from the field surveys will be stored in an excel database.
   c. Recommended prep for entering data:
      i. Using a red, ultra-fine sharpie marker, number each species code/observation in sequential order on the data sheet. This method allows you to easily follow along the numbering system during actual entry into the database and helps to eliminate mistakes.

9. Safety, Materials & Equipment:
    a. Because bird surveys are being conducted during daylight hours, observers may survey alone but are required to check in with their field crew leader on a daily basis. Field crew leaders will work out a feasible daily check-in system with their crew to ensure safety in the field.
    b. This survey can be a single- or multiple-observer protocol.
    c. Surveyors will be equipped with the following:
        i. Data sheets
        ii. Standard Operating Procedures
        iii. Clipboard
        iv. Waterproof, permanent pens/markers (Rite in the Rain pen, ultra-fine-tip Sharpie marker)
        v. Thermometer, in metal or plastic case
        vi. Site/point map(s)
        vii. GPS unit, with points loaded
        viii. Extra batteries
        ix. Each crew will carry spare equipment and materials

Appendix B. List of all 192 species observed in the St. Louis River Estuary project areas (1977–2018) including the common name, scientific name, taxa code, guild classification, and number of individuals observed by project.

Common Name	Scientific Name	Taxa Code	Guild Classification	Historical (1977–1979)	Recent (2010–2015)	Current (2018)
American Black Duck	*Anas rubripes*	ABDU	Waterfowl	29	55	10
Alder Flycatcher	*Empidonax alnorum*	ALFL	Songbird	15	24	26
American Bittern	*Botaurus lentiginosus*	AMBI	Wading Bird	7	3	4
American Coot	*Fulica americana*	AMCO	Waterbird	5,214	2,088	54
American Crow	*Corvus brachyrhynchos*	AMCR	Corvid	154	95	231
American Goldfinch	*Spinus tristis*	AMGO	Songbird	88	65	243
American Golden-Plover	*Pluvialis dominica*	AMGP	Shorebird	1	0	0
American Kestrel	*Falco sparverius*	AMKE	Raptor	0	1	1
American Pipit	*Anthus rubescens*	AMPI	Songbird	7	2	9
American Redstart	*Setophaga ruticilla*	AMRE	Songbird	28	87	168
American Robin	*Turdus migratorius*	AMRO	Songbird	115	41	180
American Wigeon	*Mareca americana*	AMWI	Waterfowl	136	31	70
American Tree Sparrow	*Spizelloides arborea*	ATSP	Songbird	14	2	7
