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NRRI TECHNICAL REPORT

Interstate Island Habitat Restoration: Phase III – Long-Term Monitoring and Maintenance Plan Common Tern Monitoring & Migratory Shorebird Assessment

2023 Final Report

Submitted by:

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Common Tern and Buff-breasted Sandpiper on Interstate Island (photos: S. Kolbe)

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Avian Monitoring and Assessment Overview

The goal of the Interstate Island avian habitat restoration project was to restore and enhance critical breeding habitat for the Common Tern (*Sterna hirundo*) and Piping Plover (*Charadrius melodus*) in the St. Louis River Estuary (SLRE). The primary objective of the habitat restoration was to maintain and increase the population of Common Terns breeding at the Interstate Island colony. To assess the effectiveness of the restoration, post-restoration field surveys were conducted to document the breeding status of Common Terns relative to pre-restoration averages. To document breeding population size and productivity, we followed the long-term monitoring protocol developed by the Wisconsin Department of Natural Resources (DNR), to ensure comparability between pre- and post-restoration monitoring. There were no monitoring objectives related to Piping Plover since this species has not been documented on Interstate Island. A secondary objective of the project was to document shorebird use of the island during migration to determine if this species group was utilizing the restored habitat. To meet this objective, researchers developed a shorebird monitoring protocol, conducted in-person surveys, and utilized remote camera traps to observe and quantify shorebird species diversity, abundance, and spatial and temporal use of Interstate Island.

Based on post-restoration surveys, population targets are not currently being met for Common Tern, with the number of nesting pairs currently at some of the lowest recorded since the island was colonized. However, post-restoration productivity is above the range deemed necessary to sustain a viable population and above pre-restoration averages. The overall quality of the nesting habitat for Common Terns was greatly improved. If habitat quality is the primary factor limiting the size of the breeding population, we anticipate the restoration actions will result in an increase in breeding numbers but there may be a lag in response time. We also documented 22 shorebird species and 38 other avian species using the island during our surveys. Our results indicate that shorebirds as well as many other species of birds will readily use the newly restored habitat at Interstate Island, habitat which is much needed in this important bird region. Continued monitoring and management will be necessary to determine long-term effects of restoration for both Common Terns and migratory shorebirds.

Background

At the western tip of Lake Superior, the SLRE in the Duluth-Superior harbor of Minnesota and Wisconsin has been identified as a high priority area for bird conservation (Grand et al. 2020) and is designated an internationally Important Bird Area (IBA), meaning it provides essential habitat for breeding and migratory birds during some phase of their life cycle (BirdLife International 2019). Although the Duluth-Superior harbor contains one of the longest freshwater sand spits in the world and provides high-quality habitat for waterbird and shorebird species, it is used intensively by humans for recreational purposes, resulting in non-suitable breeding habitat for coastal nesting species and high levels of disturbance for migratory shorebirds.

Interstate Island, a small dredge-spoil island in the Duluth-Superior harbor, is recognized as a high-priority breeding site for Common Tern and critical habitat for Piping Plover in the Great Lakes region. However, since its creation, wind, water, and ice erosion had significantly reduced the elevation of bird nesting habitat, causing seasonal flooding of nesting areas. Effects of erosion coupled with sustained high water levels and storm surges reduced the area and quality of nesting habitat available. In response to the severity of habitat loss, the Minnesota DNR increased the elevation and constructed a protective berm along the perimeter of the tern nesting area in 2015 to buffer the effects of habitat loss. A large-scale restoration project was initiated in the autumn of 2020 to stabilize the habitat and increase the

footprint of the island. This extensive restoration project not only enhanced habitat quality for breeding Common Terns but also provided high-quality habitat for migratory birds.

Many colonial nesting waterbird species (e.g., gulls, terns, cormorants, pelicans) select breeding sites on remote islands, where disturbance, competition and predation are minimized (Soulliere et al. 2018). Interstate Island is one of only two consistently active nesting colonies of Common Terns in the Lake Superior watershed, therefore, restoration of the island was crucial to ensuring this species continued to successfully breed in the region. In addition to Common Terns, many other bird species use the island, including migratory shorebirds. Although coastal habitats in the Great Lakes region provide important migration corridors for numerous waterbird and shorebird species (Potter et al. 2007, Soulliere et al. 2018), human land use in much of this region has reduced the availability of undisturbed coastal and island habitats. Previous research in the SLRE has suggested that suitable migratory shorebird habitat (e.g., mudflats, sandy or rocky shorelines) is lacking (Grinde et al. 2019). These habitats provide birds a place to safely rest and replenish food resources between long-distance flights, a stage that is crucial to ensuring birds can complete their migratory journeys.

Research has historically focused on the breeding and wintering grounds for many avian species, as this is where they spend a significant amount of their time. However, in recent years, the focus has broadened to include the importance of stopover habitat for long-distance migratory species. Interstate Island provides suitable breeding habitat for colonial waterbirds as well as high-quality stopover habitat for shorebirds. It is especially important because the island is isolated from daily human activity (e.g., unleashed dogs, beachgoers) and provides the potential for longer daily (or even multi-day) use by shorebirds. Most migratory shorebird species observed in this region breed in the Arctic and winter in Central America and South America and are only seen locally during spring and autumn migration. The Great Lakes region is especially important for Greater and Lesser Yellowlegs, Least Sandpiper, Pectoral Sandpiper, Dunlin, and Short- and Long-billed Dowitchers (Potter et al. 2007). Therefore, the presence of a minimally disturbed island with high-quality shoreline and adjacent habitat acts as an essential steppingstone for these birds as they complete their annual migratory journeys.

To document post-restoration (2020 – 2023) use of Interstate Island by Common Terns during the breeding season and by shorebirds during migration, we did the following:

1) Conducted population monitoring of nesting Common Terns during the breeding season (May – August) and compared to pre-restoration population monitoring data to assess immediate effectiveness of the restoration activities on nesting terns.

2) Conducted in-person and remote camera surveys (May – October) to quantify the abundance and diversity of migratory shorebirds, both spatially and temporally.

3) Described site conditions and ongoing challenges that will need to be addressed as part of the long-term monitoring plan for Interstate Island.

Methods

Common Tern Monitoring

Breeding Population Survey Methods – Annually from 2020 through 2023, the Common Tern nesting area was surveyed approximately every 4 - 5 days, beginning mid May and continuing until late August (Fig. 1). All nests containing eggs were marked upon first observation with a uniquely numbered wooden marker (Fig. 2). The location (cell number) of the nests within the tern nesting enclosure was also

recorded. On subsequent surveys, the fate of each marked nest was recorded (i.e., number of eggs present, if the nest was abandoned, and/or the number of chicks present). If a nest was empty (eggs predated or hatched), the nest marker was removed and the fate of the nest was documented. New nests were marked during each subsequent visit until the number of active nests began to decline (i.e., post peak nest count). Nest marking was used to determine the peak nest count, which was the survey with the highest number of active nests and the measure of the annual breeding population size.

Figure 1. Wildlife managers and researchers conducting breeding population surveys at the Common Tern nesting colony on Interstate Island (photo: MN DNR).

Figure 2. Nest monitoring and chick banding of Common Terns on Interstate Island (photos: C. Henderson).

Productivity Survey Methods – Common Tern chicks were fitted with a federally issued U.S. Geological Survey (USGS) stainless steel leg band when chicks were first encountered, generally 1 – 5 days after hatching (Fig. 2). The band number and estimated age of the chick (in days) were recorded. During subsequent surveys, the fate of each chick was recorded. If the bird was recaptured alive, the band number, age, and location where it was recaptured (cell number) were recorded. If the bird was found dead, the band was removed, the band number and location where the bird was found dead were recorded, and the carcass was buried. Surveys continued until the fate of all chicks was determined, with final surveys occurring in the first half of August. The fate of chicks (dead, alive, unknown) was summarized to determine annual productivity. Any chicks ≥15 days old at last recapture were considered to be successfully fledged. Annual productivity was determined by dividing the number of chicks successfully fledged by the peak nest count.

Co-nesting Ring-billed and Herring Gulls – Estimates of the number of nesting pairs of each species is provided, based on annual surveys conducted by the Wisconsin and Minnesota DNR. The survey's aim is to document peak nesting activity for these species in the SLRE. Since 1990, DNR staff have estimated the number of nesting pairs of each species on Interstate Island annually with the exception of five years (1991, 2010, 2015, 2017, 2020). The survey is a total nest count that is scheduled to be conducted about the time eggs first start to hatch, which is assumed to coincide with peak nest count. The extent of the island is gridded off into sections using biodegradable spray paint. Three nest counters walk a transect within each sectioned area and count the number of nests occurring within their designated survey area. Surveyors tally the number of Ring-billed Gull (*Larus delawarensis*) and Herring Gull (*Larus argentatus*) nests in each section using handheld tally counters. Each surveyor is given two tally counters, one for each species. At the end of each transect, one person records the number of nests for each species in the given section. Surveyors reset the tally counters to zero and repeat the process until the entire island has been surveyed. The total number of nests counted for each species is then tallied for the entire island and also separately for nests that occur within the tern nesting enclosure. Herring Gull nest counts started in 2000 and continued annually, coinciding with the Ring-billed Gull surveys.

Additional Management Actions – In addition to the annual management activities described above, in 2021 and 2022, one-third of the tern nesting area was covered with snow fencing in the autumn to deter Ring-billed Gull from nesting within the enclosure the following spring. This fencing was removed in early May each year, after most gulls had established nesting locations on the island for the season but before Common Terns returned to the island to nest. In 2022 – 2023, the gull deterrent string grid that is placed within the tern nesting enclosure was replaced with electric woven wire fencing string. The string grid was placed in parallel rows, spaced 2 ft. apart, within the area of the enclosure where the terns nest in highest density and at 4 ft. apart in the remaining sections of the enclosure. The purpose of replacing the string grid was to use a material that is expected to last longer and require less maintenance. We also placed bamboo stakes vertically throughout different sections of the enclosure at different densities to determine if it would deter nesting by gulls. Stakes were placed 36 in. apart in rows 18 in. apart in one section (higher density) and 29 in. apart in rows 29 in. apart in another section (lower density). In 2023, the U.S. Department of Agriculture (USDA) Wildlife Services implemented lethal gull removal in the main tern nesting area. A pellet gun was used and gulls nesting in closest proximity to nesting terns were targeted.

Shorebird Monitoring

In-person survey methods – In-person surveys were conducted weekly during daylight hours between mid May through early October, 2020 – 2023. Surveyors walked the perimeter of the island and through

the tern enclosure documenting all species observed, which were recorded on aerial photo field sheets, with accuracy estimated to within 10m near or on shore. Ring-billed Gull and Herring Gull observations were excluded from the in-person surveys due to the high abundance of these species present during much of the survey period. Species identification and spatial location data were the major targets of these surveys. During each in-person survey, the date, start and end time (i.e., effort), observer(s) names, and supplemental information about environmental conditions were collected and recorded on data sheets. Supplemental data included air temperature (°C), weather conditions, sky cover, wind intensity, noise/disturbance code, and notes about anything unusual or important (e.g., aerial predator present, active restoration activity).

At the beginning of each survey, binoculars and spotting scopes were used to scan the field of view in the direction the surveyors would walk (Fig. 3). Transects were walked in opposite directions weekly (i.e., clockwise one week and counter-clockwise the next). One observer would spatially record the bird observations on the field sheet while the other would scan and identify species observed and estimated abundance in a given area. Both observers would verify species identification when required. Birds were identified to the species level when possible; birds that were difficult to identify to species level due to environmental variables such as poor light conditions, heavy vegetation cover, or distance from the observer were counted and recorded to the lowest taxonomic level possible (e.g., unknown plover). Latin names associated with species are provided in Appendix A but are not included in text for all species to aid readability. All data collected were entered into an Excel spreadsheet, quality control checks were completed, and field data sheets were scanned and digitally stored at the Natural Resources Research Institute (NRRI), Duluth, MN. To document spatial use, all data collected on field sheets were digitized using ArcGIS Pro.

