

Shorebird Science and Conservation Collective

Report to the Minnesota Board of Water and Soil Resources

Using shorebird tracking data as an outreach tool for programs through the Minnesota Board of Water and Soil Resources



Lesser Yellowlegs, Pelican Lake, Buffalo, MN
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Smithsonian
Migratory Bird Center

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May 2023

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Executive Summary

Conservation Request

The Minnesota Board of Water and Soil Resources (MN BWSR) requested scientific information from the Shorebird Science and Conservation Collective (hereafter, “Shorebird Collective”) to help raise public and departmental awareness about the importance of Minnesota habitats for shorebirds. Specifically, they requested maps and summary information of shorebird movements in Minnesota to use as examples that could be integrated into newsletters and other outreach tools. This document presents the following information that could be incorporated into outreach products:

- Background information on shorebirds and tracking technologies to inform their conservation;
- Summary information of shorebirds in Minnesota; and
- Movement details and maps of individual tracked shorebirds detected in Minnesota and their migratory connections across the Western Hemisphere.

About the Shorebird Science and Conservation Collective

The Shorebird Collective is a partnership of scientists and practitioners working to translate the collective findings of shorebird tracking and community science data into effective on-the-ground actions to advance shorebird conservation in the Western Hemisphere. Learn more at:

<https://nationalzoo.si.edu/migratory-birds/shorebird-collective>.

About the Minnesota Board of Water and Soil Resources

The MN BWSR is the administrative agency for soil and water conservation districts, watershed districts, and watershed management organizations in the state of Minnesota. Their overall mission is to improve and protect the state’s water and soil resources by working in partnership with local organizations and private landowners.

Shorebird Background for Outreach

About Shorebirds

Shorebirds are among the planet's most migratory groups of animals. Many species in the Western Hemisphere, for example, travel thousands of miles every year between their breeding grounds in the Arctic and wintering grounds in the Caribbean and Central and South America, stopping at key sites along the way to rest and refuel.

52 shorebird species occur in North America, 33 of which are found in Minnesota (**Appendix I**) (Benz et al. 2019, Morrison et al. 2000). While some species breed in the state, others appear for only a few short weeks during spring and fall migration. Across their vast range, shorebirds depend on a variety of habitats, including coastlines, shallow wetlands, mudflats, lake and pond edges, grasslands, and fields. Common shorebird habitats in Minnesota include wetlands, muddy lake and pond edges, flooded agricultural fields, and grasslands.

While shorebirds are champion migrants, their populations are rapidly declining. Many populations have lost over 70% of their numbers in the past 50 years (NABCI 2022), making them one of the most vulnerable bird groups in North America. Habitat loss, development, human disturbance, and climate change are just some of the major threats facing shorebirds today. Effective shorebird management is even more of a challenge due to their extensive range across multiple countries. Despite these trends, many public and private groups are working to protect shorebirds and the habitats they depend on (**Appendix II**).

Tracking Shorebird Movements

Effective shorebird conservation requires knowledge of where shorebirds go, when they arrive, and how they use different habitats. Shorebird tracking data can provide valuable insight to these important questions and ultimately help biologists and practitioners make more informed conservation and land management decisions to protect shorebirds and their habitats.

Tracking data are collected via tiny electronic tags (i.e., tracking device) (**Figure 1**) which are attached directly to individual birds and may be carried by the birds year-round. A satellite tag, for example, works by sending its signal to an orbiting satellite; the satellite then re-transmits the location data back to a receiving station which researchers can access through their computer. The two types of satellite tags commonly used to study birds include Global Positioning System (GPS) and Argos tags. GPS tags typically have high spatial accuracy (i.e., minimal location error), while Argos tags can have location error of 500-2,500 meters.

One key benefit of tracking data compared to other data types such as survey or count data is it gives detailed information on movements and habitat use of individual animals in areas that are difficult to access, such as remote areas or private lands. Therefore, tracking data can show relative use of different habitats as well as detailed timing of movements.



Figure 1. Black-bellied Plover with < 5g. solar satellite tag; Dan Ruthrauff, USGS

Tracked Shorebirds in Minnesota

We examined all satellite tracks contributed to the Shorebird Collective as of September 2022¹ (Box 1). 56 individuals of eight species moved through the state of Minnesota during their annual cycle. 21 of these individuals stopped or bred within the state. Tracked individuals include:

- 14 Pectoral Sandpiper *Calidris melanotos*
- 5 American Woodcock *Scolopax minor*
- 1 Buff-breasted Sandpiper *Calidris subruficollis*
- 1 Lesser Yellowlegs *Tringa flavipes*

Figure 2 provides information on shorebird distributions in Minnesota based off these data. The highest concentrations of tracked species (Figure 2A) and individuals (Figure 2B) was found in the Prairie Potholes region of the state². Note that while the number of tagged individuals is limited, these birds could act as sentinels that may highlight where many more birds are present. Thus, additional survey work could be done on the ground to confirm the importance of these areas/regions used by the tagged birds. Additional information may become available as data contributors continue to share new tracking data with the Shorebird Collective. We invite the MN BWSR to periodically check in with the Shorebird Collective on the availability of new data to support their efforts.