American White Pelican	*Pelecanus erythrorhynchos*	AWPE	Waterbird	0	41	178
Bald Eagle	*Haliaeetus leucocephalus*	BAEA	Raptor	32	55	64
Bank Swallow	*Riparia riparia*	BANS	Songbird	56	9	14
Baltimore Oriole	*Icterus galbula*	BAOR	Songbird	1	10	22
Barn Swallow	*Hirundo rustica*	BARS	Songbird	48	3	88
Baird's Sandpiper	*Calidris bairdii*	BASA	Shorebird	0	0	5
Black-and-white Warbler	*Mniotilta varia*	BAWW	Songbird	0	15	31
Black-billed Cuckoo	*Coccyzus erythropthalmus*	BBCU	Songbird	0	3	1
Black-bellied Plover	*Pluvialis squatarola*	BBPL	Shorebird	10	0	0
Black-capped Chickadee	*Poecile atricapillus*	BCCH	Songbird	60	52	301
Black-crowned Night-Heron	*Nycticorax nycticorax*	BCNH	Wading Bird	3	0	0
Belted Kingfisher	*Megaceryle alcyon*	BEKI	Waterbird	57	29	52
Brown-headed Cowbird	*Molothrus ater*	BHCO	Blackbird	120	52	46
Blue-headed Vireo	*Vireo solitarius*	BHVI	Songbird	0	1	2
Blackburnian Warbler	*Setophaga fusca*	BLBW	Songbird	0	1	1
Blue Jay	*Cyanocitta cristata*	BLJA	Corvid	13	34	171
Blackpoll Warbler	*Setophaga striata*	BLPW	Songbird	1	1	2
Bobolink	*Dolichonyx oryzivorus*	BOBO	Blackbird	0	0	7
Black Tern	*Chlidonias niger*	BLTE	Gulls & Terns	105	0	0
Bonaparte's Gull	*Chroicocephalus philadelphia*	BOGU	Gulls & Terns	261	22	35
Brewer's Blackbird	*Euphagus cyanocephalus*	BRBL	Blackbird	1	0	0
Brown Creeper	*Certhia americana*	BRCR	Songbird	0	1	3
Brown Thrasher	*Toxostoma rufum*	BRTH	Songbird	8	0	1

Common Name	Scientific Name	Taxa Code	Guild Classification	Historical (1977–1979)	Recent (2010–2015)	Current (2018)
Black-throated Green Warbler	*Setophaga virens*	BTNW	Songbird	0	3	3
Bufflehead	*Bucephala albeola*	BUFF	Waterfowl	50	283	208
Broad-winged Hawk	*Buteo platypterus*	BWHA	Raptor	0	0	8
Blue-winged Teal	*Spatula discors*	BWTE	Waterfowl	1,344	44	93
Canada Goose	*Branta canadensis*	CAGO	Waterfowl	96	2,980	1,940
Canvasback	*Aythya valisineria*	CANV	Waterfowl	0	121	11
Caspian Tern	*Hydroprogne caspia*	CATE	Gulls & Terns	0	0	1
Canada Warbler	*Cardellina canadensis*	CAWA	Songbird	0	1	4
Clay-colored Sparrow	*Spizella pallida*	CCSP	Songbird	0	0	9
Cedar Waxwing	*Bombycilla cedrorum*	CEDW	Songbird	37	79	218
Chipping Sparrow	*Spizella passerina*	CHSP	Songbird	0	5	14
Chimney Swift	*Chaetura pelagica*	CHSW	Songbird	0	0	2
Cliff Swallow	*Petrochelidon pyrrhonota*	CLSW	Songbird	44	9	33
Cape May Warbler	*Setophaga tigrina*	CMWA	Songbird	0	2	0