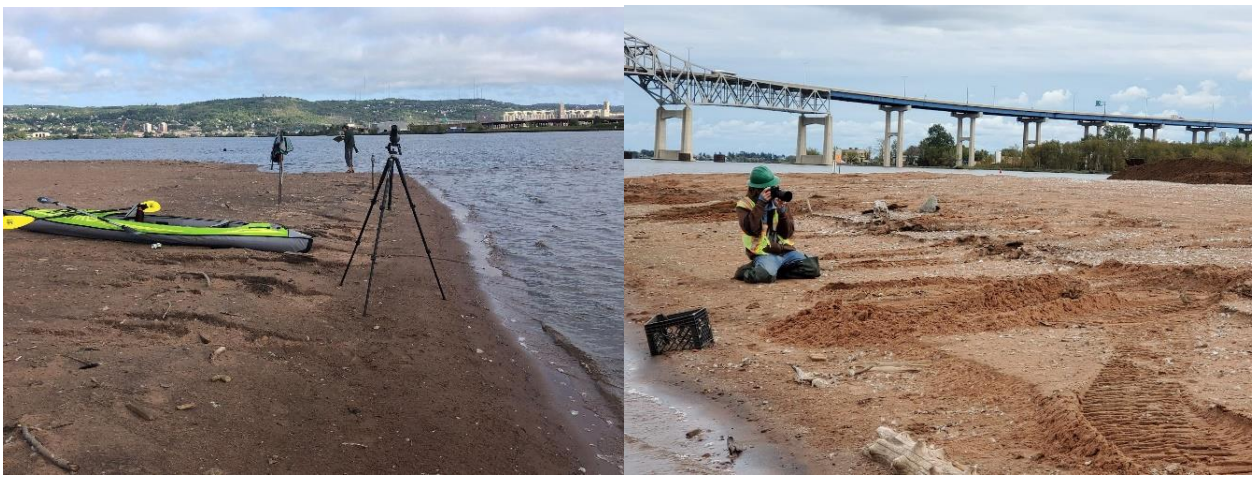

Figure 3. In-person migration surveys at Interstate Island included use of a spotting scope and binoculars to scan the field of view before surveyors walked the perimeter of the island. NRRI researcher Steve Kolbe photographing a Buff-breasted Sandpiper (in the tire rut in the right edge of the image) during autumn migration at Interstate Island in 2020 (photos: S. Nelson and A. Bracey).

Remote camera survey methods – Remote camera trap arrays were placed along the perimeter of the island to ensure nearly full coverage (Fig. 4). Browning Strike Force HD Pro X trail cameras were deployed at fixed locations established on land to maximize coverage of the shoreline. The number of cameras deployed and maintained annually varied due to differences in total area to be covered and camera function. In 2020, 16 cameras were deployed on Interstate Island, in 2021, 15 cameras were

deployed, in 2022, 14 cameras were deployed, and in 2023, 15 cameras were deployed. All cameras were set to record images daily at 10-minute intervals during daylight hours (~5:30 – 21:00). In 2020 and 2021 cameras were set to collect images from May – Oct. However, based on the amount of effort needed to review camera images, we changed the duration of the cameras in 2022 and 2023 to be placed only during peak migration for a week in August. On average, six photos were taken per hour for ~ 15.5 hours each day. This resulted in ~93 frames captured daily. Coinciding with in-person surveys, cameras were checked weekly to ensure function (e.g., batteries and SD cards working/not full) and to maintain the integrity of the camera view (e.g., camera pole intact and camera facing proper direction).

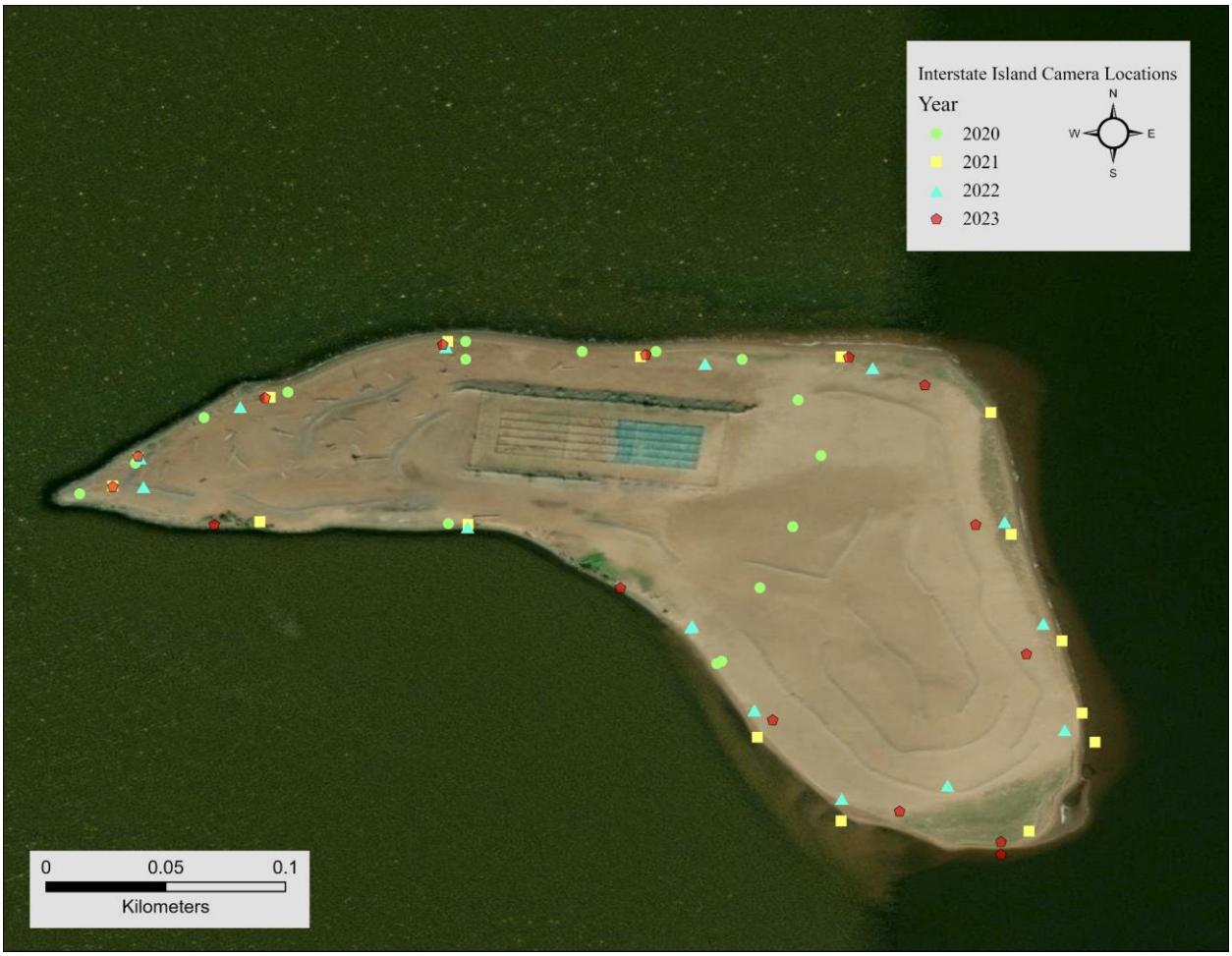

Figure 4. Location of remote camera trap arrays on Interstate Island (2020 – 2023) used to document use of shoreline habitat by migrating shorebirds. Note: the location of the cameras each year represents the extent of shoreline; for example, 2020 represents the shoreline before additional habitat restoration was completed in 2021.

All photographs obtained from the remote camera traps were stored on SD cards, uploaded to Google Drive, and stored in folders by year and camera ID. Within each camera folder, a Google Sheet was created to record observations for each camera. For each frame, the unique Camera ID, TimeStamp, and date were recorded. VLC Media Player (VideoLAN 2021) was used to look at each photo. An interactive zoom function in this program allowed observers processing the images to zoom into each of the four quadrants of the photo. Individuals would carefully scan each frame to look for birds. Every species

observed standing, sitting, or laying on the island or floating on the water nearby was recorded on a separate row in Google Sheets along with the count of each species. Species observed in flight were not counted. If no birds were observed in a frame, it was recorded as a zero. For birds that were difficult to identify, a separate column was created to enter percent certainty and to specify that a second observer was required to try to identify the bird to species, if possible. If the bird could not be identified to species, it was recorded by guild (e.g., shorebird, waterbird). We used weekly in-person survey data and eBird data (eBird 2021) to identify the timing of peak migratory intensity for early- and late-season shorebird movement in the region (Fig. 5). We identified the second week in August (Aug 15 – 21) as the target window for summarizing remote camera trap images. Every image collected between Aug 15 – 21 was processed manually.

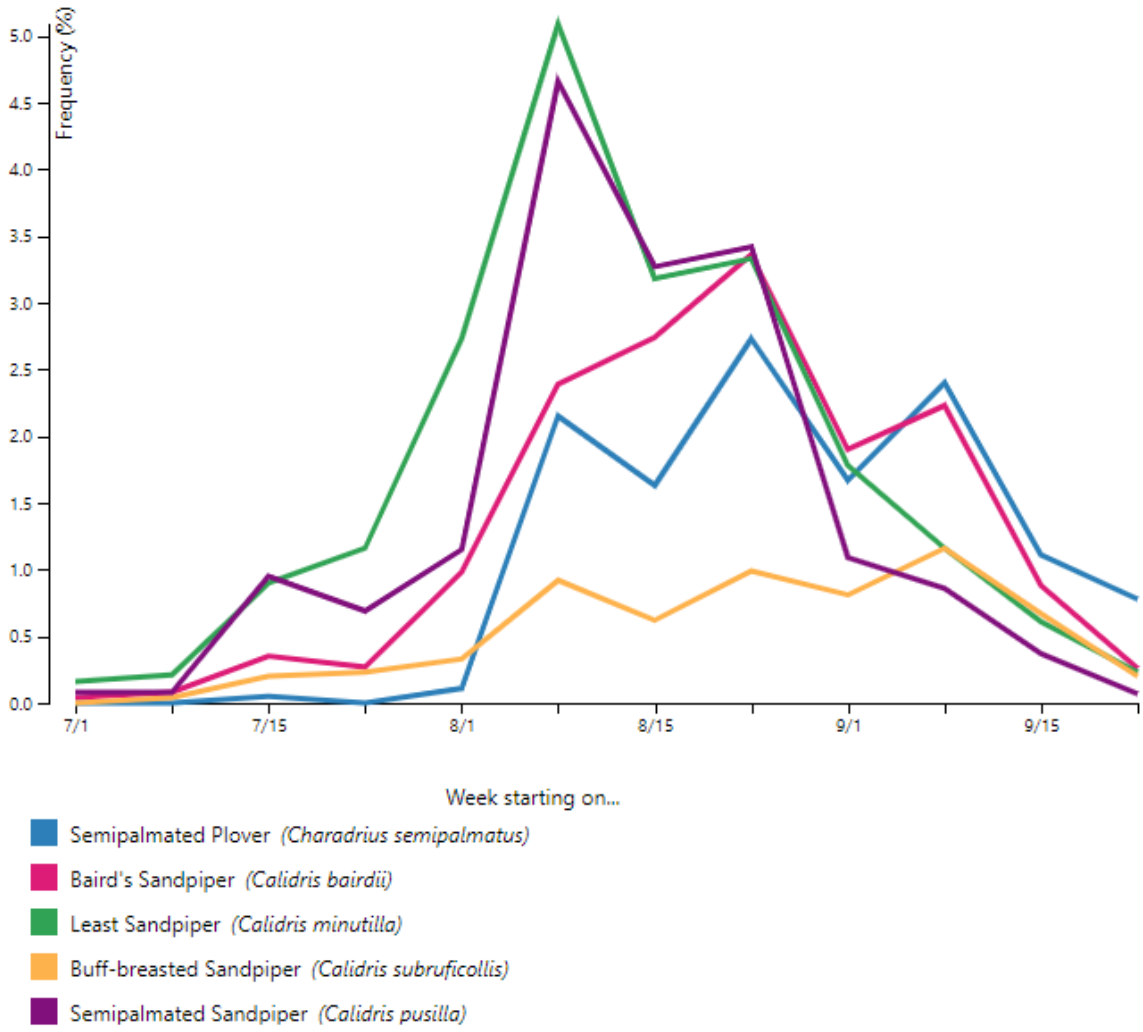

Figure 5. Estimated peak shorebird movements through St. Louis County, MN based on eBird observations for early and late shorebird migrant species (eBird 2021). We used these estimates coupled with in-person survey data to determine the most appropriate time period to summarize remote camera trap data to coincide with peak movement.

Results

Common Tern Monitoring

All Common Tern monitoring and management activities occurred twice weekly from mid May through August (2020 – 2023). To reduce predation on tern eggs and chicks and co-nesting by Ring-billed Gull within the tern nesting area, chain link fencing was installed in 2020 (Fig. 6A); this replaced the use of a chicken wire fence which required annual repair and maintenance. The newly installed fencing included an exterior 'buffer' around the perimeter of the tern nesting enclosure where gull nests were removed. The chain link fencing also subdivided the tern nesting area which facilitated tern monitoring activities (e.g., capturing chicks; Fig. 6B). A string grid was also installed within the tern nesting area in parallel rows, separated by four feet and at waist height in an effort to reduce the number of gulls entering and attempting to nest (Fig. 6B). Because terns are smaller and more agile flyers than gulls, they can easily fly through the string grid. Annual Common Tern monitoring and management also requires maintenance of sparse vegetation which is done by hand pulling and herbicide application (Fig. 6C). We also installed wooden shelters which the chicks used to avoid extreme weather conditions (e.g., high heat or severe rain) and to hide from predators (e.g., Ring-billed Gull; Fig. 6D). All banding data were submitted annually to the USGS Bird Banding Laboratory via the Wisconsin DNR.