Box 1. Summary of shorebird tracks in Minnesota

1,480 individuals of 17 species contributed to the Shorebird Collective



35 individuals of 8 species flew over the state of Minnesota



21 individuals of 4 species stopped or bred within the state

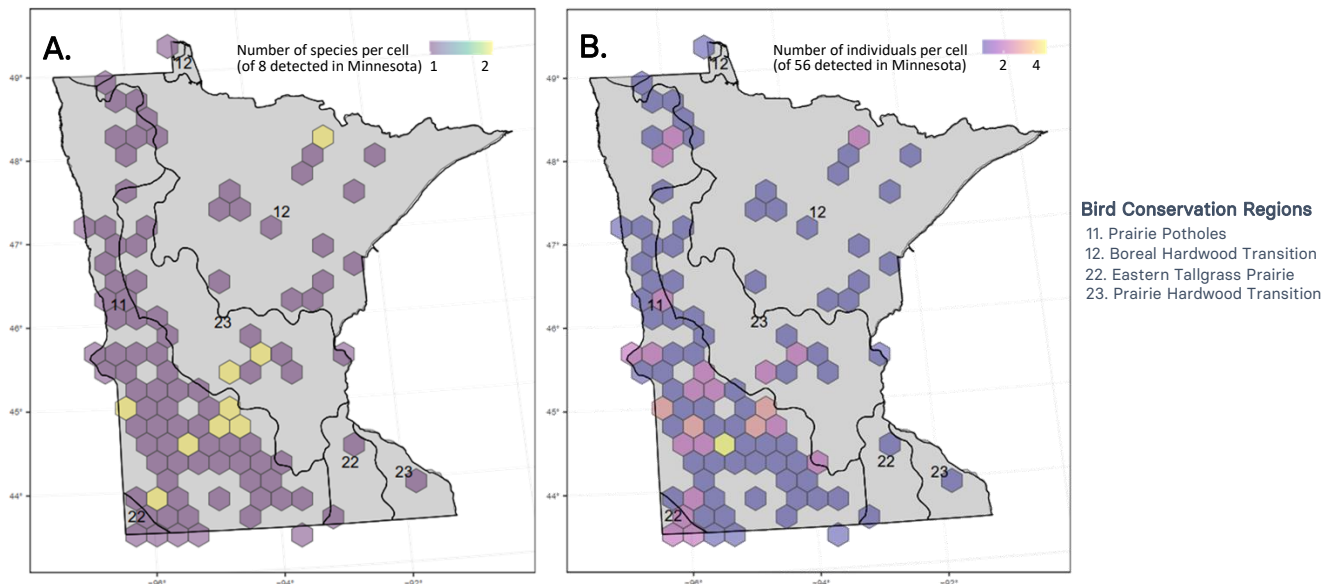


Figure 2. Summary of A. species and B. individual concentrations from contributed satellite tracking data overlaid with Bird Conservation Regions. Summarized data are for eight species and 56 tracked individuals detected in Minnesota. This includes both individuals that flew over the state on migration and/or stopped or bred in the state.

¹ These data come from 52 organizations, collected from 2006 to 2022.

² The Prairie Potholes region extends from the Canadian provinces of Manitoba, Saskatchewan, and Alberta to portions of Montana, the Dakotas, Minnesota, and Iowa. The myriad of seasonal depressional wetlands is known to support hundreds of thousands of shorebirds every year. Minnesota falls on the easternmost border of the ecoregion.

Using Tracking Data for Outreach & Conservation

Shorebird tracking data can be used as a tool to raise awareness about the importance of Minnesota habitats for shorebirds. For example, as part of a phase II, the MN BWSR could work with the Shorebird Collective to provide MN CREP applicants with tailored maps of shorebird tracks detected on their property to get landowners interested in shorebirds. These data could also be used to identify specific habitats/areas used by shorebirds across the state to help prioritize actions for effective management.

The following pages provide tracking maps and summary information for a subset of individuals detected in Minnesota (**Table 1, Figures 3-9**). The MN BWSR can use these data to aid in the development of newsletter articles and other outreach products pertaining to shorebirds. The Shorebird Collective is happy to provide additional shorebird tracks, pending data contributor permissions, if the MN BWSR would benefit from these data.

Table 1. Summary information on a subset of tracked shorebirds in Minnesota. See Figures 3-9 for more details on individual bird movements. See page 13 for more information on data contributors.

Common Name	Data Contributor	Duty Cycle*	Breeding Site	Wintering Site	Stopover Duration in Minnesota	One-way Migration Distance
Pectoral Sandpiper #1	Rick Lanctot	1 location recorded daily	Alaska, USA	Santa Fe, Argentina	Aug 2018: 14 days Southbound migration	8,700 miles
Pectoral Sandpiper #2	Rick Lanctot	1 location recorded daily	Alaska, USA	Corrientes, Argentina	Aug 2018: 18 days Southbound migration	8,900 miles
American Woodcock #1	Erik Blomberg	Up to 1 location recorded daily	Minnesota, USA	Georgia, USA	Apr-July 2021: 105 days Breeding grounds	1,200 miles
American Woodcock #2	Erik Blomberg	Up to 1 location recorded daily	Manitoba, Canada	Alabama, USA	Apr 2020: 15 days Northbound migration	1,500 miles
Lesser Yellowlegs	Jim Johnson	1 location recorded every 2 days	Manitoba, Canada	Rivera, Uruguay	Jul 2019: 15 days Southbound migration	7,300 miles

* Duty Cycle refers to the fixed schedule to which a tag (i.e., tracking device) records location data. Scientists can program the tag's schedule prior to deployment. Depending on the study and tag capabilities, scientists may program the tag to record location data continuously (i.e., several times a day) or at fixed intervals (e.g., every two days, once a week, etc.). Some tags also only allow for a limited set of location data to be collected (e.g., up to 60 records).