Common Goldeneye	*Bucephala clangula*	COGO	Waterfowl	680	145	155
Common Grackle	*Quiscalus quiscula*	COGR	Blackbird	63	215	1,269
Cooper's Hawk	*Accipiter cooperii*	COHA	Raptor	0	1	0
Common Loon	*Gavia immer*	COLO	Waterbird	20	3	13
Common Merganser	*Mergus merganser*	COME	Waterfowl	74	25	107
Common Nighthawk	*Chordeiles minor*	CONI	Songbird	1	1	0
Common Raven	*Corvus corax*	CORA	Corvid	0	19	59
Common Redpoll	*Acanthis flammea*	CORE	Songbird	167	0	0
Common Tern	*Sterna hirundo*	COTE	Gulls & Terns	18	73	1
Common Yellowthroat	*Geothlypis trichas*	COYE	Songbird	126	128	169
Chestnut-sided Warbler	*Setophaga pensylvanica*	CSWA	Songbird	1	3	11
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO	Waterbird	3	114	141
Downy Woodpecker	*Dryobates pubescens*	DOWO	Woodpecker	13	11	24
Dunlin	*Calidris alpina*	DUNL	Shorebird	38	0	2
Eastern Bluebird	*Sialia sialis*	EABL	Songbird	0	0	4
Eastern Kingbird	*Tyrannus tyrannus*	EAKI	Songbird	7	1	6
Eastern Phoebe	*Sayornis phoebe*	EAPH	Songbird	3	4	14
Eastern Wood-Pewee	*Contopus virens*	EAWP	Songbird	0	0	5
European Starling	*Sturnus vulgaris*	EUST	Invasive	32	6	51
Evening Grosbeak	*Coccothraustes vespertinus*	EVGR	Songbird	115	0	2
Fox Sparrow	*Passerella iliaca*	FOSP	Songbird	0	0	1
Forster's Tern	*Sterna forsteri*	FOTE	Gulls & Terns	5	0	10
Gadwall	*Mareca strepera*	GADW	Waterfowl	10	4	31
Great Blue Heron	*Ardea herodias*	GBHE	Wading Bird	122	24	16
Great Crested Flycatcher	*Myiarchus crinitus*	GCFL	Songbird	2	6	5
Golden-crowned Kinglet	*Regulus satrapa*	GCKI	Songbird	0	2	7

Common Name	Scientific Name	Taxa Code	Guild Classification	Historical (1977–1979)	Recent (2010–2015)	Current (2018)
Gray-cheeked Thrush	*Catharus minimus*	GCTH	Songbird	1	0	1
Gray Catbird	*Dumetella carolinensis*	GRCA	Songbird	71	20	32
Green Heron	*Butorides virescens*	GRHE	Wading Bird	55	9	5
Greater Scaup	*Aythya marila*	GRSC	Waterfowl	0	8	46
Greater Yellowlegs	*Tringa melanoleuca*	GRYE	Shorebird	2	0	30
Green-winged Teal	*Anas crecca*	GWTE	Waterfowl	249	81	125
Golden-winged Warbler	*Vermivora chrysoptera*	GWWA	Songbird	0	0	1
Harris's Sparrow	*Zonotrichia querula*	HASP	Songbird	3	0	0
Hairy Woodpecker	*Dryobates villosus*	HAWO	Woodpecker	3	8	45
Herring Gull	*Larus argentatus*	HERG	Gulls & Terns	191	25	20
Hermit Thrush	*Catharus guttatus*	HETH	Songbird	0	0	3
House Finch	*Haemorhous mexicanus*	HOFI	Songbird	0	1	3