Figure 6. Chain link fencing (**A**) and a string grid (**B**) were installed on Interstate Island in 2020 to secure the Common Tern nesting area. Vegetation growth (**C**) needs to be removed annually to maintain suitable nesting habitat for Common Terns, which prefer sparsely vegetated habitats. Wooden shelters (**D**) protect chicks from severe weather and predators.

Breeding population and productivity surveys – Annual peak nest counts and productivity were compared to pre-restoration population estimates. Peak nest counts at or above 200 were recorded in 9 of 31 (39%) years between 1989 and 2019. Peak nest count for this same time period was (Mean ± SD) 183 ± 50. Peak nest count between the years 2020 and 2023 was 107 ± 9 (Fig. 7). The 2022 peak nest count was the lowest recorded (*n* = 91 nests) since the colony was established and monitored consistently in 1989, when peak nest count was 81. In 2023, peak nest count was 120, which was encouraging but still significantly lower than the mean count of 183 nests and well below the population target of 200 nesting pairs. Productivity at or above 0.8 young fledged per peak nest count was recorded in 17 of 31 (55%) years between 1989 and 2019. Productivity for this same time period was (Mean ± SD) 0.82 ± 0.38. Productivity for 2020 – 2023 was 1.27 ± 0.14 (Fig. 7).

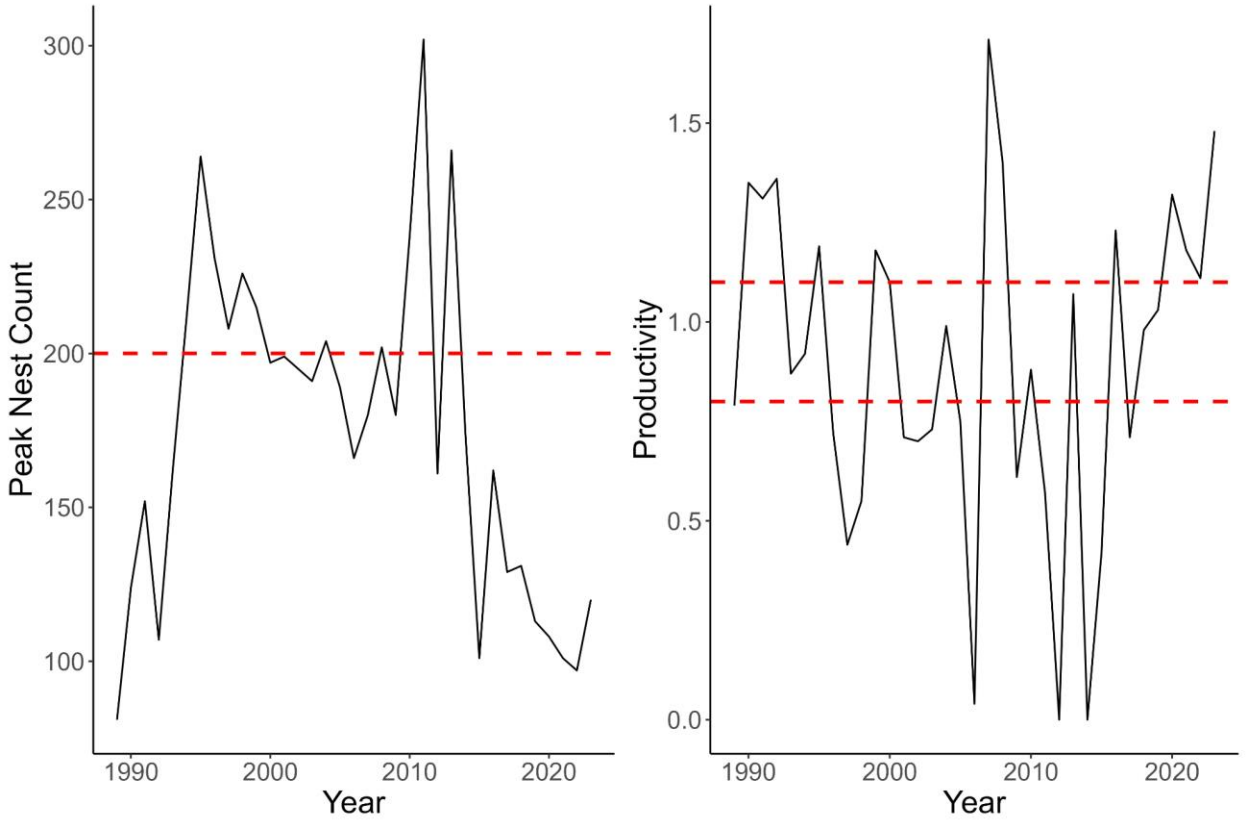

Figure 7. Peak nest count and productivity measures for Common Terns nesting at the Interstate Island colony from 1989 – 2023. The red dashed lines represent target population metrics of 200 nesting pairs (peak nest count) and productivity between 0.8 – 1.1 young fledged per nesting pair.

Nesting Ring-billed and Herring Gulls – The average number (± SD) of nesting pairs of Ring-billed Gull on Interstate Island between 1990 and 2022 was 9,724 ± 4,532, with an average of 948 ± 935 nesting within the tern nesting enclosure (Fig. 8). There was no survey conducted in 2020, but in 2021 – 2023 an average of 12,722 ± 854 pairs nested on the island with an average of 494 ± 75 nests occurring within the tern nesting enclosure. In 2023, 13,605 pairs of Ring-billed Gulls nested on the island with 551 nests occurring within the tern nesting enclosure. The average number (± SD) of nesting pairs of Herring Gulls on Interstate Island (2000 – 2023) was 19 ± 8. In 2023, 19 pairs of Herring Gull nested on the island. The number of Herring Gull nesting on the island is relatively small and has been consistent over time. There have never been any Herring Gull nests located within the Common Tern nesting enclosure.

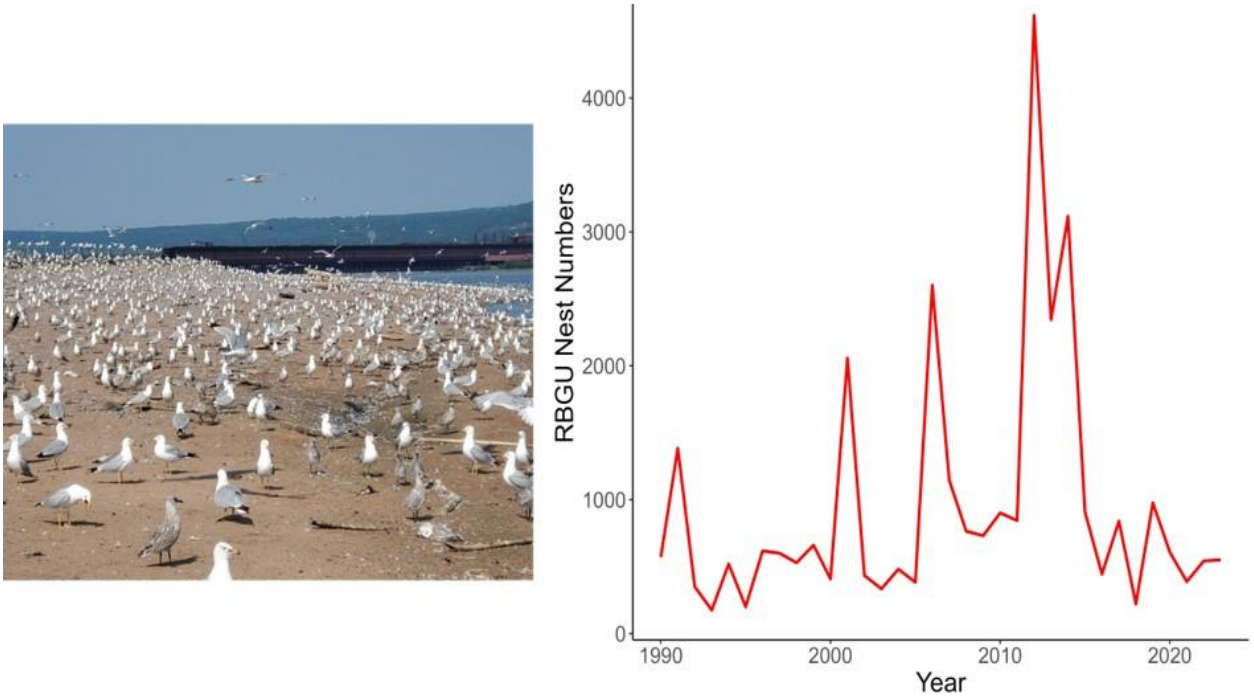

Figure 8. Number of Ring-billed Gull (RBGU) nests occurring in the Common Tern nesting enclosure at Interstate Island from 1990 – 2023. The number of nests increased in years of high water when available nesting habitat was severely reduced on the island, resulting in birds attempting to nest in the tern enclosure in higher numbers. Post-restoration RBGU nest numbers are lower as a result of habitat restoration.

Additional Management Actions – The number of gull nests was reduced by 24% in the portion of the tern nesting enclosure that was covered by snow fencing relative to uncovered sections in 2021 and 2022. However, gull predation was still high, as 64 tern nests had been predated by the peak nest count. The string grid replacement withstood the winter and was largely in-place in spring of 2023. The bamboo stakes used to deter nesting by gulls was not effective. Gull nesting attempts were slightly higher where bamboo was placed relative to areas without bamboo. In the sections with denser bamboo placement a total of 79 gull nests were found, in the sections with lower density stakes 77 gull nests were found, and in sections without bamboo there were 71 gull nests found. A total of 40 nesting Ring-billed Gulls were lethally removed from the tern nesting area. The lethal removal of nesting gulls significantly reduced gull predation of tern eggs with 92% of total tern nests marked (130) surviving to the peak nest count.

Summary of All Species Detected

During the four years of monitoring at Interstate Island, a total of 60 species were detected during in-person surveys and on remote cameras, including Common Tern, Herring Gull, and Ring-billed Gull (Appendix A). The conservation status of each species is provided based on Cornell University's Birds of the World species accounts (BOTW) which were sourced from the International Union for Conservation of Nature's Red List of Threatened Species (IUCN 2022). Of these 60 species detected, 43 were considered to be of low concern, 10 were considered to be declining, and 6 were considered to be common birds in steep decline (Table 1). Nine of the 10 species listed as declining were shorebirds and three of the six species listed as common birds in steep decline were shorebirds (Table 1; Figure 9). The waterbird species listed as common birds in steep decline were Common Tern and Herring Gull, both

species that breed on Interstate Island. Additionally, six species were designated as Species of Greatest Conservation Need by the Minnesota DNR. The species considered to be of special concern (SPC) included two waterbird species (American White Pelican and Franklin's Gull), one raptor (Bald Eagle), and one shorebird (Marbled Godwit; Table 1). The species listed as threatened (THR) included Common Tern and Peregrine Falcon (Table 1).

Table 1. List of species detected at Interstate Island (2020 – 2023) designated with a conservation status other than low concern based on Cornell University's Birds of the World species accounts (Common Bird in Steep Decline or Declining) or listed as a Species of Greatest Conservation Need by the Minnesota DNR. Species are listed by group (Shorebird, Songbird, Waterbird, Raptor) and English name.