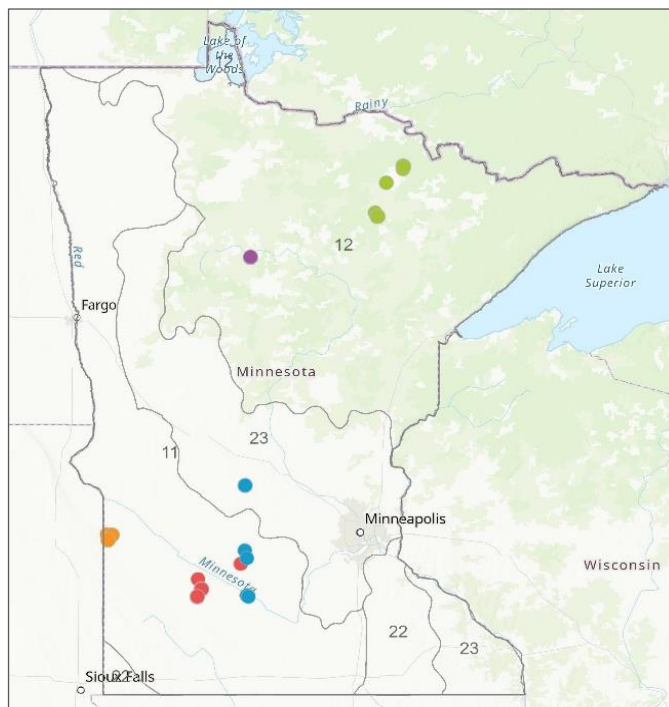


Figure 3. Detections of individual shorebirds in Minnesota overlaid with Minnesota Bird Conservation Regions. The colored points on the map show the detected locations of the birds recorded by the tracking devices. Note that this map is a summary of shorebird detections across multiple years and does not necessarily reflect the birds co-occurring in Minnesota at the same time.

Individual Bird ID

- Pectoral Sandpiper #1
- Pectoral Sandpiper #2
- American Woodcock #1
- American Woodcock #2
- Lesser Yellowlegs

Bird Conservation Regions

- 11. Prairie Potholes
- 12. Boreal Hardwood Transition
- 22. Eastern Tallgrass Prairie
- 23. Prairie Hardwood Transition

Pectoral Sandpiper

Two Pectoral Sandpipers were detected in the Prairie Potholes region of western Minnesota during stopover on southbound migration (**Figures 3 and 4**). Pectoral Sandpiper #1 stopped for 14 days on agricultural fields in Redwood County, while Pectoral Sandpiper #2 stopped for three days along an agricultural impoundment in Stearns County before flying 30 miles south to a small natural wetland in Nicollet County for another 15 days.

About Pectoral Sandpipers

Pectoral Sandpipers are a medium-sized shorebird with a brown streaked breast and white belly (Farmer et al. 2020). They are typically present in the Prairie Potholes region of Minnesota during spring and fall migration (peak months: April-May, July-September). As a long-distance migrant, they breed on tundra in the high arctic and winter throughout South America (Farmer et al. 2020). They prefer upland and wet grassland landscapes (e.g., grassy shorelines and marshes, flooded fields, wet meadows) and feed mostly on aquatic and terrestrial invertebrates (Farmer et al. 2020).



Pectoral Sandpiper Facts

- Breeding males have an inflatable throat sac which puffs out during display flights to attract mates (Farmer et al. 2020).
- Some Pectoral Sandpipers breed as far west as Siberia, Russia, making impressive 10,000+ mile journeys (one-way) as they migrate to and from their breeding and wintering grounds (Farmer et al. 2020).
- Male Pectoral Sandpipers can go for weeks at a time without sleep during the courtship period (Lesku et al. 2012).



Figure 4. Detections of **A.** Pectoral Sandpiper #1 in Redwood County, Minnesota and **B.** Pectoral Sandpiper #2 in Stearns and Nicollet Counties, Minnesota. Both individuals stopped in the state on southbound migration. Figure 5 provides details of their annual movements. Pectoral Sandpiper tracking data contributed by Rick Lanctot, U.S. Fish and Wildlife Service.

Annual Movements

Pectoral Sandpiper #1 was fitted with a tracking device in June 2018 on its breeding grounds in Arctic National Wildlife Refuge in Alaska, USA (**Figure 5**). It began its southbound migration in mid-July and made its first stop in Tuktut Nogait National Park in Northwest Territories, Canada. From Northwest Territories, it flew 1,200 miles south to its next stop along the Hudson Bay in Manitoba, Canada, then flew to Minnesota, USA where it stopped for 14 days in August. From Minnesota, the bird flew 3,200 miles nonstop to Esmeraldas, Ecuador and stayed for a week, then made two additional stops in Loreto, Peru and Beni, Bolivia before reaching its wintering grounds in Santa Fe, Argentina at the end of September. The tracking device's signal was lost a month later. **Approximate one-way flight distance between its Alaskan breeding grounds and Argentine wintering grounds: 8,700 miles.**