Horned Grebe	*Podiceps auritus*	HOGR	Waterbird	18	32	37
Horned Lark	*Eremophila alpestris*	HOLA	Songbird	0	0	1
Hooded Merganser	*Lophodytes cucullatus*	HOME	Waterfowl	51	64	110
House Wren	*Troglodytes aedon*	HOWR	Songbird	0	2	8
Indigo Bunting	*Passerina cyanea*	INBU	Songbird	1	0	0
Killdeer	*Charadrius vociferus*	KILL	Shorebird	123	5	11
Lapland Longspur	*Calcarius lapponicus*	LALO	Songbird	6	0	8
Least Bittern	*Ixobrychus exilis*	LEBI	Wading Bird	3	0	1
Least Flycatcher	*Empidonax minimus*	LEFL	Songbird	13	17	29
Least Sandpiper	*Calidris minutilla*	LESA	Shorebird	18	0	13
Lesser Scaup	*Aythya affinis*	LESC	Waterfowl	1,117	447	830
Lesser Yellowlegs	*Tringa flavipes*	LEYE	Shorebird	14	5	25
Lincoln's Sparrow	*Melospiza lincolnii*	LISP	Songbird	0	1	0
Mallard	*Anas platyrhynchos*	MALL	Waterfowl	1,253	931	514
Magnolia Warbler	*Setophaga magnolia*	MAWA	Songbird	2	1	1
Marsh Wren	*Cistothorus palustris*	MAWR	Songbird	91	18	65
Merlin	*Falco columbarius*	MERL	Raptor	0	4	10
Mourning Dove	*Zenaida macroura*	MODO	Dove	19	7	4
Mourning Warbler	*Geothlypis philadelphia*	MOWA	Songbird	4	2	8
Nashville Warbler	*Oreothlypis ruficapilla*	NAWA	Songbird	3	21	13
Northern Cardinal	*Cardinalis cardinalis*	NOCA	Songbird	0	0	6
Northern Flicker	*Colaptes auratus*	NOFL	Woodpecker	38	15	66
Northern Harrier	*Circus hudsonius*	NOHA	Raptor	8	2	5
Northern Parula	*Setophaga americana*	NOPA	Songbird	0	0	2
Northern Pintail	*Anas acuta*	NOPI	Waterfowl	17	12	11
Northern Waterthrush	*Parkesia noveboracensis*	NOWA	Songbird	1	5	30
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	NRWS	Songbird	2	18	15
Northern Shoveler	*Spatula clypeata*	NSHO	Waterfowl	13	26	67

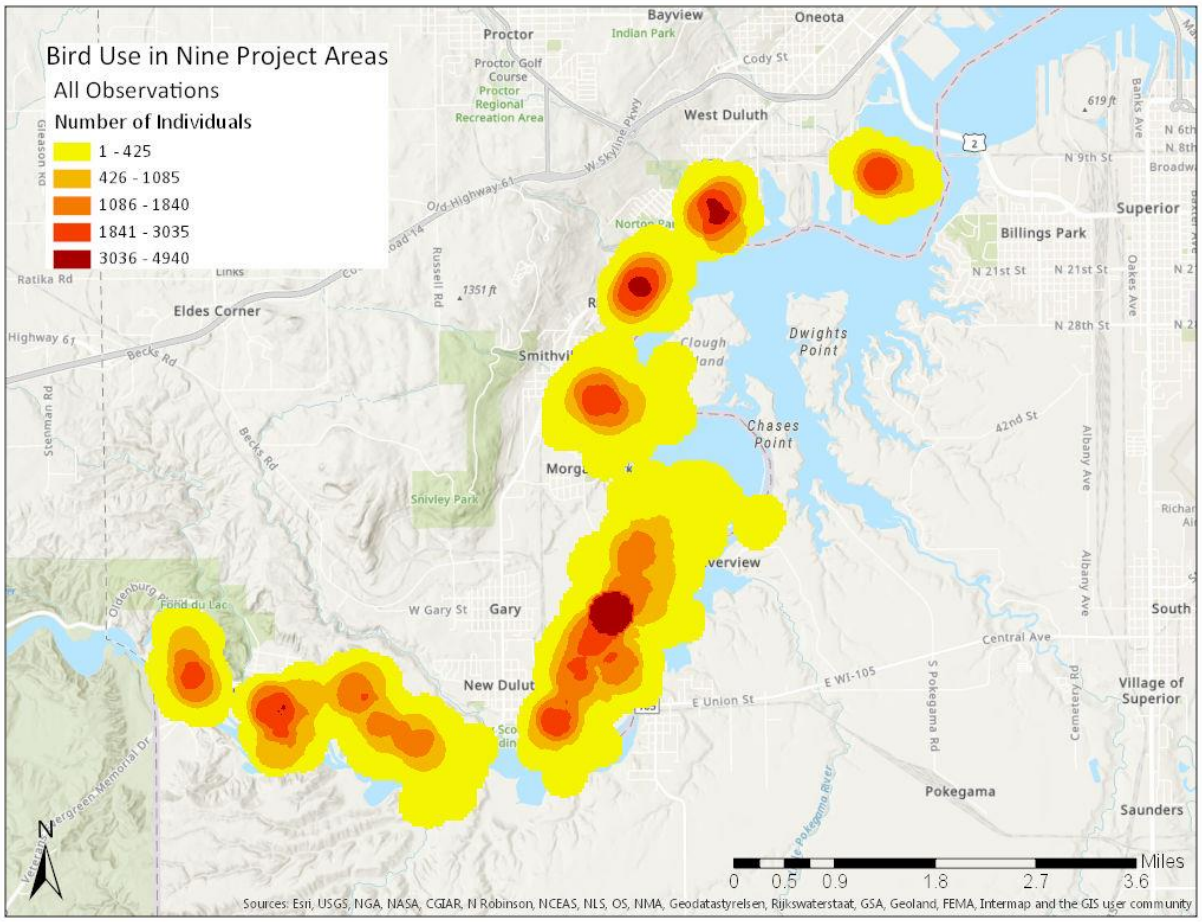
Common Name	Scientific Name	Taxa Code	Guild Classification	Historical (1977–1979)	Recent (2010–2015)	Current (2018)
Northern Shrike	*Lanius borealis*	NSHR	Songbird	1	1	1
Olive Sided Flycatcher	*Contopus cooperi*	OSFL	Songbird	0	0	1
Orange-crowned Warbler	*Oreothlypis celata*	OCWA	Songbird	1	2	0
Osprey	*Pandion haliaetus*	OSPR	Raptor	0	1	1
Ovenbird	*Seiurus aurocapilla*	OVEN	Songbird	1	14	49
Palm Warbler	*Setophaga palmarum*	PAWA	Songbird	34	7	49
Pied-billed Grebe	*Podilymbus podiceps*	PBGR	Waterbird	40	136	114
Peregrine Falcon	*Falco peregrinus*	PEFA	Raptor	0	1	1
Pectoral Sandpiper	*Calidris melanotos*	PESA	Shorebird	1	0	1