Group	English Name	Common Bird in Steep Decline	Declining	SGCN
Shorebird				
	American Golden-Plover		X	
	Black-bellied Plover	X		
	Buff-breasted Sandpiper		X	
	Dunlin	X		
	Lesser Yellowlegs		X	
	Marbled Godwit		X	SPC
	Pectoral Sandpiper		X	
	Ruddy Turnstone		X	
	Sanderling	X		
	Semipalmated Sandpiper		X	
	Whimbrel		X	
	Willet		X	
Songbird				
	Horned Lark	X		
Waterbird				
	American White Pelican			SPC
	Common Tern	X		THR
	Franklin's Gull		X	SPC
	Herring Gull	X		
Raptor				
	Bald Eagle			SPC
	Peregrine Falcon			THR

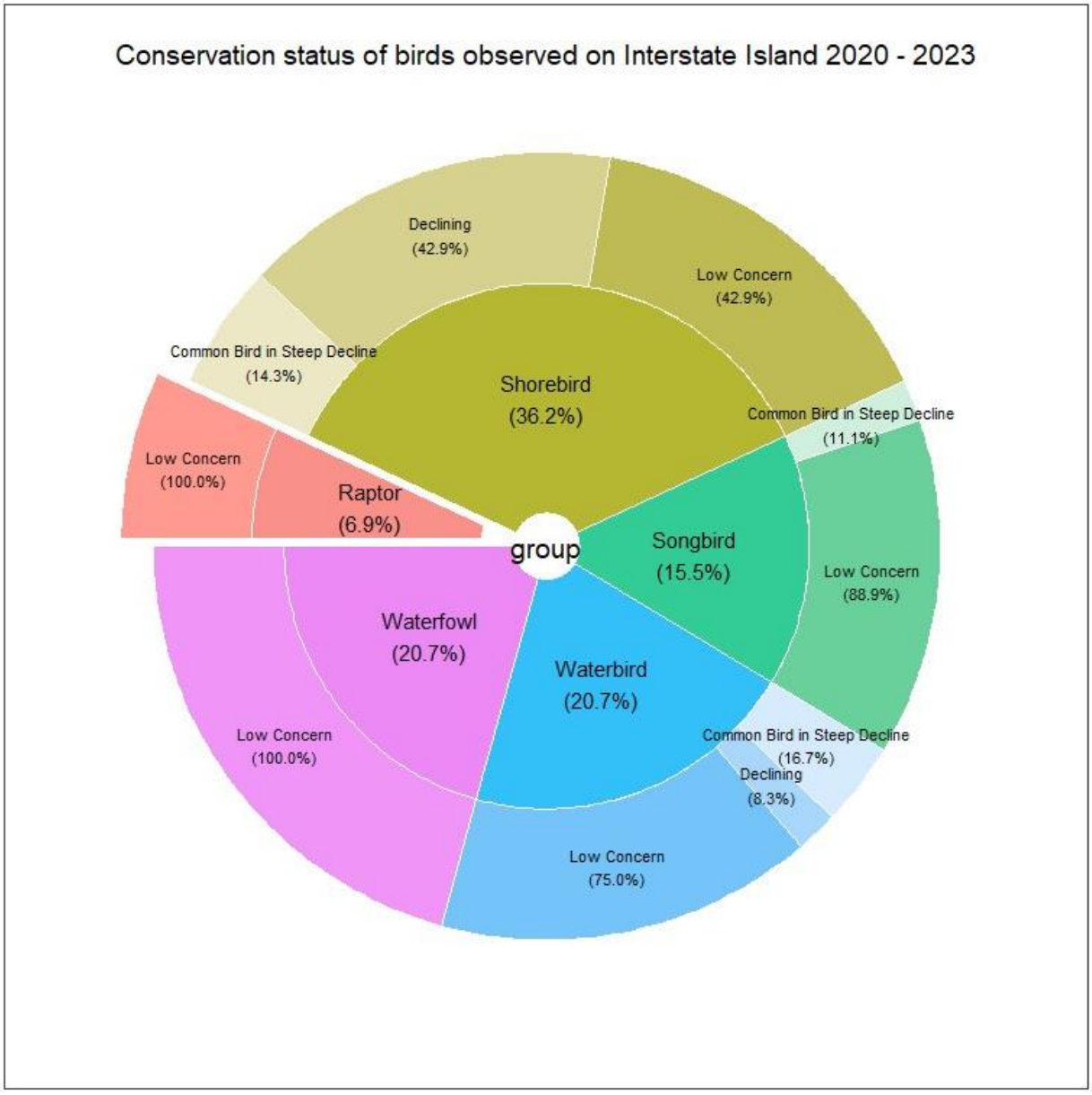

Figure 9. Conservation status of birds detected on Interstate Island during in-person surveys and remote cameras (2020 – 2023). The conservation status is based on Cornell University's Birds of the World accounts for each species and shows the percentage of each species listed in each of the following categories (Low Concern, Declining, Common Bird in Steep Decline by group (Raptor, Shorebird, Songbird, Waterbird, Waterfowl).

Shorebird Monitoring

The number of in-person migratory shorebird surveys conducted during each season (spring migration, breeding season, autumn migration) varied by year (Table 2). Together a total of four spring migration surveys were conducted between May 11 – 25, 17 breeding season surveys were conducted between June 2 – July 28**,** and 37 autumn migration surveys were conducted between August 2 – October 6. Due to variation in the timing of ice-out each year, it was not possible to safely access the island in April or early May. Therefore, the number of surveys conducted during spring migration was lower than

expected in 2021 and spring surveys were not conducted in 2022 or 2023 for this reason. Additionally, due to the timing of Ring-billed Gull and Herring Gull nest initiation, the island was already occupied with thousands of nesting gulls by late March. Due to these factors, use of the island and detection of use by shorebirds was limited in the spring.

In-person survey results – A total of 58 in-person weekly surveys were conducted between May 11 and October 6 (Table 2). A total of 53 species and 2,734 individuals were observed during these surveys, including 18 species and 1,509 individual shorebirds (Appendix A). Semipalmated Sandpiper was the most abundant shorebird species observed (38% of all shorebirds), followed by Least Sandpiper (13%), Semipalmated Plover (11%), Baird's Sandpiper (10%) and American Golden-Plover (7%). Because shorebirds can be difficult to identify due to their quick movements and small size, 4% of shorebirds observed in person were not identified to species. The density of shorebird observations was low in May, due in part to the number of surveys conducted, site accessibility, and the number of Ring-billed Gull already occupying the island in high numbers. There were few shorebird observations during June and July because most shorebirds that move through this region during the spring are Arctic breeders. Long-distance migrant species such as Baird's and Semipalmated Sandpipers typically peaked earlier in the season than shorter-distance migrants such as Semipalmated and Black-bellied Plovers. Variation in the density of shorebird species observed between years was likely a consequence of survey intensity (i.e., once per week surveys) versus migration intensity, which can vary significantly from day to day (Fig. 10). Restoration work completed at Interstate Island created multiple locations that were heavily used by migratory shorebirds, especially in the central portion of the Island (within the tern nesting enclosure) and on the eastern half of the island (Fig. 11a). The increased habitat quality and quantity of interior acreage and additional shoreline of the restored island also allowed migrant birds to "spread out" across the island (Fig. 11a).

Table 2. The number of birds detected during in-person surveys at Interstate Island during each season is provided along with the survey period (month), year, and number of surveys conducted. Species richness and the number of species detected (count) is provided for all taxonomic groups as well as for shorebirds specifically.

Season	Survey Period	Year	Number of Surveys	Total Species Richness (Count)	Shorebird Species Richness (Count)
Spring Migration	May	2020	3	7 (82)	2 (10)
		2021	1	7 (64)	2 (4)
		2022	0	.	.
		2023	0	.	.
Breeding Season	June–July	2020	8	4 (74)	0
		2021	7	5 (196)	0
		2022	0	.	.
		2023	1	1 (1)	1 (1)
Autumn Migration	Aug-Sept	2020	9	25 (349)	14 (236)
		2021	9	30 (407)	14 (302)
		2022	9	30 (696)	14 (503)
		2023	10	34 (865)	15 (476)

Buff-breasted Sandpiper (left) and Black-bellied Plover (right) were two species of shorebirds observed using Interstate Island during the 2020 and 2021 migration season (photos: S. Kolbe).

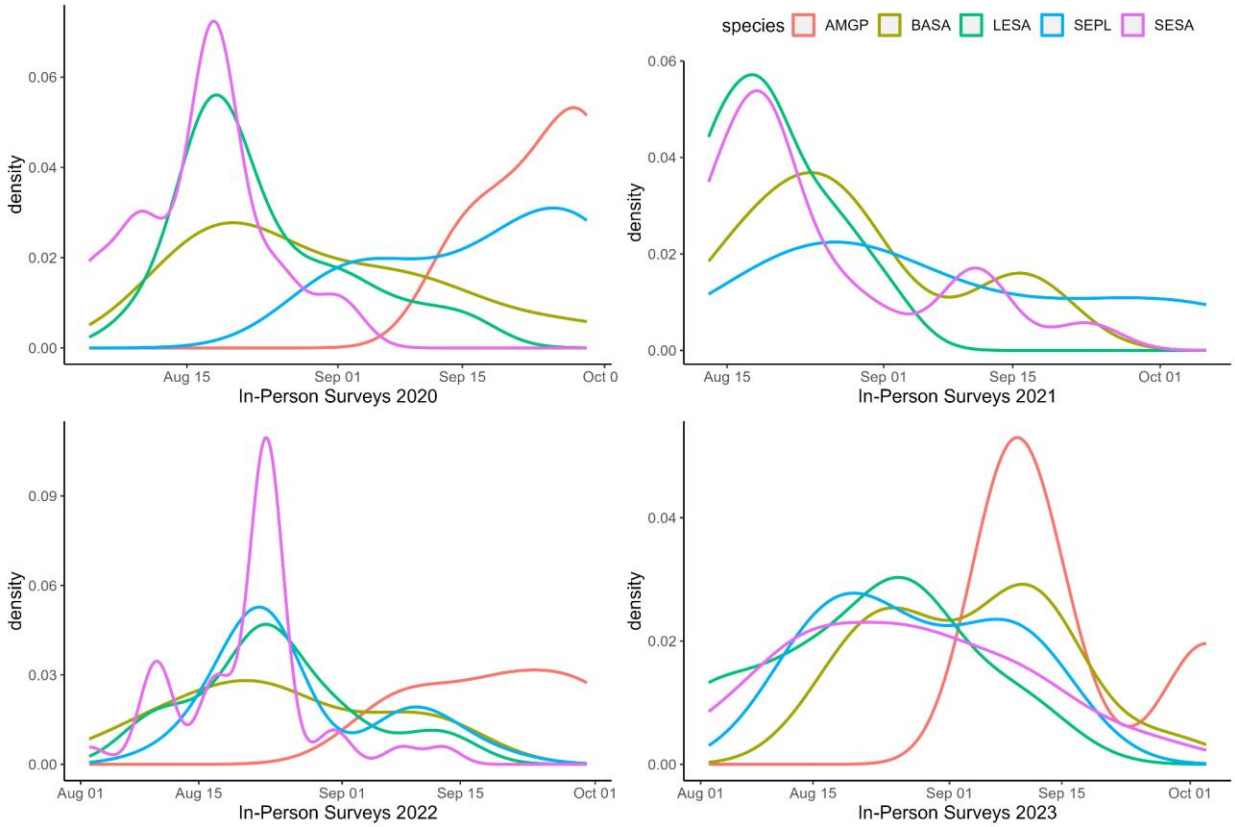

Figure 10. Density of top five most abundant shorebird species observed during in-person surveys (Aug – Oct) at Interstate Island (2020 – 2023). The four-letter alpha codes for all species can be found in *Appendix A.* Here AMGP = American Golden-Plover, BASA = Baird's Sandpiper, LESA = Least Sandpiper, SEPL = Semipalmated Plover, and SESA = Semipalmated Sandpiper.

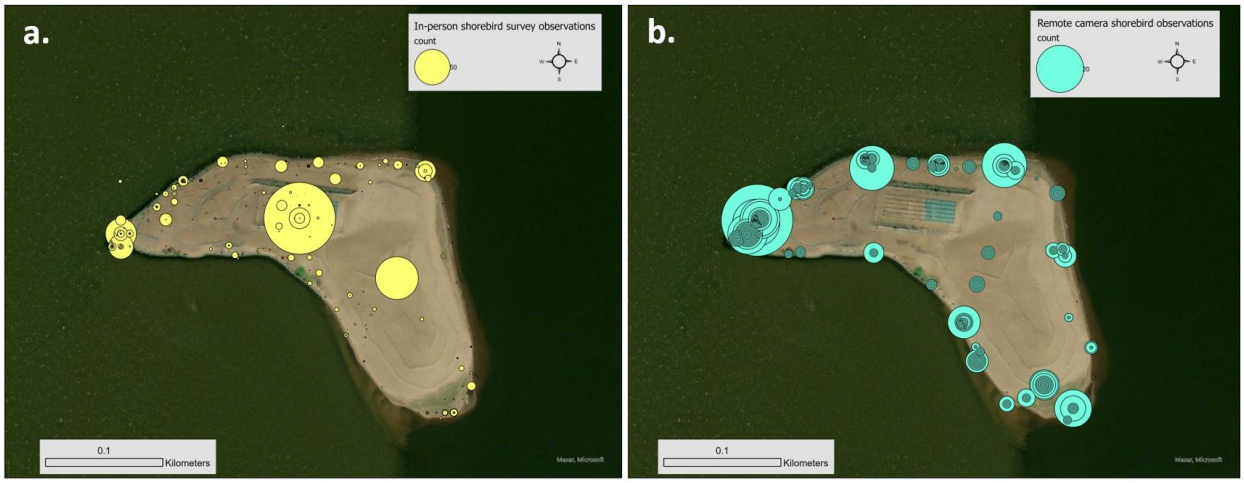

Figure 11. Maps showing the proportional distribution of shorebird observations on Interstate Island (2020 - 2023) based on total count for both **a.** in-person surveys and **b.** remote camera observations. Note: the location of the remote camera observations in 2020 occurred at the shoreline (i.e., before the additional habitat restoration was completed in 2021; see Fig. 4 for camera locations.