Pectoral Sandpiper #2 was fitted with a tracking device in June 2018 on its breeding grounds in Utqiagvik, Alaska, USA (**Figure 5**). It began its southbound migration in mid-July and initially made multiple short stops (i.e., less than four days) in the Yukon, Northwest Territories, and Nunavut provinces of Canada. From Nunavut, it flew to Minnesota, USA where it stopped for 18 days in August, then flew 2,500 miles nonstop to Port-au-Prince, Haiti where it stayed for 20 days. From Haiti, the bird made an additional two stops in Apure, Venezuela and Beni, Bolivia, and by mid-October, reached what is presumed to be its wintering grounds in Corrientes, Argentina though the tracking device's signal was lost a week later. **Approximate one-way flight distance between its Alaskan breeding grounds and Argentine wintering grounds: 8,900 miles.**

Note: Both birds flew substantial nonstop distances (i.e., 2,500+ miles) after stopping in Minnesota in the fall, highlighting the value of Minnesota landscapes (i.e., agricultural fields, wetlands) as critical stopover habitat for the birds.

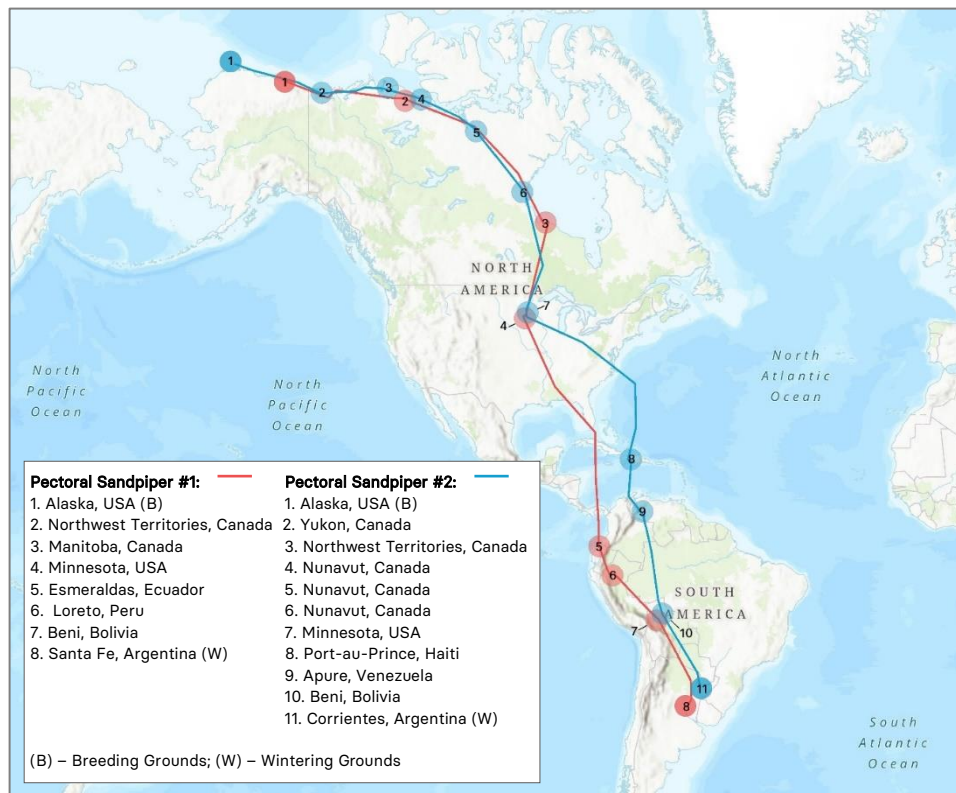


Figure 5. Annual movements of the two Pectoral Sandpipers with labeled breeding, wintering, and stopover locations. Pectoral Sandpiper tracking data contributed by Rick Lanctot, U.S. Fish and Wildlife Service.

American Woodcock

Two American Woodcocks were detected in the Boreal Hardwood Transition region of northern Minnesota (**Figures 3 and 6**). American Woodcock #1 spent the breeding season in forested lands three miles north of Sturgeon Lake in St. Louis County, arriving early April and departing mid-July, while American Woodcock #2 stopped for 15 days on northbound migration within forested lands in Cass County.

About American Woodcocks

American Woodcocks are a plump, short-legged shorebird with a short neck and long, straight bill (McAuley et al. 2020). They are a breeding species in Minnesota and found exclusively in the eastern half of the United States and southern Canada (McAuley et al. 2020). Woodcocks favor both young forests and open landscapes, often spending the days in forests and nights in fields (McAuley et al. 2020). They feed mostly on earthworms and insects, which they capture with their flexible bill (McAuley et al. 2020). As Minnesota's smallest game bird, state management actions include cutting willow and alder brush to renew brush growth used for nesting and feeding (MN DNR 2023).



American Woodcock Facts

- A woodcock's eyes are large and positioned high and far back on its head. This provides panoramic vision to detect predators while probing into the ground for food (McAuley et al. 2020).
- Male woodcocks attract mates with a series of calls and elaborate, spiraling flight displays, otherwise known as the "sky dance" (McAuley et al. 2020). This mating ritual takes place every spring at dawn and dusk.