Philadelphia Vireo	*Vireo philadelphicus*	PHVI	Songbird	0	0	1
Pine Grosbeak	*Pinicola enucleator*	PIGR	Songbird	19	0	0
Pine Siskin	*Spinus pinus*	PISI	Songbird	49	28	121
Pine Warbler	*Setophaga pinus*	PIWA	Songbird	0	0	1
Pileated Woodpecker	*Dryocopus pileatus*	PIWO	Woodpecker	0	6	32
Purple Finch	*Haemorhous purpureus*	PUFI	Songbird	3	19	52
Purple Martin	*Progne subis*	PUMA	Songbird	72	0	0
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR	Songbird	14	4	7
Ring-billed Gull	*Larus delawarensis*	RBGU	Gulls & Terns	282	179	240
Red-breasted Merganser	*Mergus serrator*	RBME	Waterfowl	0	17	63
Red-breasted Nuthatch	*Sitta canadensis*	RBNU	Songbird	0	0	17
Red-bellied Woodpecker	*Melanerpes carolinus*	RBWO	Woodpecker	0	1	9
Ruby-crowned Kinglet	*Regulus calendula*	RCKI	Songbird	1	6	21
Redhead	*Aythya americana*	REDH	Waterfowl	9	428	15
Red-eyed Vireo	*Vireo olivaceus*	REVI	Songbird	8	28	138
Red-headed Woodpecker	*Melanerpes erythrocephalus*	RHWO	Woodpecker	1	0	0
Rough-legged Hawk	*Buteo lagopus*	RLHA	Raptor	5	1	1
Ring-necked Duck	*Aythya collaris*	RNDU	Waterfowl	720	525	379
Red-necked Grebe	*Podiceps grisegena*	RNGR	Waterbird	0	16	7
Rock Pigeon	*Columba livia*	ROPI	Pigeon	2	6	20
Red-shouldered Hawk	*Buteo lineatus*	RSHA	Raptor	0	0	1
Red-tailed Hawk	*Buteo jamaicensis*	RTHA	Raptor	2	0	11
Ruby-throated Hummingbird	*Archilochus colubris*	RTHU	Hummingbird	8	4	15
Rusty Blackbird	*Euphagus carolinus*	RUBL	Blackbird	13	4	216
Ruddy Duck	*Oxyura jamaicensis*	RUDU	Waterfowl	0	3	0
Ruffed Grouse	*Bonasa umbellus*	RUGR	Grouse	3	0	2
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL	Blackbird	1,263	1,138	1,395
Sandhill Crane	*Antigone canadensis*	SACR	Wading Bird	0	1	18
Sanderling	*Calidris alba*	SAND	Shorebird	3	0	0
Savannah Sparrow	*Passerculus sandwichensis*	SAVS	Songbird	16	0	4

Common Name	Scientific Name	Taxa Code	Guild Classification	Historical (1977–1979)	Recent (2010–2015)	Current (2018)
Slate-colored Junco	*Junco heymalis hyemalis*	SCJU	Songbird	1	8	16
Scarlet Tanager	*Piranga olivacea*	SCTA	Songbird	0	3	1
Semipalmated Plover	*Charadrius semipalmatus*	SEPL	Shorebird	18	0	1
Semipalmated Sandpiper	*Calidris pusilla*	SESA	Shorebird	215	0	2
Sedge Wren	*Cistothorus platensis*	SEWR	Songbird	4	16	1
Snow Bunting	*Plectrophenax nivalis*	SNBU	Songbird	46	1	6
Snowy Owl	*Bubo scandiacus*	SNOW	Raptor	1	0	0
Sora	*Porzana carolina*	SORA	Rail	4	21	31