Remote camera survey results – We analyzed 34,503 remote camera trap frames and documented a total of 4,771 detections of 16 shorebird species (Tables 3 & 4; Appendix A). A total of 193 days were documented by the cameras (2020 – 2023). Average effort for reviewing camera images was ~ 45 minutes per camera day. This number varied based on the number of birds present, the resolution, angle of the camera, etc. We did not review all images captured outside of the August 15 – 21 window due to the high number of gulls present and to the amount of effort it would require to process. Based on the total number of operational cameras in each year (n = 14 (2020), n = 13 (2021 – 2023)) at ~93 photos collected per camera per day x 7 days per year, a total of 34,503 frames were reviewed. It took an estimated 279 hours of effort to review camera images for one week in August, for all years combined. Shorebirds were detected in approximately 52.5% of all frames between August 15 – 21. Of the documented shorebird detections, 16% were identifiable to species level (Table 3). Of the identifiable species, the top five most abundant were Semipalmated Sandpiper (35%), followed by Semipalmated Plover (23%), Sanderling (15%), Least Sandpiper (9%) and Ruddy Turnstone (5%; Fig. 12). Because a large proportion of the shorebirds detected on the remote cameras were unidentifiable, we included those detections in Figure 12. The density of shorebirds detected at each camera between August 15 – 21 each year shows variation by species (Fig. 12) and high use of the NW corner of the island (Fig.11b).

Table 3. The number of birds detected during in-person surveys and from remote camera traps at Interstate Island between August 15 – 21. For each year and survey type (in-person or camera), the effort (number of observation days), number of operating cameras, species richness and the number of species detected (count), and percent of detections to species level is provided for shorebirds specifically.

Survey Type	Year	Number of Cameras	Number of Observation Days	Number of shorebird detections	% detections to species
In-Person	2020	*NA*	1 (Aug 18)	4 (117)	100
	2021	*NA*	1 (Aug 19)	5 (36)	100
	2022	*NA*	1 (Aug 17)	5 (30)	100
	2023	*NA*	1 (Aug 18)	11 (171)	100
Remote Camera	2020	13	7	6 (1,232)	15
	2021	14	7	10 (1,097)	11
	2022	14	7	8 (815)	9
	2023	15	7	11 (1,627)	23
	2020	13	1 (Aug 18)	4 (286)	12
	2021	14	1 (Aug 19)	4 (187)	5
	2022	14	1 (Aug 17)	1 (103)	15
	2023	15	1 (Aug 18)	7 (393)	16

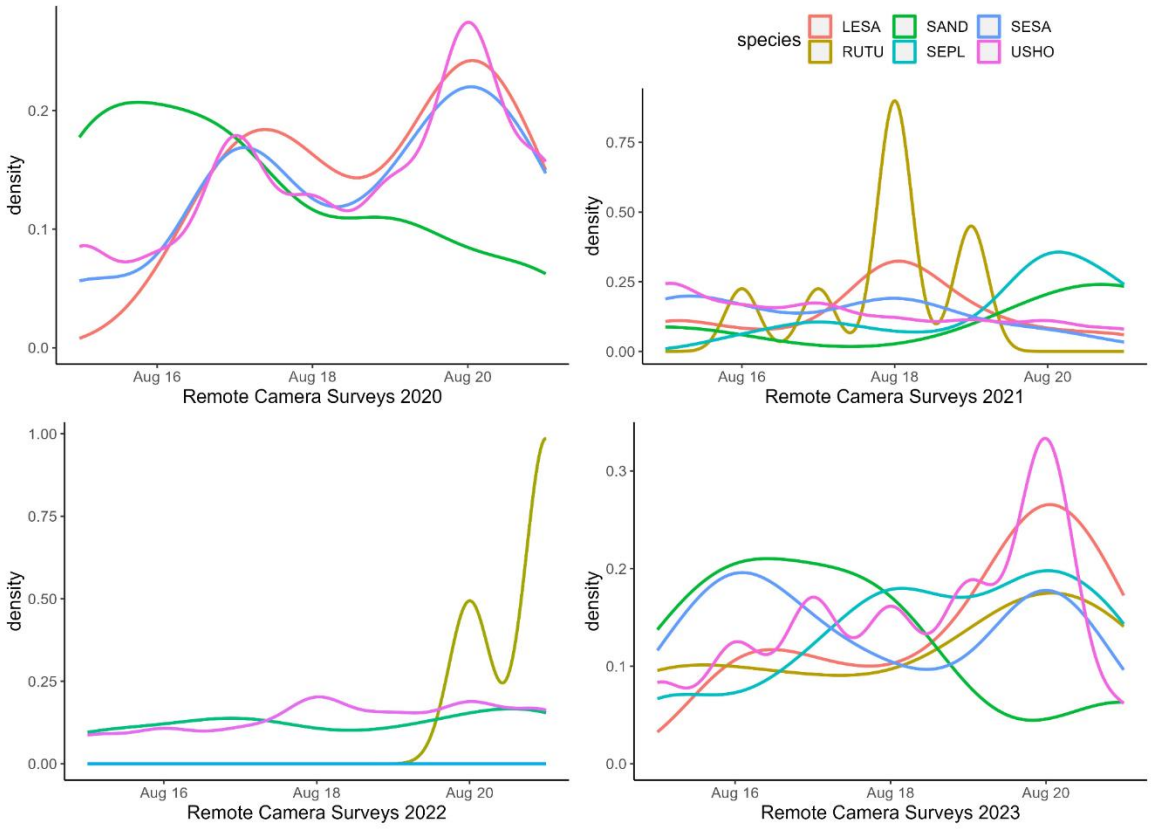

Figure 12. Density of top five most abundant shorebird species detected on remote camera surveys (Aug 15 – 21) at Interstate Island (2020 – 2023). The four-letter alpha codes for all species can be found in *Appendix A*. Here LESA = Least Sandpiper, RUTU = Ruddy Turnstone, SAND = Sanderling, SEPL = Semipalmated Plover, SESA = Semipalmated Sandpiper, and USHO = unknown shorebird.

Comparison of survey methods – Data from in-person surveys and remote cameras were available for the same time frame (mid May through early October). However, because of the effort required to review camera images, we focused on one week in August (15 – 21) each year to analyze the camera images. Therefore, shorebird density was only summarized for in-person surveys during autumn migration (Aug – Oct; Fig. 13), while shorebird density documented using remote camera images was summarized for one week in August (Fig. 13). The in-person surveys provided information about peak observations throughout the season, while the remote cameras further documented how migration intensity varied throughout the course of a day, a week, and between years (Fig. 13). We compared species richness between in-person surveys conducted during the week of August (15 – 21) to camera images analyzed during that same time period. A total of 12 shorebird species were detected from in-person surveys (*n* = 4 survey days and 4.5 survey hours), whereas a total of 15 shorebird species were detected on the remote cameras (*n* = 28 survey days and 279 survey hours; Table 4). Weather conditions can greatly affect migratory movements as well as the quality of camera images (e.g., less movement and lower quality images during wet/rainy conditions). For example, in 2022, during the week of Aug 15 – 21, the weather was rainy, windy, and cold, which may have resulted in fewer shorebird detections.

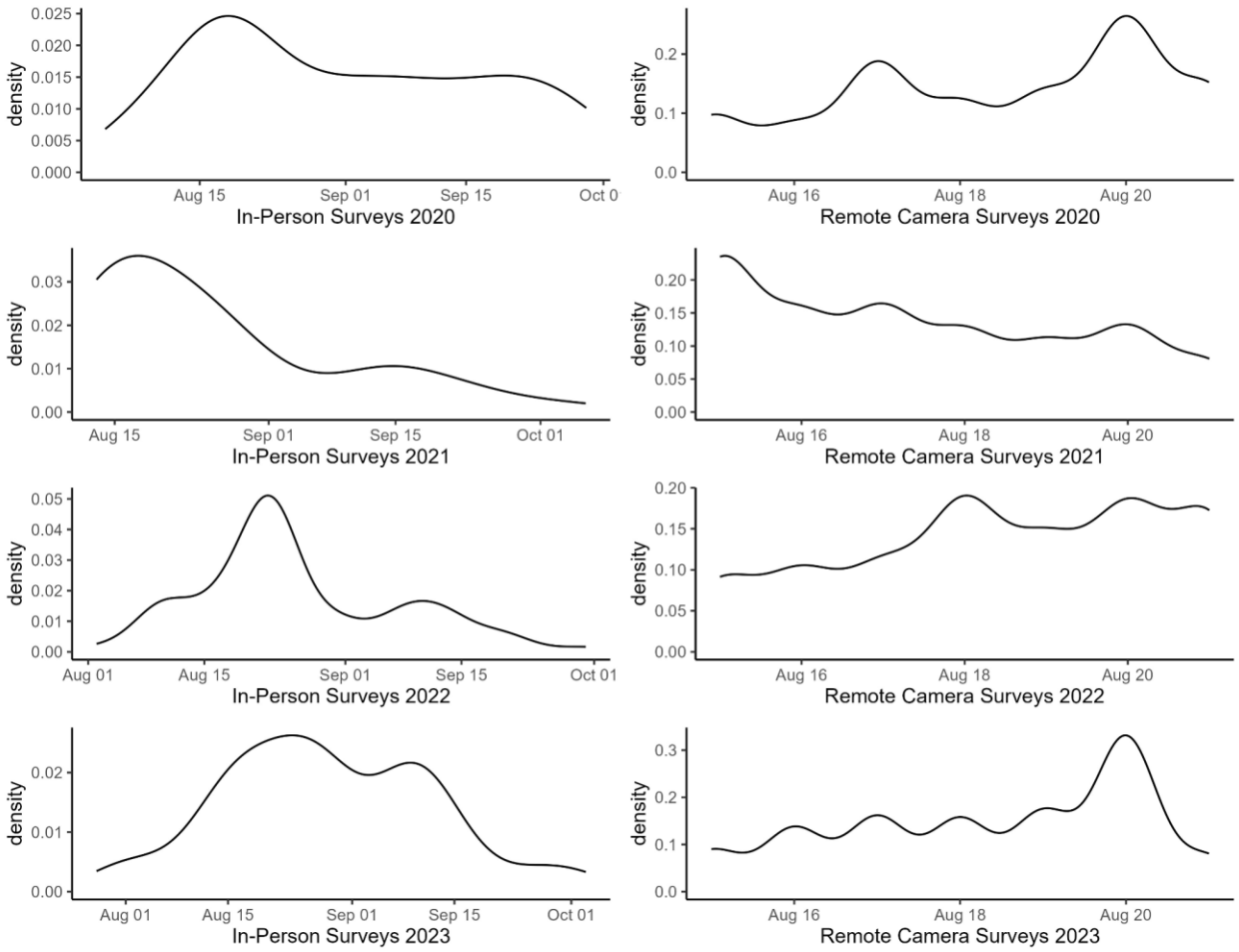

Figure 13. Density of shorebird observations for in-person surveys (Aug – Oct) and remote camera surveys (Aug 15 – 21) at Interstate Island (2020 – 2023).

Table 4. List of shorebird species detected for each survey type (in-person or remote camera) between August 15 – 21 (2020 – 2023). The number corresponds to the number of years each species was detected within the week timeframe. Note: only one in-person survey per year occurred within this time period, whereas remote camera data represents seven days per year.

Species Detected	*In-Person*	*Remote Camera*
American Golden-Plover	0	2
Baird's Sandpiper	4	2
Black-bellied Plover	0	1
Buff-breasted Sandpiper	1	2
Greater Yellowlegs	0	1
Killdeer	1	1
Least Sandpiper	4	4
Lesser Yellowlegs	1	0
Pectoral Sandpiper	1	0
Ruddy Turnstone	2	4
Sanderling	1	3
Semipalmated Plover	3	4
Semipalmated Sandpiper	4	4
Solitary Sandpiper	0	1
Spotted Sandpiper	2	2
Stilt Sandpiper	1	2
Whimbrel	0	1
Willet	0	1

Additional Species Observations

There were many species other than Common Tern and species groups other than shorebirds observed at Interstate Island during both in-person surveys and on remote camera images (*n* = 60 species; Appendix A). Because Common Tern, Ring-billed Gull, and Herring Gull are discussed in depth elsewhere in the report, we removed those species from most summaries going forward. The density of birds observed at Interstate Island varied by guild and time of year; however, similar trends in peak observation times occurred across years (Fig. 14). A total of four raptor species were observed during both in-person surveys and on remote camera images. The species observed and the number of individuals observed (in-person surveys) and number of detections (remote cameras) were as follows, respectively: Bald Eagle (*n* = 3; *n* = 171), Merlin (*n* =3; *n* = 2), Peregrine Falcon (*n* = 7; *n* = 15) and Turkey Vulture (*n* = 3; *n* = 19). There were a total of nine species of songbird observed during in-person surveys; American Pipit (*n* = 71), Chipping Sparrow (*n* = 1), Dark-eyed Junco (*n* = 2), Horned Lark (*n* = 161), Lapland Longspur (*n* = 133), Palm Warbler (*n* = 1), Savannah Sparrow (*n* = 19), Tennessee Warbler (*n* = 1), and Yellow-rumped Warbler (*n* = 3). There was only one unidentified songbird observed on the remote camera images. There were also American Crow observed during in-person surveys (*n* = 3) and on remote camera images (*n* = 116). Aside from Common Tern, Ring-billed Gull, and Herring Gull, there were a total of nine waterbird species observed during both in-person surveys and on remote camera images. The species and number of individuals observed were as follows for in-person surveys and remote camera images, respectively: American Coot (*n* = 43; *NA*), American White Pelican (*n* = 7; *n* = 81), Bonaparte's Gull (*n* = 20; *n* = 77), Caspian Tern (*n* = 10; *n* = 5), Double-crested Cormorant (*n* = 103; *n* = 442), Franklin's Gull (*n* = 2; *NA*), Great Blue Heron (*NA*; *n* = 18), Parasitic Jaeger (*n* = 1; *NA*), and Red-

necked Grebe (*n* = 1; *NA*). There were also a total of 12 waterfowl species observed. The species and number of individuals observed were as follows for in-person surveys and remote camera images, respectively: American Black Duck (*n* = 1; *NA*), Bufflehead (*n* = 6; *NA*), Blue-winged Teal (*n* = 6; *NA*), Canada Goose (*n* = 356; *n* = 120,642), Common Merganser (*n* = 1; *NA*), Green-winged Teal (*n* = 2; *n* = 6), Hooded Merganser (*n* = 2; *n* = 55), Lesser Scaup (*n* = 32; *NA*), Mallard (*n* = 113; *n* = 5,962), Northern Shoveler (*n* = 2; *n* = 9), Redhead (*n* = 3; *NA*), and Snow Goose (*NA, n* = 2). There were also unidentified waterfowl, gulls and tern species observations for remote camera images (*n* = 2,710).