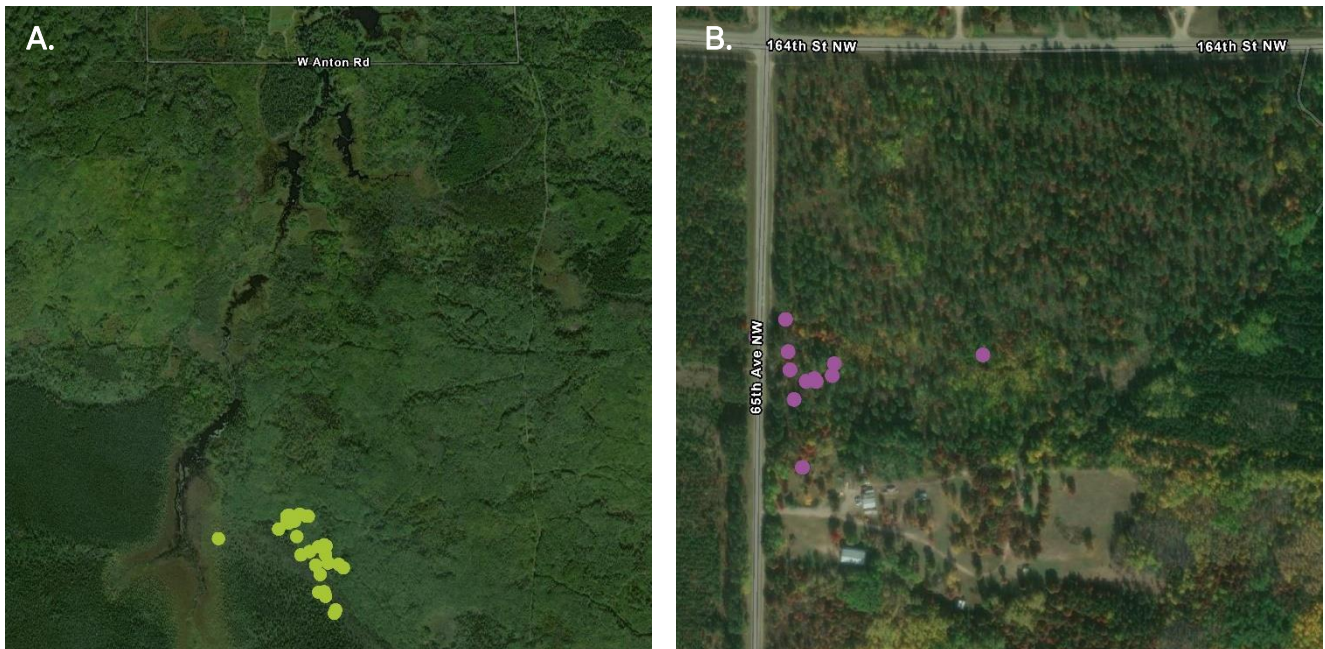


Figure 6. Detections of **A.** American Woodcock #1 in St. Louis County, Minnesota and **B.** American Woodcock #2 in Cass County, Minnesota. Woodcock #1 spent the breeding season in the state while Woodcock #2 stopped for 15 days on northbound migration. Figure 7 provides details of their annual movements. American Woodcock tracking data contributed by Erik Blomberg, University of Maine.

Annual Movements

American Woodcock #1 was fitted with a tracking device on its wintering grounds in Georgia, USA in February 2021 (**Figure 7**). It departed north in early March and made its first stop in wooded lands just south of Louisville, Kentucky, USA. After three weeks, it stopped for another week in western Michigan, USA before making its way to his or her breeding grounds in northern Minnesota, USA. The tracking device's signal was lost during the breeding season. **Approximate one-way flight distance between its Georgia wintering grounds and Minnesota breeding grounds: 1,200 miles.**

American Woodcock #2 was fitted with a tracking device on its wintering grounds in Alabama, USA in February 2020 (**Figure 7**). By mid-March, the bird began making its way north and made its first stop along the Missouri River in Missouri, USA. From Missouri, it slowly made its way up the state and into northern Iowa, USA over the course of three weeks. He or she then flew to northern Minnesota, USA where it stopped for another 15 days. By late April, the bird arrived on its breeding grounds along the border of Riding Mountain National Park in Manitoba, Canada. The tracking device's signal was lost during the breeding season. **Approximate one-way flight distance between its USA wintering grounds and Canadian breeding grounds: 1,500 miles.**



Figure 7. Annual movements of the two American Woodcocks with labeled breeding, wintering, and stopover locations. American Woodcock tracking data contributed by Erik Blomberg, University of Maine.

Lesser Yellowlegs

Track locations for one Lesser Yellowlegs was detected in the Prairie Potholes region of western Minnesota (Figures 3 and 8). He or she stopped for 15 days on southbound migration and rotated between different agricultural fields east of Salt Lake in Lac qui Parle County.

About Lesser Yellowlegs

Lesser Yellowlegs are a medium-sized shorebird with grayish brown plumage and distinct yellow legs (Tibbitts et al. 2020). They are typically present in the Prairie Potholes region of Minnesota during spring and fall migration (peak months: April-May, July-September). As a long distant migrant, they breed in the boreal wetlands of Canada and Alaska and winter throughout Central and South America (Tibbitts et al. 2020). They occur in a variety of shallow wetland habitats, including mudflats, marshes, lake and pond edges, meadows, and flooded agricultural fields (Tibbitts et al. 2020). Their diet primarily consists of aquatic insects, though they also feed on crustaceans, snails, and small fish (Tibbitts et al. 2020).