Solitary Sandpiper	*Tringa solitaria*	SOSA	Shorebird	5	0	6
Song Sparrow	*Melospiza melodia*	SOSP	Songbird	235	155	303
Spotted Sandpiper	*Actitis macularius*	SPSA	Shorebird	61	10	27
Sharp-shinned Hawk	*Accipiter striatus*	SSHA	Raptor	4	0	6
Stilt Sandpiper	*Calidris himantopus*	STSA	Shorebird	6	4	0
Swamp Sparrow	*Melospiza georgiana*	SWSP	Songbird	185	72	241
Swainson's Thrush	*Catharus ustulatus*	SWTH	Songbird	0	0	7
Tennessee Warbler	*Oreothlypis peregrina*	TEWA	Songbird	8	0	1
Tree Swallow	*Tachycineta bicolor*	TRES	Songbird	157	108	254
Trumpeter Swan	*Cygnus buccinator*	TRUS	Waterfowl	0	43	118
Tundra Swan	*Cygnus columbianus*	TUSW	Waterfowl	242	51	14
Turkey Vulture	*Cathartes aura*	TUVU	Raptor	1	17	47
Veery	*Catharus fuscescens*	VEER	Songbird	34	50	72
Virginia Rail	*Rallus limicola*	VIRA	Rail	12	15	16
Warbling Vireo	*Vireo gilvus*	WAVI	Songbird	16	14	5
White-breasted Nuthatch	*Sitta carolinensis*	WBNU	Songbird	0	3	30
White-crowned Sparrow	*Zonotrichia leucophrys*	WCSP	Songbird	2	2	5
Wilson's Phalarope	*Phalaropus tricolor*	WIPH	Shorebird	15	0	0
Wilson's Snipe	*Gallinago delicata*	WISN	Shorebird	11	3	3
Wilson's Warbler	*Cardellina pusilla*	WIWA	Songbird	0	5	3
Wood Duck	*Aix sponsa*	WODU	Waterfowl	302	27	115
White-rumped Sandpiper	*Calidris fuscicollis*	WRSA	Shorebird	2	0	0
White-throated Sparrow	*Zonotrichia albicollis*	WTSP	Songbird	55	23	36
Yellow-bellied Flycatcher	*Empidonax flaviventris*	YBFL	Songbird	0	0	1
Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA	Woodpecker	0	0	10
Yellow Warbler	*Setophaga petechia*	YEWA	Songbird	64	163	192
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	YHBL	Blackbird	62	0	0
Yellow-rumped Warbler	*Setophaga coronata*	YRWA	Songbird	55	63	187
Yellow-throated Vireo	*Vireo flavifrons*	YTVI	Songbird	0	1	3

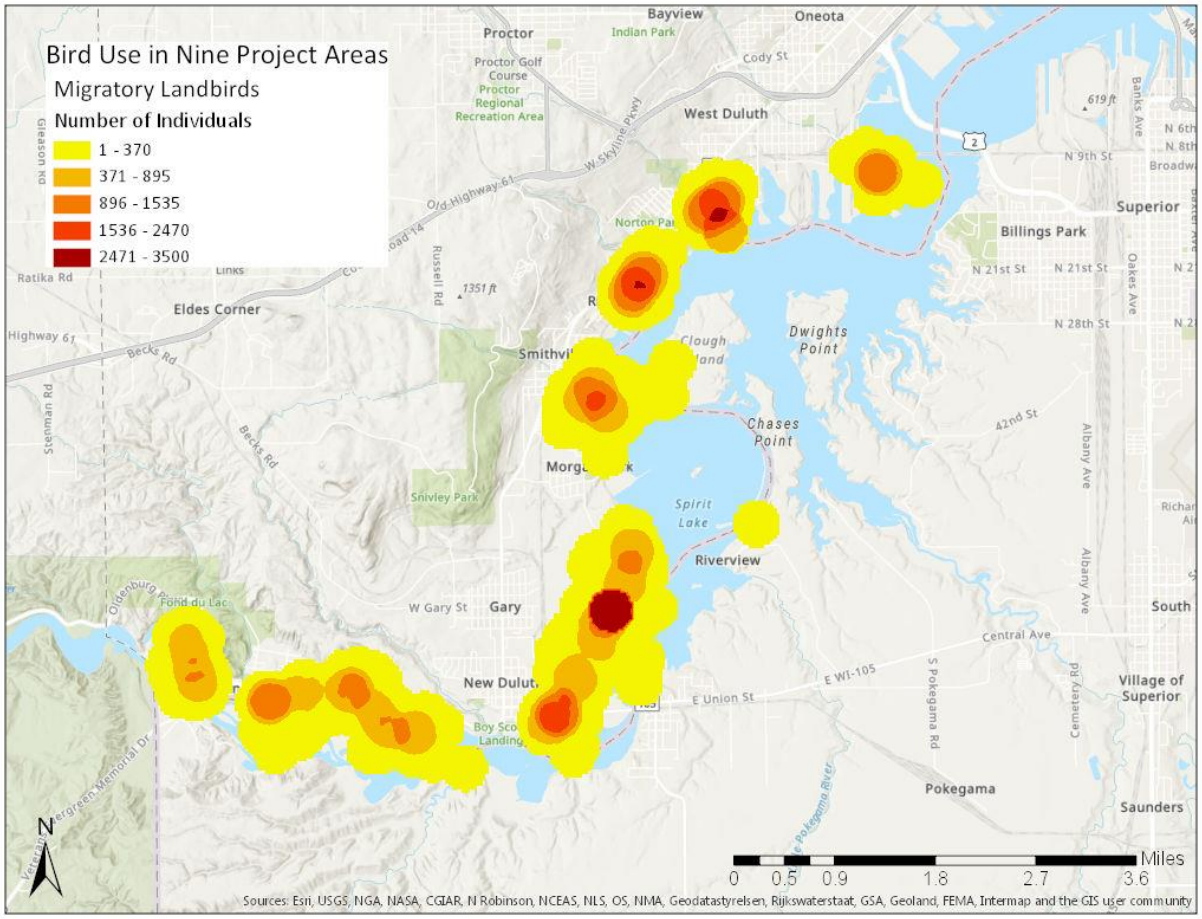
Appendix C. Common names of species identified as species of conservation concern that were observed at least once in the SLRE. Lists include Species in Greatest Conservation Need (SGCN), U.S. Shorebirds of Conservation Concern (SHCC), Waterbirds of Conservation Concern (WACC), Partners in Flight Species of Continental Concern (PIF), and USFWS Region 3 and/or National Birds of Conservation Concern (USFWS Regional or National). Species with asterisks (*) represent species observed in 2018 surveys (52 species total).