A flock of Bonaparte's Gulls observed during an in-person survey at Interstate Island in 2020 (photo: S. Kolbe).

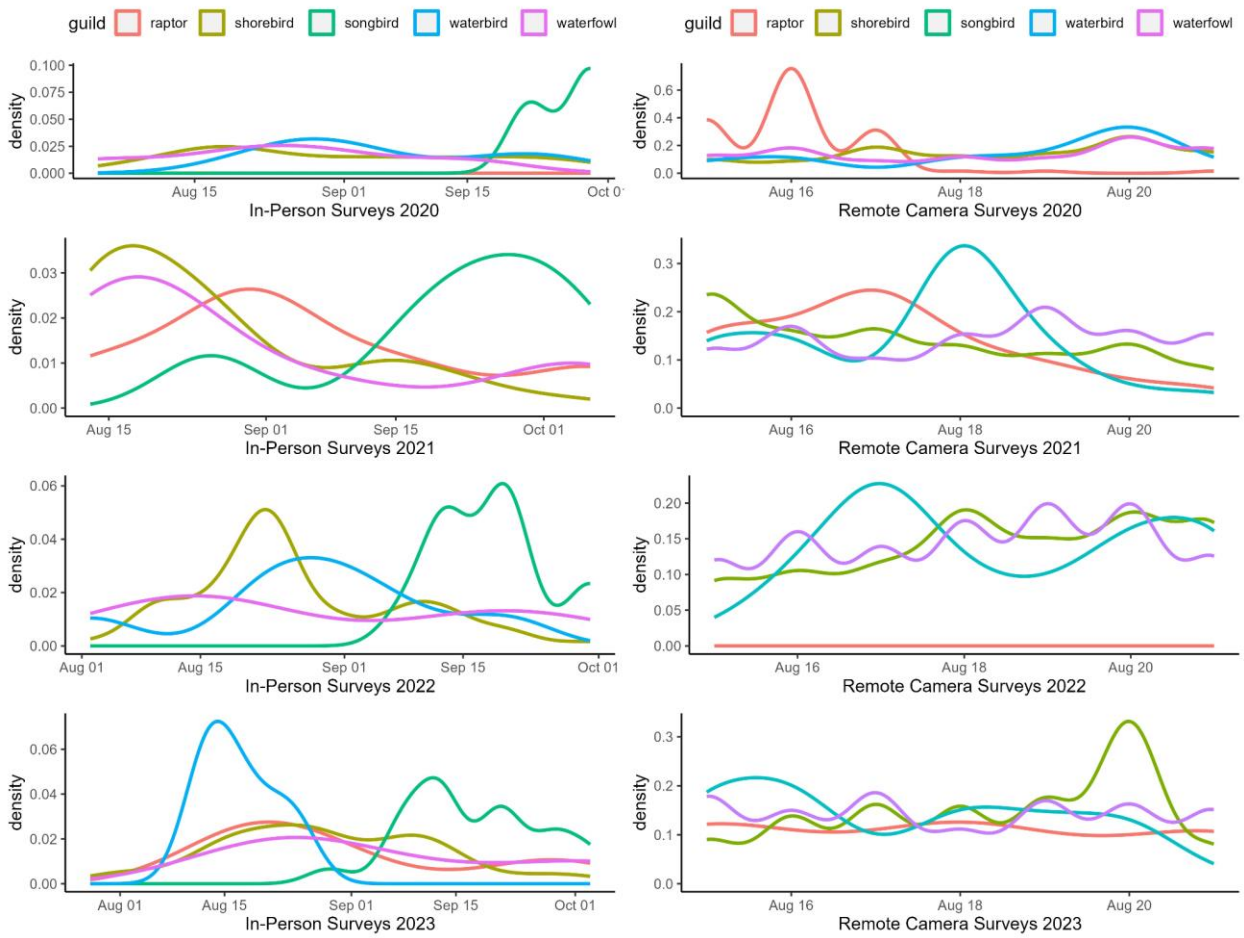

Figure 14. Density of all bird species observed by guild from in-person surveys and remote camera surveys conducted at Interstate Island (2020 – 2023). Note: Corvid was removed due to low number of observations during in-person surveys and Common Tern, Ring-billed Gull, and Herring Gull were excluded from both survey types because they are summarized independently in the report.

Discussion and Recommendations

Common Tern Monitoring

The restoration of Interstate Island was a critical first step in mitigating the effects of habitat loss on breeding Common Terns in the SLRE. The current population target for Common Terns nesting at the Interstate Island colony, based on the Wisconsin Common Tern Recovery Plan (Matteson 1988), is to maintain a 10-year average of 200 nesting pairs and a long-term average of 0.8 – 1.1 chicks fledged per nesting pair. Although the post-restoration productivity measures were within target range for this species, they need to be considered in conjunction with the target breeding population number of 200 nesting pairs (Matteson 1988). Therefore, population targets are not currently being met and nesting numbers are at the lowest since the island was colonized.

In the last 10 years there has been a substantial decline in the number of nesting pairs of Common Terns on Interstate Island. The expansion of the island was the most important step in securing the island for nesting terns. However, continued research and monitoring is needed to identify and mitigate ongoing threats that are causing continued population declines. One of the primary threats is the chronic

predation of eggs and chicks and competition for nesting space from Ring-billed Gulls. Based on the annual surveys conducted by the Minnesota and Wisconsin DNR, the number of Ring-billed Gull nests occurring in the tern nesting enclosure increased in years of high water (e.g., 2012 – 2013) when available nesting habitat was severely reduced on the island; this resulted in gulls attempting to nest in the tern enclosure in higher numbers. Post-restoration numbers of gull nests in the tern enclosure were lower, likely due to the expanded footprint of the island which provided additional available habitat for nesting gulls. Once pairs of gulls establish a nesting location on the island, which typically happens in late March, they have high site fidelity to that specific location and will repeatedly try to nest there, even when their nests are continually destroyed. The annual management activities aimed at reducing the number of gulls nesting in the tern enclosure described above (i.e., snow fencing, bamboo stakes, and gull culling) had mixed results. While placement of snow fencing reduced the number of gull nests occurring in the tern nesting enclosure, predation events were still high. The bamboo stakes proved to be ineffective in reducing the number of nesting gulls, although this technique has been successful in other locations (e.g., Boothby et al. 2018). Lethal gull control appears to have had the most significant effect on nest success. In 2022, when gull nests were removed but no lethal control occurred, only 60% of marked nests survived to peak nest count (five year average of 66%); however, in 2023, when lethal control was used, 92% of nests survived to peak nest count. Gulls are the most significant predator on both Common Tern eggs and chicks. The data from 2023 suggests that the impact of culling 40 gulls (0.002% of the breeding population of Ring-billed Gulls on Interstate Island) had a significant impact on Common Tern nest and chick survival. Continued monitoring and additional years of culling gulls will be needed to better determine the impact of this management action. However, given the suspected impact removing only a small number of birds had on nest success, we suggest that annual culling of gulls in the tern nesting enclosure should continue to minimize disturbance and predation by gulls. The effectiveness of this activity should be included as part of the long-term management plan for this species on Interstate Island.

Another potential threat to Common Terns on Interstate Island is related to contaminant exposure. Specifically, previous and on-going research indicates that breeding adults are foraging in contaminated areas of the SLRE (Bracey et al. 2020). As a result, chicks hatched on Interstate Island have higher mercury concentrations compared to breeding populations that are not located in impaired areas despite the fact that they share the same wintering areas (Bracey et al. 2020). Additional research is underway that will improve our understanding of the source of the mercury, links across the food chain, and to identify high-risk foraging areas. The results of this ongoing mercury study will provide important information regarding risk of contaminants and impacts to this Common Tern population.

Identifying management actions that would likely increase the number of nesting pairs is critical. However, understanding population dynamics for colonial nesting species at a scale that can provide insight into drivers of population change is challenging and requires integration of data across the Great Lakes region and Canada. While addressing these challenges on a large scale is needed, it is equally important to understand site-specific (e.g., Interstate Island) factors influencing productivity. Annual management actions can mitigate otherwise potentially catastrophic events that could result in zero productivity (e.g., chronic predation) or colony abandonment. The installment of the chain link fencing was an extremely valuable investment, which has already shown to be an improvement to the previous fencing in that chicks cannot as easily run from one nesting subsection to another, which reduces predation risk and increases our ability to effectively handle them for monitoring and banding. Consistent monitoring is critical to guide the adaptive management options that are necessary to ensure the highest probability of success for the colony. For example, we found that gulls nesting in the Common Tern area were predating tern eggs and concluded that adaptive management techniques associated with deploying additional gull deterrents and exploring options for lethal control are

outcomes of this monitoring effort. Long-term support for monitoring is essential to increase the breeding population of Common Tern on Interstate Island and will require dedication from non-game wildlife management and project partners.

Shorebird Monitoring

The restoration of Interstate Island provided an opportunity to increase the availability of high-quality, protected migratory shorebird habitat in the SLRE. The dynamic nature of migration, daily and yearly variability in migratory intensity, and the logistical timing of surveys makes it inherently challenging to consistently document migration. The combination of once weekly in-person surveys and remote camera trap arrays allowed us to document shorebird species richness and abundance, both spatially and temporally on the land and nearshore waters on Interstate Island. A total of 22 species of shorebirds were observed on Interstate Island over the four years of monitoring. Of these, the Semipalmated Sandpiper was the most common species observed during both in-person and remote camera surveys. This species is listed as a declining species by Birds of the World (Billerman et al. 2022). Eight additional shorebird species observed on Interstate Island during autumn migration (American Golden-Plover, Buff-breasted Sandpiper, Lesser Yellowlegs, Marbled Godwit, Pectoral Sandpiper, Ruddy Turnstone, Whimbrel, and Willet) are also listed as species in decline, as defined by Birds of the World accounts (Billerman et al. 2022). Black-bellied Plover, Dunlin, and Sanderling were also observed on Interstate Island and are listed as Common Birds in Steep Decline (Billerman et al. 2022). Pectoral Sandpipers and Lesser Yellowlegs are rare on the island and typically prefer vegetated mudflats during migration, a habitat that is not present on the island. Marbled Godwits, Willets and Whimbrels are rare autumn and uncommon spring migrants in the region, but the island does provide suitable stopover habitat. Remote cameras were especially effective at detecting rare but regular migrants that would be less often detected during once-weekly in-person surveys. Interstate Island provides excellent stopover habitat for American Golden-Plover and Buff-breasted Sandpiper because they prefer open dry habitats and were commonly found on the island.

Not all shorebirds use the same habitat during migration, and different features of Interstate Island fulfill different shorebird stopover needs. In general, shorebirds used five microhabitats on Interstate Island: wet sandy shoreline (i.e., beach), dry inland sand, rocky shoreline, inland vegetation, and shallow, stagnant pools of water. Some generalist species such as Least and Semipalmated Sandpipers and Semipalmated Plovers will readily use any of these habitats, but other species are much more habitat specific. Wet sandy shoreline - present on the north, east, and southwest perimeter of the island - was used by species such as Sanderling and Dunlin as they foraged for invertebrates in the wet sand (Fig. 15). This habitat is common in the SLRE as it is found contiguously on the Lake Superior side of Minnesota and Wisconsin Points, and may explain the relative scarcity of these species on the island. Dry inland sand is favored by American Golden-Plover, Buff-breasted Sandpiper, and Baird's Sandpiper; these species were found using the interior of the island as much, or more, than the shoreline area (Fig. 15). Increasing the footprint of the island, especially on the eastern side of the island, increased the availability of this habitat. This is important because dry inland sand is relatively limited in the SLRE, especially in recent years as high water levels have reduced the extent of beach along Minnesota and Wisconsin Points. Currently, Interstate Island provides some of the best – if not the best – dry inland sand stopover habitat in the SLRE. Rocky shoreline is found on the western side of the island and is the preferred habitat of Black-bellied Plover, Ruddy Turnstone and Spotted Sandpiper but is also readily used by shorebird generalists (Fig. 15). Additionally, this habitat is favored by roosting Common and Caspian Terns, Double-crested Cormorants, and American White Pelicans both during and outside of the breeding season. Inland vegetation that grows along and within the tern enclosure attracts migrating shorebirds because they find insects (and perhaps cover from predators) associated with the vegetation.