Lesser Yellowlegs Facts

- While Lesser and Greater Yellowlegs look quite similar, Lesser Yellowlegs are comparatively smaller with a shorter and thinner bill (Tibbitts et al. 2020).
- Lesser Yellowlegs sometimes bathe by repeatedly flying into the air and plunging into water, otherwise known as “flight bathing” (Dodd et al. 1989, Rowan 1929)
- Lesser Yellowlegs will hover over wounded flockmates in addition to joining other shorebird species in attacks on predators (Cornell Lab of Ornithology, Gabrielson and Lincoln 1959).

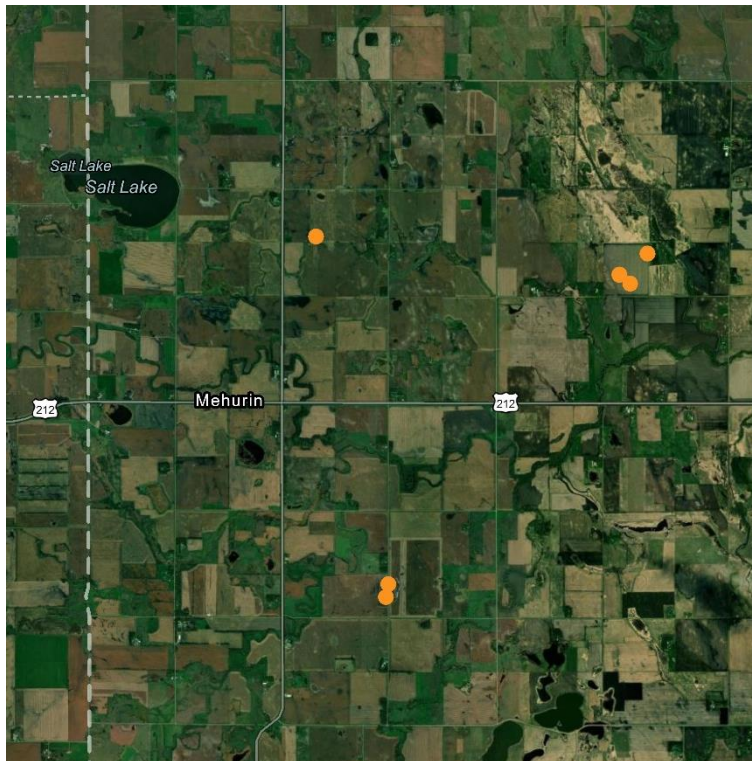


Figure 8. Detections of one Lesser Yellowlegs in Lac qui Parle County, Minnesota. The bird stopped for 15 days on southbound migration. Figure 9 provides details of its annual movements. Lesser Yellowlegs tracking data contributed by Jim Johnson, U.S. Fish and Wildlife Service.

Annual Movements

The Lesser Yellowlegs was fitted with a tracking device in June 2019 on its breeding grounds along the Hudson Bay in Manitoba, Canada (**Figure 9**). It began its southbound migration in early July, making its first stop in Minnesota, USA where it stayed for 15 days. From Minnesota, it flew 3,000+ miles nonstop to St. George's, Grenada, stopping for another 15 days. From Grenada, it flew to Beni, Bolivia and finally reached its wintering grounds in Rivera, Uruguay in early September. The bird wintered in Uruguay through March then shifted west to Buenos Aires, Argentina for another month. By early May, he or she departed north and made its first stop near Golfo de Nicoya, a WHSRN site³ in Guanacaste, Costa Rica. The tracking device's signal was lost a few days later as it continued its way north. The last detection point was made in South Dakota, USA. **Approximate one-way flight distance between its Canadian breeding grounds and Uruguayan wintering grounds: 7,300 miles.**

Note: Similar to the two Pectoral Sandpipers, this bird made an impressive 3,000+ mile nonstop flight after stopping in Minnesota in the fall, highlighting again, the value of local landscapes in Minnesota as stopover habitat for shorebirds.



Figure 9. Annual movements of the Lesser Yellowlegs with labeled breeding, wintering, and stopover locations. Lesser Yellowlegs tracking data contributed by Jim Johnson, U.S. Fish and Wildlife Service.

³ WHSRN is a voluntary, non-regulatory network of public and private partners working to protect shorebirds through a network of key sites throughout the Americas. There are currently 116 WHSRN sites in 19 countries covering over 15.6 million hectares of shorebird habitat across the Americas. Learn more at: <https://whsrn.org/>.

Data Contributors

Tracking data for this project were contributed to the Shorebird Collective by the following people and organizations. Individuals with an asterisk (*) indicates the technical point of contact for the dataset. A full list of data contributors to the Shorebird Collective can be found at:

<https://nationalzoo.si.edu/migratory-birds/shorebird-collective>.