Common Name	Lists	Common Name	Lists
American Black Duck *	SGCN	Least Bittern *	USFWS Regional, SGCN, WACC
American Bittern *	USFWS Regional, SGCN, WACC	Least Sandpiper *	SHCC
American Golden-Plover	SHCC	Lesser Scaup *	SGCN
American Kestrel *	SGCN	Lesser Yellowlegs *	USFWS National, SHCC
American White Pelican *	SGCN, WACC	Northern Harrier *	SGCN
Bald Eagle *	USFWS National/Regional	Northern Pintail *	SGCN
Baird's Sandpiper *	SHCC	Northern Rough-winged Swallow *	SGCN
Black-billed Cuckoo *	USFWS Regional, SGCN, PIF	Olive Sided Flycatcher *	USFWS National/Regional, SGCN, PIF
Black-bellied Plover	SHCC	Peregrine Falcon *	USFWS National/Regional, SGCN
Black-crowned Night-Heron	SGCN, WACC	Pectoral Sandpiper *	SHCC
Belted Kingfisher *	SGCN	Philadelphia Vireo *	SGCN
Bobolink *	SGCN, PIF	Pied-billed Grebe *	USFWS Regional, WACC
Bonaparte's Gull *	WACC	Purple Finch *	SGCN
Black Tern	USFWS Regional, SGCN, WACC	Purple Martin	SGCN
Brown Thrasher *	SGCN	Red-headed Woodpecker	USFWS National/Regional, SGCN, PIF
Caspian Tern *	WACC	Red-necked Grebe *	SGCN, WACC
Canada Warbler *	USFWS National/Regional, PIF	Red-shouldered Hawk *	SGCN
Chimney Swift *	SGCN	Rusty Blackbird *	USFWS National/Regional
Cape May Warbler	SGCN, PIF	Sanderling	SHCC
Common Loon *	SGCN, WACC	Semipalmated Plover *	SHCC
Common Merganser *	SGCN	Semipalmated Sandpiper *	USFWS National, SGCN, SHCC
Common Nighthawk	SGCN	Sedge Wren *	SGCN
Common Tern *	USFWS Regional, SGCN, WACC	Snowy Owl	PIF
Dunlin *	USFWS National, SHCC	Sora *	WACC
Evening Grosbeak *	SGCN, PIF	Solitary Sandpiper *	USFWS National/Regional, SHCC
Forster's Tern *	SGCN, WACC	Spotted Sandpiper *	SHCC
Greater Yellowlegs *	SGCN, SHCC	Stilt Sandpiper	SHCC
Green Heron *	WACC	Trumpeter Swan *	SGCN
Golden-winged Warbler *	USFWS National/Regional, SGCN, PIF	Veery *	SGCN
Harris's Sparrow	USFWS National, PIF	Virginia Rail *	SGCN
Herring Gull *	WACC	Wilson's Phalarope	SGCN, SHCC
Horned Grebe *	USFWS Regional, SGCN, WACC	Wilson's Snipe *	SHCC
Killdeer *	SHCC	Yellow-headed Blackbird	SGCN

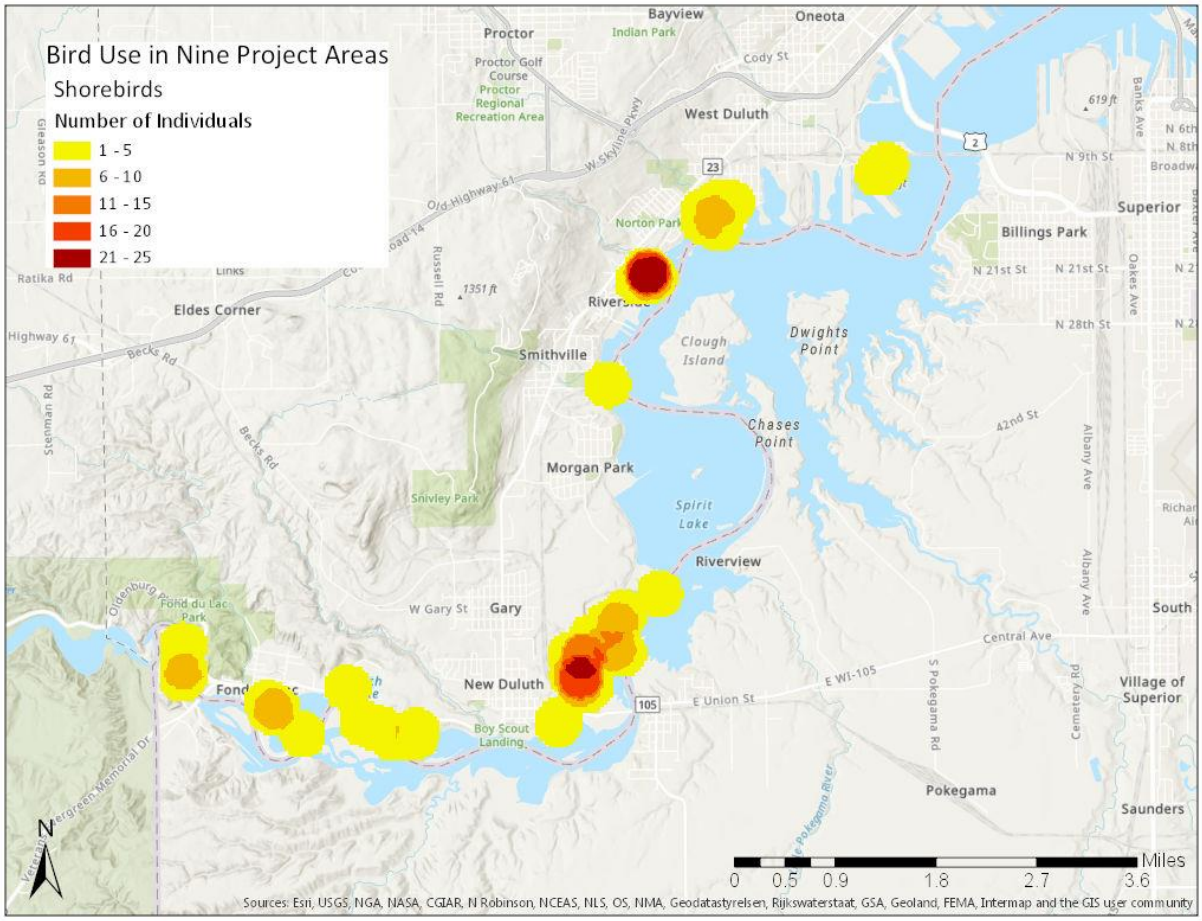
Appendix D. Heat map representing where all 16 guilds were most observed in the nine project areas from April–October 2018.