This is mostly used by generalist shorebirds such as Least Sandpipers and it seems this is opportunistic behavior (i.e., shorebirds do not seek out vegetation on sandy islands). Shallow, stagnant pools of water (frequently referred to as mudflats when large in size) are the preferred habitat of many shorebird species including Long-billed and Short-billed Dowitcher, Greater and Lesser Yellowlegs, Pectoral Sandpiper, and Stilt Sandpiper. A combination of storms, wind, and current created stagnant pools of water and resultant wet mud on small interior portions of southeastern Interstate Island (Fig. 15). Some of the restoration work also created pools of water in the interior of Interstate Island in 2020. When these habitat features were present, we observed species such as Dowitchers or Yellowlegs that are otherwise rarely or never seen on the island. Shallow water and/or mudflats are rare or nonexistent in the SLRE, and our observations of birds using very small and – during active restoration – highly disturbed areas demonstrates that these habitats are extremely limited in the region and if created elsewhere would provide much needed stopover habitat for a variety of migratory shorebirds. The importance and quality of each of these five microhabitats is elevated because they exist on an isolated island free from human and human-associated disturbances. Shorebird behavior is very different on Interstate Island when compared to Minnesota or Wisconsin Point: we frequently observed calm behavior and even sleeping from shorebirds on Interstate Island, behavior which is very rare on crowded beaches.

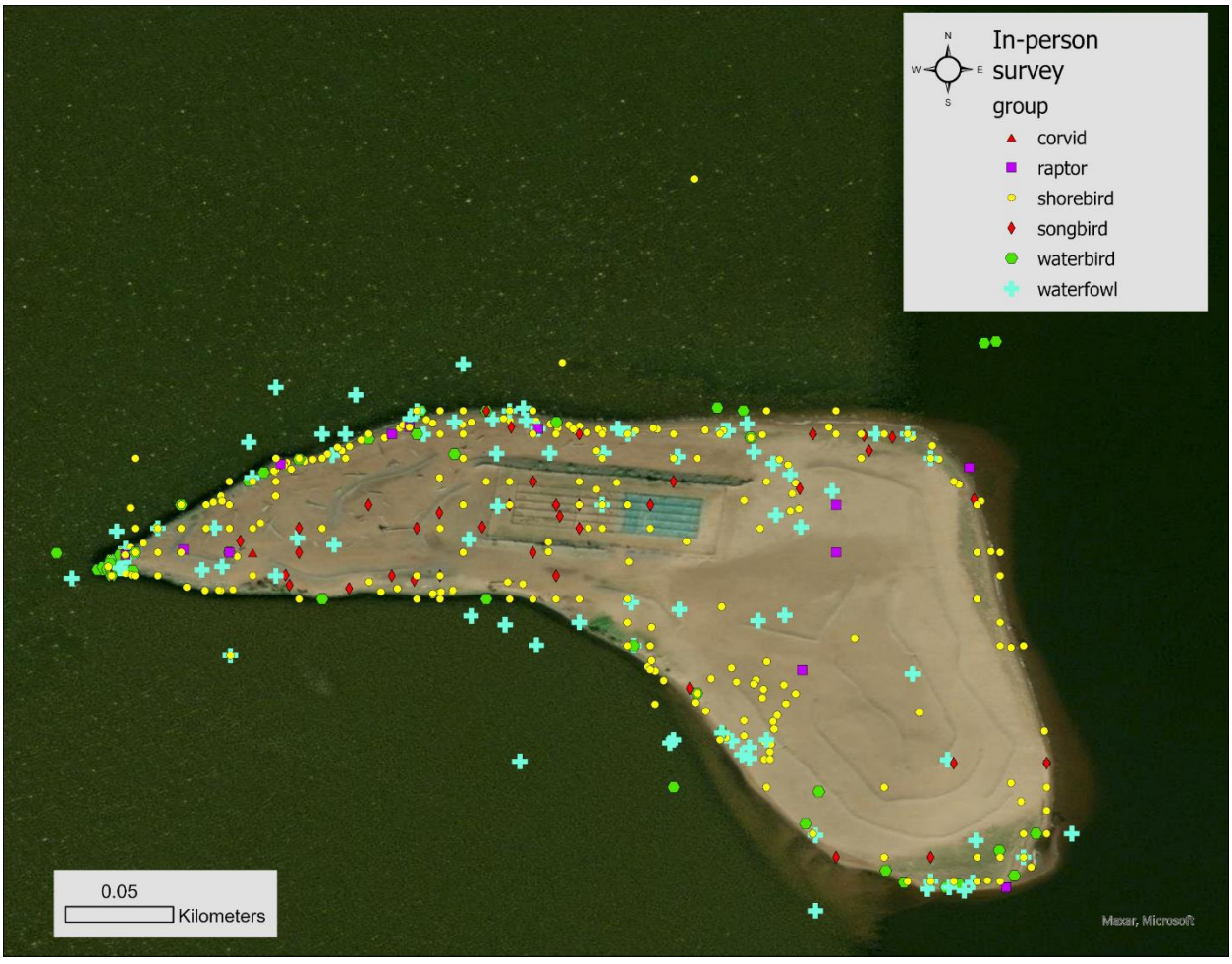

Figure 15. Map of Interstate Island showing the location of bird observations by group during in-person surveys (2020 – 2023).

Stilt Sandpiper foraging in a shallow pool of water on the southern portion of the island in 2021 (photo: S. Kolbe).

Semipalmated Sandpiper resting on a sunny autumn day on Interstate Island in 2021 (photo: S. Kolbe).

Direct comparison of in-person surveys to remote camera surveys for documenting shorebird use of Interstate Island will be useful for guiding future monitoring efforts. A comparison of pros and cons associated with each survey type is provided in Figure 16. In-person surveys allowed us to document bird use of the entire island and offshore waters, which would not have been possible with fixed camera locations oriented to face only along the shoreline. In-person surveys also allowed us to document abundance, which proves challenging when only using remote cameras. For example, a single bird frequently moves along the shoreline throughout the course of a day and could be recorded on a single camera or multiple cameras many times in a day. Abundance could potentially be estimated by aligning time and date stamps from each camera; however, due to slight variation in the timing of image capture this would prove challenging and would likely not be worth the effort. Placing remote cameras throughout the SLRE, during peak migration, in locations that are difficult to reach but that may provide good quality habitat for shorebirds could help identify places to target restoration or protection.

The monitoring schedule implemented for these surveys was relatively intensive and would not likely be feasible for long-term monitoring efforts. Due to the number of gulls nesting on the island and the challenges associated with documenting early season spring migration in the region, we recommend future monitoring efforts aimed at documenting shorebird use focus on autumn migration. If the main objective is to identify features of the entire island (not just shoreline habitats) that shorebirds and other species are using (e.g., rocky shoreline, shallow pools of water, inland vegetation), we recommend intensifying in-person surveys during peak autumn migration. For example, conducting in-person surveys daily or every 2 – 3 days from mid to late August would increase the probability of capturing peak movement and would reduce time and money spent during the other seasons when overall use is lower and less predictable. Use of remote cameras would be best for documenting presence/absence of species and overall species richness and would be recommended for use in locations that are not readily accessible for regular in-person monitoring. However, even at remote sites, it is important to be able to inspect camera function and integrity (e.g., washing out, dead batteries) to ensure they are adequately capturing useful information.

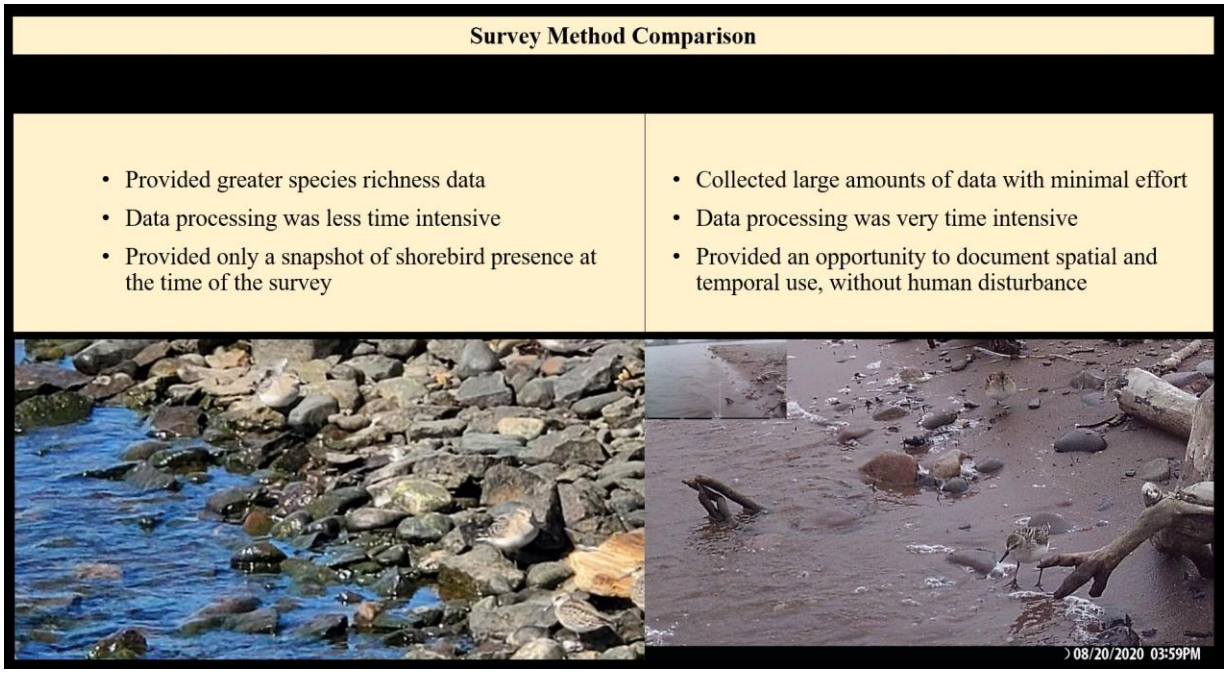

Figure 16. Summary comparing in-person surveys and remote camera surveys for monitoring shorebird use on Interstate Island.

Additional Species Observations

A total of 38 species other than shorebirds were observed using Interstate Island during the course of these surveys. Of these, six were listed as Species of Greatest Conservation Need (Marbled Godwit, American White Pelican, Common Tern, Franklin's Gull, Bald Eagle, and Peregrine Falcon) and three (Common Tern, Herring Gull, and Horned Lark) were listed as Common Birds in Steep Decline by Birds of the World accounts (Billerman et al. 2022). Interstate Island also provides stopover habitat to ground-feeding birds such as American Pipit, Horned Lark, Lapland Longspur, and Savannah Sparrow. All of these species prefer open habitats such as fields and meadows, habitats which are not common in the SLRE and the surrounding forest-dominated landscape. These species prefer the dry inland portions of the island and are also frequently observed foraging within the inland vegetation around and within the tern enclosure.

From the arrival of Ring-billed Gulls in spring through to the departure of the last migrants in late autumn, it is likely that Interstate Island has more birds per acre at any time of day than any other location in the SLRE. Hundreds of Canada Geese and Mallards also use the island to roost each night along with smaller numbers of Double-crested Cormorants and American White Pelicans. The relative safety and isolation of this island coupled with the variety of microhabitats available makes Interstate Island a very important place to many species of birds throughout the year.

Conclusions and Recommendations

The restoration design of Interstate Island provides an important example of how single species management efforts not only benefit the target species but can provide critical habitat to other species in need. Further, this project highlights the importance and utility of monitoring target taxa to provide a metric related to restoration success. The number and diversity of shorebirds that spent time on Interstate Island, free of human disturbance, likely increased their fitness by providing the habitat needed to sufficiently rest and forage. Our results indicate that shorebirds, as well as many other species of birds, readily used the newly restored habitat at Interstate Island, which is much needed in this important bird region. Active management provides the opportunity to create habitat and to identify which aspects of that habitat target species prefer, which can improve management actions in the future. Creation of additional dredge spoil islands and sandbar habitat throughout the SLRE would undoubtedly increase the attractiveness of the area as stopover habitat for migratory shorebirds and waterbirds.