The following contributors provided detailed tracks and maps of shorebird movements:

1. Pectoral Sandpiper Tracks:

Rick Lanctot*¹, Sarah Saalfeld¹, Christopher Latty¹, Stephen Brown², Shiloh Schulte², Dan Ruthrauff³, Rebecca McGuire⁴, Jean-François Lamarre^{5,6}

Unpublished data, U.S. Fish and Wildlife Service, Manomet, U.S. Geological Survey-Alaska Science Center, Wildlife Conservation Society, Polar Knowledge Canada, Canadian High Arctic Research Station, Université du Québec à Rimouski

2. American Woodcock Tracks:

Erik J. Blomberg*⁷, Amber M. Roth⁷, Alexander C. Fish⁷, Liam A. Berigan⁷

Unpublished data, American Woodcock Migration Research Cooperative

3. Lesser Yellowlegs Tracks:

Jim A. Johnson*¹, Katie S. Christie*⁸, Laura A. McDuffie³, Christian Friis⁹, Callie Gesmundo*¹, Christopher M. Harwood¹, Benoit Laliberté⁹, Erica Nol¹⁰, Jennie Rausch⁹, Audrey R. Taylor¹¹, Jay R. Wright¹², Joint Base Elmendorf-Richardson¹³

Associated Citation: McDuffie, L. A., Christie, K. S., Taylor, A. R., Nol, E., Friis, C., Harwood, C. M., Rausch, J., Laliberté, B., Gesmundo, C., and Johnson, J. A. 2022. Flyway-scale GPS tracking reveals migratory routes and key stopover and non-breeding locations of lesser yellowlegs. *Ecology and Evolution*, 12(11), e9495.

These additional contributors shared data of shorebirds tracked in Minnesota:

Paul Woodward⁹, Lee Tibbitts³, Joaquín Aldabe², Juliana Almeida², Gabriel J. Castresana¹⁴, Dave C. Douglas³, Bob E. Gill³, Nathan R. Senner^{15,16}, Mitch D. Weegman^{17,18}, Bart M. Ballard¹⁹, Jennifer A. Linscott¹⁶, Jorge Ruiz²⁰, Juan G. Navedo²⁰, Bart Kempnaers²¹, Mihai Valcu²¹, Eunbi Kwon²¹, Bridget Olson¹

Contributor Organizations

¹ U.S. Fish and Wildlife Service, ² Manomet, ³ U.S. Geological Survey, Alaska Science Center, ⁴ Wildlife Conservation Society, ⁵ Polar Knowledge Canada, Canadian High Arctic Research Station, ⁶ Université du Québec à Rimouski, ⁷ University of Maine, ⁸ Alaska Department of Fish and Game, ⁹ Environment and Climate Change Canada's Canadian Wildlife Service, ¹⁰ Trent University, ¹¹ University of Alaska Anchorage, ¹² Ohio State University, ¹³ Joint Base Elmendorf-Richardson, ¹⁴ Ministerio de Ambiente de la Provincia de Buenos Aires, ¹⁵ University of Massachusetts Amherst, ¹⁶ University of South Carolina, ¹⁷ University of Saskatchewan, ¹⁸ University of Missouri, ¹⁹ Texas A&M University – Kingsville, ²⁰ Universidad Austral de Chile, ²¹ Max Planck Institute for Ornithology

References

- Benz, D., Forbes, A., Hertzell, A., Kessen, A., Kieser, D., Marengo, W., Richardson, J., Russell, R., Stucker, S., Smith, A., and Tustison, T. 2019. Checklist of the birds of Minnesota. Minnesota Ornithologists' Union Records Committee, Hastings, MN, USA.
- Cornell Lab of Ornithology. 2019. All About Birds: Lesser Yellowlegs. Cornell Lab of Ornithology, Ithaca, NY, USA. Retrieved from: https://www.allaboutbirds.org/guide/Lesser_Yellowlegs/.
- Dodd, A.M., Holdsworth, P., and Goodyer, N. 1989. Unusual flight-bathing behaviour by Greenshanks. *British Birds*, 82:28-29.
- Farmer, A., Holmes, R.T., and Pitelka, F.A. 2020. Pectoral Sandpiper (*Calidris melanotos*), version 1.0. In *Birds of the World* (S.M. Billerman, Ed.). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Gabrielson, I.N., and F.C. Lincoln. 1959. *The Birds of Alaska*. Stackpole Company, Harrisburg, PA, USA.
- Iglesia, M., and B., Winn. 2021. A shorebird management manual. Manomet, MA, USA.
- Lesku, J.A., Rattenborg, N.C., Valcu, M., Vyssotski, A.L., Kuhn, S., Kuemmeth, F., Heidrich, W., and Kempenaers, B. 2012. Adaptive sleep loss in polygynous pectoral sandpipers. *Science*, 337:1654-1658.
- McAuley, D.G., Keppie, D.M., and Whiting, R.M., Jr. 2020. American Woodcock (*Scolopax minor*), version 1.0. In *Birds of the World* (A.F. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, NY, USA.
- [MN DNR] Minnesota Department of Natural Resources. 2016. Minnesota's Wildlife Action Plan 2015-2025. Division of Ecological and Water Resources, Minnesota Department of Natural Resources, St. Paul, MN, USA.
- [MN DNR] Minnesota Department of Natural Resources. 2023. Minnesota Department of Natural Resources, St. Paul, MN, USA. Retrieved from: <https://www.dnr.state.mn.us/birds/woodcock.html>.
- Morrison, R.I.G., Gill, R.E., Harrington, B.A., Skagen, S., Page, G.W., Gratto-Trevor, C.L., and Haig, S.M. 2000. Population estimates of Nearctic shorebirds. *Waterbirds*, 23: 337-352.
- [NABCI] North American Bird Conservation Initiative. 2022. The State of the Birds, USA, 2022.
- Rowan, W. 1929. Notes on Alberta waders included on the British list, Part VII. *British Birds*, 23:2-17.
- Tibbitts, T.L. and W. Moskoff. 2020. Lesser Yellowlegs (*Tringa flavipes*), version 1.0. In *Birds of the World* (A.F. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, NY, USA.