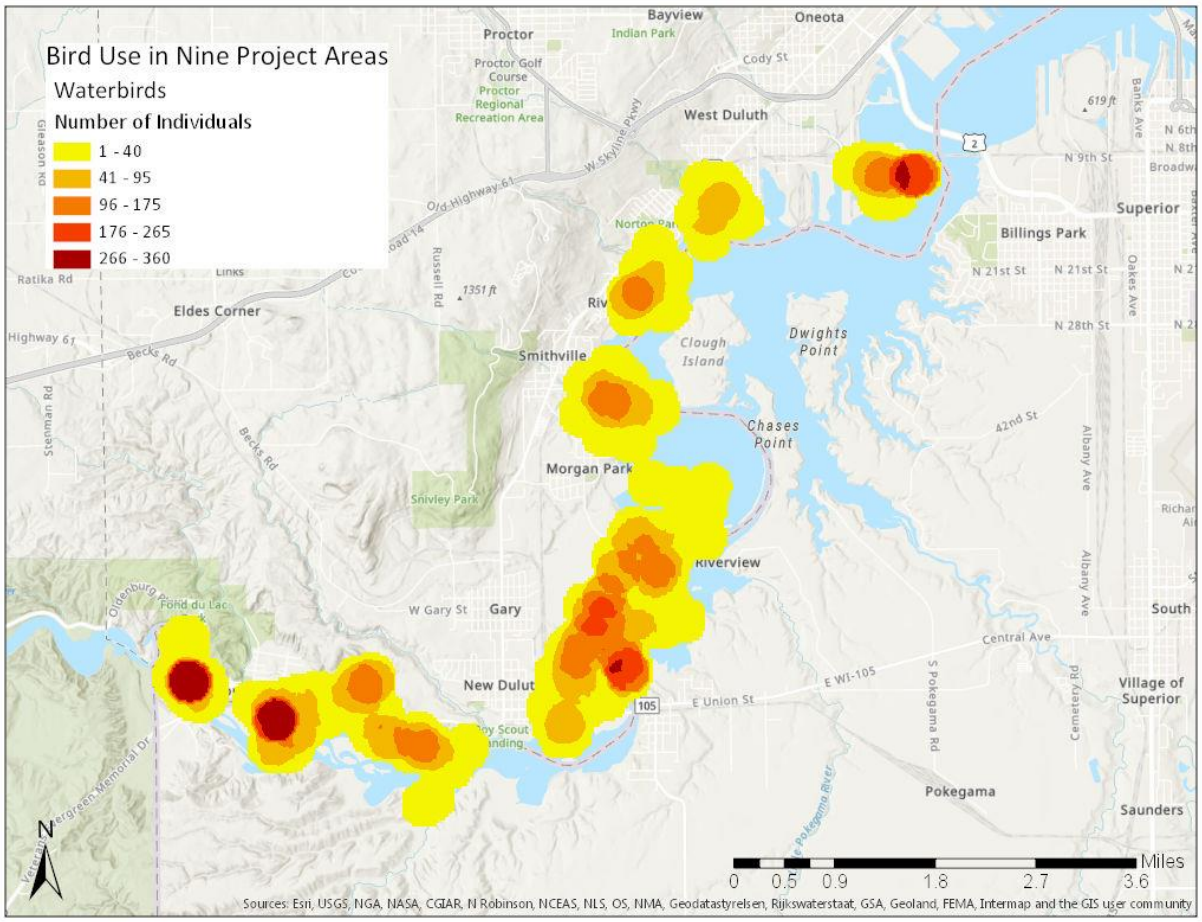
Appendix E. Heat map representing where migratory landbirds were most observed in the nine project areas from April–October 2018.



Appendix F. Heat map representing where shorebirds were most observed in the nine project areas from April–October 2018.



Appendix G. Heat map representing where waterbirds were most observed in the nine project areas from April–October 2018.



Appendix H. Heat map representing where waterfowl were most observed in the nine project areas from April–October 2018.