The restoration was a critical first step in protecting the breeding colony of Common Terns. However, we continue to be concerned about the current population trends and overall productivity of breeding terns on Interstate Island. The intent of the restoration was to increase and protect tern breeding habitat and reduce Ring-billed Gull competition for nesting habitat and reduce predation on tern eggs and chicks. At this point of monitoring (four years' post-restoration), the data indicate that although the number of breeding pairs of Common Terns is below the target of 200 nesting pairs, productivity post-restoration has been higher than pre-restoration averages. The improved habitat quality within the tern enclosure (e.g., high quality sand and pebbles) allowed for water to effectively drain from the nesting area, which is extremely important during incubation, to maintain necessary temperatures to keep eggs viable. Because many terns that successfully fledge and survive will return to Interstate Island to breed (~3 yrs post-fledge), the recent increase in productivity should result in higher numbers of nesting pairs in the future. Because of deferred breeding, it may take several more years to see increases in population size. Although the status of the Common Tern breeding population on Interstate Island continues to be precarious, the improved habitat quality and additional management efforts associated

with removing co-nesting gulls has benefited this population and continued efforts to maintain habitat quality and reduce competition and predation by gulls should allow this population to increase on Interstate Island. Continued research is also necessary to determine the role of contaminants on population declines as well as to continue to collect consistent monitoring data, which is critical to understanding reasons for declines and identifying future management actions that can help to conserve this important breeding colony for Common Terns in the SLRE.

Comparing methods for monitoring shorebirds was valuable and can help guide future monitoring efforts both at Interstate Island and at other sites of interest. Anecdotally, we have noticed steady use of Interstate Island by migrating shorebirds and potentially an increase in the number and diversity. However, it will take additional years of monitoring to show definitively that this is the case. We are confident that the restoration activities have had, and will continue to have, a positive impact on stopover habitat for shorebirds in the SLRE. The results of this project can help inform future efforts to enhance the quality of stopover habitat and to create additional habitat for shorebirds and other species in the SLRE. The monitoring efforts on Interstate Island suggest strongly that shorebirds will readily use newly created islands to rest and forage during migration. Therefore, it is likely that if more suitable habitat were to be created within the SLRE (e.g., additional islands or sheltered shoreline habitat), that it would readily be used by shorebirds and many other species throughout the year.

An important lesson that was exemplified by this project is the value of looking at the benefits of restoration actions through a broader lens, i.e. beyond the lens of a single target species. Doing so allowed us to consider what additional birds may have benefitted from the habitat restoration, beyond even shorebirds. Because habitat does not exist for the singular purpose of benefiting one particular species or group of species, it is essential to consider how modification of any landscape will positively or negatively affect conditions for a broader suit of species. The extensive conservation efforts currently underway in the SLRE, including those being spearheaded by the Lake Superior Headwaters Sustainability Partnership, are founded upon the principles of using a holistic approach to protecting and restoring natural resources. Therefore, the framework for incorporating the results of the Interstate Island project into future project planning in the SLRE already exists and so the benefits of this project will persist and carry over into future efforts.

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Appendix A. List of species detected during in-person surveys on Interstate Island (2020 – 2023). The four-letter alpha code is provided for each species as well as English and scientific name, group it was included in for data summarization, 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 contains a link to the Minnesota DNR listed species that provides additional information about each species designated a SGCN. The categories of SGCN observed at Interstate Island were SPC = special concern and THR = threatened. Species status based on Birds of the World (BOTW) accounts) are also listed. The number of individuals detected (count) by survey type (in-person or remote camera) is also provided for each species.

Alpha codes	English name	Scientific name	Group	Family	Behavior	SGCN*	BOTW	In-person survey	Remote camera survey
ABDU	American Black Duck	*Anas rubripes*	Waterfowl	Anatidae	Dabbler		Low Concern	1	0
AMCO	American Coot	*Fulica americana*	Waterbird	Rallidae	Surface Dive		Low Concern	43	0
AMCR	American Crow	*Corvus brachyrhynchos*	Corvid	Corvidae	Ground Forager		Low Concern	3	116
AMGP	American Golden-Plover	*Pluvialis dominica*	Shorebird	Charadriidae	Probing		Declining	108	7
AMPI	American Pipit	*Anthus rubescens*	Songbird	Motacillidae	Ground Forager		Low Concern	71	0
AWPE	American White Pelican	*Pelecanus erythrorhynchos*	Waterbird	Pelecanidae	Dabbler	SPC	Low Concern	7	81
BAEA	Bald Eagle	*Haliaeetus leucocephalus*	Raptor	Accipitridae	Soaring	SPC	Low Concern	3	171
BASA	Baird's Sandpiper	*Calidris bairdii*	Shorebird	Scolopacidae	Probing		Low Concern	145	27
BBPL	Black-bellied Plover	*Pluvialis squatarola*	Shorebird	Charadriidae	Ground Forager		Common Bird in Steep Decline	50	12
BBSA	Buff-breasted Sandpiper	*Calidris subruficollis*	Shorebird	Scolopacidae	Ground Forager		Declining	50	4
BOGU	Bonaparte's Gull	*Chroicocephalus philadelphia*	Waterbird	Laridae	Dabbler		Low Concern	20	77
BUFF	Bufflehead	*Bucephala albeola*	Waterfowl	Anatidae	Surface Dive		Low Concern	6	0
BWTE	Blue-winged Teal	*Anas discors*	Waterfowl	Anatidae	Dabbler		Low Concern	6	0
CANG	Canada Goose	*Branta canadensis*	Waterfowl	Anatidae	Ground Forager		Low Concern	356	120,642

Alpha codes	English name	Scientific name	Group	Family	Behavior	SGCN*	BOTW	In-person survey	Remote camera survey
CATE	Caspian Tern	*Hydroprogne caspia*	Waterbird	Laridae	Aerial Diver		Low Concern	10	5
CHSP	Chipping Sparrow	*Spizella passerina*	Songbird	Passerellidae	Ground Forager		Low Concern	1	0
COME	Common Merganser	*Mergus merganser*	Waterfowl	Anatidae	Surface Dive		Low Concern	1	0
COTE	Common Tern	*Sterna hirundo*	Waterbird	Laridae	Aerial Diver	THR	Common Bird in Steep Decline	102	3,487
DEJU	Dark-eyed Junco	*Junco hyemalis*	Songbird	Passerellidae	Ground Forager		Low Concern	2	0
DCCO	Double-crested Cormorant	*PhalacrocoraX auritus*	Waterbird	Phalacrocoracidae	Surface Dive		Low Concern	103	442
DUNL	Dunlin	*Calidris alpina*	Shorebird	Scolopacidae	Probing		Common Bird in Steep Decline	4	0
FRGU	Franklin's Gull	*Leucophaeus pipixcan*	Waterbird	Laridae	Ground Forager	SPC	Declining	2	0
GBHE	Great Blue Heron	*Ardea herodias*	Waterbird	Ardeidae	Stalking		Low Concern	0	18
GRYE	Greater Yellowlegs	*Tringa melanoleuca*	Shorebird	Scolopacidae	Probing		Low Concern	1	3
GWTE	Green-winged Teal	*Anas crecca*	Waterfowl	Anatidae	Dabbler		Low Concern	2	6
HERG	Herring Gull	*Larus argentatus*	Waterbird	Laridae	Ground Forager		Common Bird in Steep Decline	1	3,092
HOLA	Horned Lark	*Eremophila alpestris*	Songbird	Alaudidae	Ground Forager		Common Bird in Steep Decline	161	0
HOME	Hooded Merganser	*Lophodytes cucullatus*	Waterfowl	Anatidae	Surface Dive		Low Concern	2	55
KILL	Killdeer	*Charadrius vociferus*	Shorebird	Charadriidae	Ground Forager		Low Concern	10	5
LALO	Lapland Longspur	*Calcarius lapponicus*	Songbird	Calcariidae	Ground Forager		Low Concern	133	0
LBDO	Long-billed Dowitcher	*Limnodromus scolopaceus*	Shorebird	Scolopacidae	Probing		Low Concern	1	0

Alpha codes	English name	Scientific name	Group	Family	Behavior	SGCN*	BOTW	In-person survey	Remote camera survey
LESA	Least Sandpiper	*Calidris minutilla*	Shorebird	Scolopacidae	Probing		Low Concern	202	81
LESC	Lesser Scaup	*Aythya affinis*	Waterfowl	Anatidae	Surface Dive		Low Concern	32	0
LEYE	Lesser Yellowlegs	*Tringa flavipes*	Shorebird	Scolopacidae	Probing		Declining	3	0
MAGO	Marbled Godwit	*Limosa fedoa*	Shorebird	Scolopacidae	Probing	SPC	Declining	11	0
MALL	Mallard	*Anas platyrhynchos*	Waterfowl	Anatidae	Dabbler		Low Concern	113	5,962
MERL	Merlin	*Falco columbarius*	Raptor	Falconidae	Aerial Forager		Low Concern	3	2
MSHO	Unknown Medium Shorebird	*NA*	Shorebird	NA	NA		NA	.	112
NSHO	Northern Shoveler	*Anas clypeata*	Waterfowl	Anatidae	Dabbler		Low Concern	2	9
PAWA	Palm Warbler	*Setophaga palmarum*	Songbird	Parulidae	Ground Forager		Low Concern	1	0
PAJA	Parasitic Jaeger	*Stercorarius parasiticus*	Waterbird	Stercorariidae	Aerial Forager		Low Concern	1	0
PEFA	Peregrine Falcon	*Falco peregrinus*	Raptor	Falconidae	Aerial Diver	THR	Low Concern	7	15
PESA	Pectoral Sandpiper	*Calidris melanotos*	Shorebird	Scolopacidae	Probing		Declining	12	0
REDH	Redhead	*Aythya americana*	Waterfowl	Anatidae	Surface Dive		Low Concern	3	0
RBGU	Ring-billed Gull	*Larus delawarensis*	Waterbird	Laridae	Ground Forager		Low Concern	X	14,148
RNGR	Red-necked Grebe	*Podiceps grisegena*	Waterbird	Podicipedidae	Surface Dive		Low Concern	1	0
RUTU	Ruddy Turnstone	*Arenaria interpres*	Shorebird	Scolopacidae	Ground Forager		Declining	45	43
SAND	Sanderling	*Calidris alba*	Shorebird	Scolopacidae	Probing		Common Bird in Steep Decline	21	137

Alpha codes	English name	Scientific name	Group	Family	Behavior	SGCN*	BOTW	In-person survey	Remote camera survey
SAVS	Savannah Sparrow	*Passerculus sandwichensis*	Songbird	Passerellidae	Ground Forager		Low Concern	19	0
SEPL	Semipalmated Plover	*Charadrius semipalmatus*	Shorebird	Charadriidae	Ground Forager		Low Concern	162	210
SESA	Semipalmated Sandpiper	*Calidris pusilla*	Shorebird	Scolopacidae	Ground Forager		Declining	573	312
SNGO	Snow Goose	*Anser caerulescens*	Waterfowl	Anatidae	Ground Forager		Low Concern	0	2
SOSA	Solitary Sandpiper	*Tringa solitaria*	Shorebird	Scolopacidae	Probing		Low Concern	0	1
SPSA	Spotted Sandpiper	*Actitis macularius*	Shorebird	Scolopacidae	Probing		Low Concern	18	13
SSHO	Unknown Small Shorebird	*NA*	Shorebird	NA	NA		NA	.	6,679
STSA	Stilt Sandpiper	*Calidris himantopus*	Shorebird	Scolopacidae	Probing		Low Concern	28	28
TEWA	Tennessee Warbler	Leiothlypis peregrina	Songbird	Parulidae	Foliage Gleaner		Low Concern	1	0
TUVU	Turkey Vulture	Cathartes aura	Raptor	Cathartidae	Soaring		Low Concern	3	19
UDUC	Unknown Duck	NA	Waterfowl	NA	NA		NA	.	2,223
UGUL	Unknown Gull	NA	Waterbird	NA	NA		NA	.	390
UNKN	Unknown bird (could not ID to family)	NA	NA	NA	NA		NA	.	95
UPBD	Unknown passerine	NA	Songbird	NA	NA		NA	.	1
UPSA	Upland Sandpiper	Bartramia longicauda	Shorebird	Scolopacidae	Ground Forager		NA	1	0
USHO	Unknown Shorebird	NA	Shorebird	NA	NA		NA	64	.

Alpha codes	English name	Scientific name	Group	Family	Behavior	SGCN*	BOTW	In-person survey	Remote camera survey
UTER	Unknown Tern	NA	Waterbird	NA	NA		NA	.	2
WHIM	Whimbrel	Numenius phaeopus	Shorebird	Scolopacidae	Ground Forager		Declining	0	1
WILL	Willet	Tringa semipalmata	Shorebird	Scolopacidae	Probing		Declining	0	20
YRWA	Yellow-rumped Warbler	Setophaga coronata	Songbird	Parulidae	Foliage Gleaner		Low Concern	3	0

*https://files.dnr.state.mn.us/assistance/nrplanning/bigpicture/cwcs/chapters_appendiX/appendiX_b.pdf