Appendix I: Shorebird Species in Minnesota

Table A1. Shorebird species occurrence and conservation status in Minnesota (Benz et al. 2019, MN DNR 2016)

Common Name * - Contributed tracking data available for the species in MN	Scientific Name	Season of Occurrence in MN	State Status	Federal Status
American Avocet	<i>Recurvirostra americana</i>	M		
American Golden-Plover	<i>Pluvialis dominica</i>	M		
American Woodcock*	<i>Scolopax minor</i>	B		
Baird's Sandpiper	<i>Calidris bairdii</i>	M		
Black-bellied Plover	<i>Pluvialis squatarola</i>	M		
Black-necked Stilt	<i>Himantopus mexicanus</i>	b		
Buff-breasted Sandpiper*	<i>Calidris subruficollis</i>	m		
Dunlin	<i>Calidris alpina</i>	M		
Greater Yellowlegs	<i>Tringa melanoleuca</i>	M		
Hudsonian Godwit	<i>Limosa haemastica</i>	M		
Killdeer	<i>Charadrius vociferus</i>	B		
Least Sandpiper	<i>Calidris minutilla</i>	M		
Lesser Yellowlegs*	<i>Tringa flavipes</i>	M		
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	M		
Marbled Godwit	<i>Limosa fedoa</i>	B	SC	
Pectoral Sandpiper*	<i>Calidris melanotos</i>	M		
Piping Plover	<i>Charadrius melodus</i>	b	E	E
Red Knot	<i>Calidris canutus</i>	m		T
Red-necked Phalarope	<i>Phalaropus lobatus</i>	M		
Ruddy Turnstone	<i>Arenaria interpres</i>	M		
Sanderling	<i>Calidris alba</i>	M		
Semipalmated Plover	<i>Charadrius semipalmatus</i>	M		
Semipalmated Sandpiper	<i>Calidris pusilla</i>	M		
Short-billed Dowitcher	<i>Limnodromus griseus</i>	M		
Solitary Sandpiper	<i>Tringa solitaria</i>	M		
Spotted Sandpiper	<i>Actitis macularius</i>	B		
Stilt Sandpiper	<i>Calidris himantopus</i>	M		
Upland Sandpiper	<i>Bartramia longicauda</i>	B		
Whimbrel	<i>Numenius phaeopus</i>	m		
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	M		
Willet	<i>Tringa semipalmata</i>	M		
Wilson's Phalarope	<i>Phalaropus tricolor</i>	B	T	
Wilson's Snipe	<i>Gallinago delicata</i>	B		

Species Occurrence:

B: Species breeds in Minnesota
M: Species stops in Minnesota during migration months
b,m: Rare breeder (b) or migrant (m)

State/Federal Status:

SC: Special Concern
T: Threatened
E: Endangered

Appendix II: Shorebird Friendly Habitat & Resources

Creating Shorebird-Friendly Habitat

There are several considerations when creating or maintaining shorebird-friendly habitat. Knowing how, when, and which species use a site is important to inform specific management practices. For example, some actions, such as flooding fields or clearing vegetation to improve foraging opportunities, will need to occur in the weeks or months prior to the birds arriving. **Table A2** provides general habitat characteristics that make areas suitable for shorebirds.

Table A2. General habitat characteristics for shorebirds (Iglecia and Winn 2021).

Shorebird-Friendly Habitat	
Food	<ul style="list-style-type: none"> • Aquatic invertebrates • Mollusks • Crustaceans • Insects and insect larvae • Small fish
Aquatic Habitat	<ul style="list-style-type: none"> • <4" depth for most species* • Saturated substrate – e.g., mudflats, saltmarsh, coastlines, flood-irrigated croplands • Minimal, low height vegetation • Low disturbance levels on beaches <p>*Water depth requirements vary by species. Most species forage in saturated or shallow-watered areas <4" deep, though longer legged species (Lesser Yellowlegs, Long-billed Curlew) may use >7" and Phalaropes use deeper waters.</p>
Surrounding Landscape	<ul style="list-style-type: none"> • Open uplands • Moderately to heavily grazed rangelands and recently mowed haylands

Shorebird-Friendly Practices:

1. Reduce or time the use of pesticides near aquatic and grassland habitats so applications do not limit invertebrate availability and/or degrade shorebird habitat.
2. Limit disturbance (e.g., vehicles, humans/pets) in areas with high shorebird concentrations.
3. Control tall/dense vegetation in grassland and aquatic habitats through brush management or prescribed burning.
4. For managed wetlands, maintain appropriate water levels when shorebirds are present.
5. If applicable, protect on-site wetlands from livestock by installing fencing around the site and/or placing livestock watering facilities away from the wetlands to prevent erosion and habitat degradation.
6. Maintain a mosaic of different habitats to provide resources for multiple shorebird species.
7. Incorporate prescribed grazing systems on rangelands by providing shorter grass during spring and fall migration.

Additional Resources

- eBird - <https://ebird.org/>
- ShorebirdViz - <https://shorebirdviz.ebird.org/>
- Migratory Bird Joint Ventures - <https://mbjv.org/>
 - Upper Mississippi/Great Lakes Joint Venture - <https://umgljv.org/>
 - Prairie Potholes Joint Venture - <https://ppjv.org/>
- Manomet - <https://www.manomet.org/>
- Western Hemisphere Shorebird Reserve Network - <https://whsrn.org/>
- [Shorebird Management Manual](#)