Flooded grass thicket;
Tim Romano, Smithsonian

Using shorebird tracking data to help prioritize locations and timing of freshwater deployments in coastal Texas

Conservation Contribution #08

Conservation Action: Land/Water Management; Species Management

Prepared by the Shorebird Science & Conservation Collective:
Candace Stenzel, Allie Anderson, Autumn-Lynn Harrison

September 2023

*This report for public audiences describes how the Shorebird Collective fulfilled a conservation request, presents key findings, and due to data privacy settings, **shows only a subset of the data** used in a full report to our partner.*

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Project Background

Conservation Request

The Galveston Bay Foundation (GBF) and Texas Water Trade (TWT), in partnership with The Nature Conservancy of Texas and others, requested shorebird tracking data from the Shorebird Science and Conservation Collective (hereafter, "Shorebird Collective") to support TWT's coastal water fund initiative focused on delivering freshwater inland from the Texas coast to mimic natural inflows. These "focused flow" opportunities offer a range of benefits, including habitat restoration, salinity management, shorebird habitat creation on agricultural lands, and helping producers maintain crops during drought (Culp et al. 2014, Garmany 2020, Montagna et al. 2021). Specifically, GBF and TWT requested location and timing data from shorebirds tracked with electronic tags (link to page with more information on shorebird tracking data) in select areas of coastal Texas within 1) eastern Galveston Bay, Chambers County and 2) Colorado-Lavaca Estuary, Matagorda County (**Figure 1** and **Figure 2**) to help prioritize locations and timing of freshwater deployments. The Shorebird Collective compiled contributed shorebird tracking data and summary information to support this request.

Important Note: This report describes how the Shorebird Collective fulfilled GBF's and TWT's request and presents key outputs and findings showing only a subset of the data used to inform our partners. Due to the privacy settings of some datasets contributed to the Shorebird Collective, a full report of findings provided to GBF and TWT is for internal planning use only.

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 on our webpage: link to the Shorebird Collective webpage.

About the Galveston Bay Foundation

GBF is a Texas nonprofit dedicated to preserving and enhancing the Galveston Bay. Through actions, partnerships, and a commitment to science and research, GBF offers a range of solutions and opportunities to preserve the Bay for generations to come. Learn more on GBF's website: link to GBF's website.

About the Texas Water Trade

TWT is a Texas nonprofit whose mission is to catalyze sustainable water transactions in Texas to ensure clean, flowing water for people and nature. TWT works with partners across the state to identify opportunities for environmental flows restoration. Learn more on TWT's website: link to TWT's website.

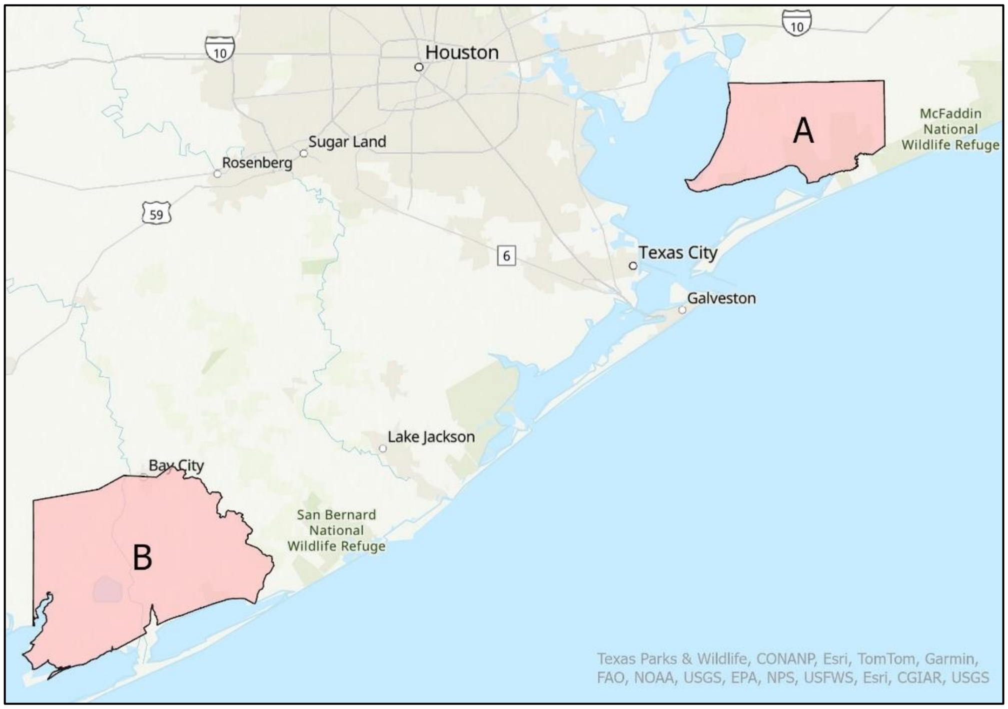


Figure 1. GBF's and TWT's areas of interest for freshwater deployments in **A)** eastern Galveston Bay, Chambers County and **B)** Colorado-Lavaca Estuary, Matagorda County.

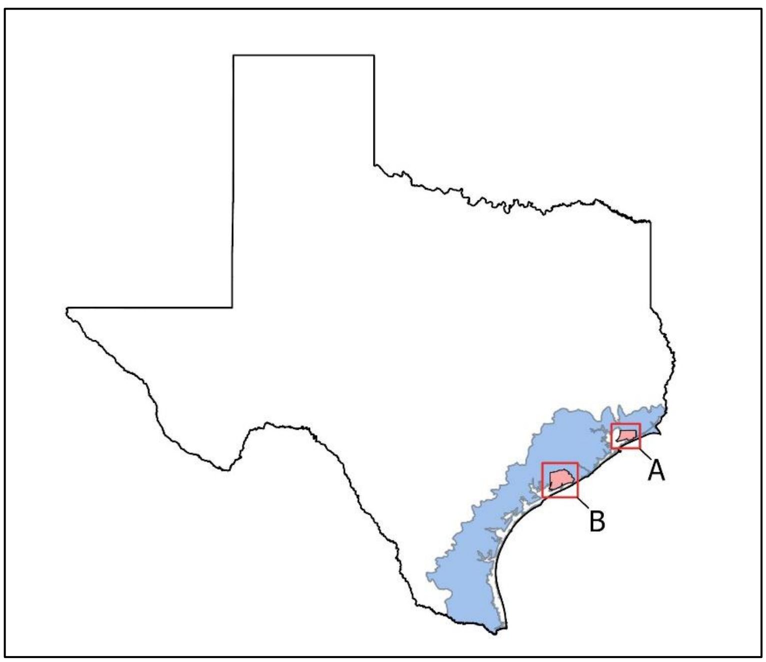


Figure 2. Map of Texas displaying the Western Gulf Coastal Plain ecoregion and GBF's and TWT's two areas of interest within the ecoregion: **A)** eastern Galveston Bay, Chambers County; **B)** Colorado-Lavaca Estuary, Matagorda County.

Key Outputs & Recommendations

Below we summarize key findings and outputs provided to GBF and TWT to support their water deployment efforts:

1. The Shorebird Collective provided GBF and TWT with detailed information on electronically tracked shorebird movements in select areas of coastal Texas within 1) eastern Galveston Bay, Chambers County and 2) Colorado-Lavaca Estuary, Matagorda County to help prioritize locations and timing of freshwater deployments. In a full report to GBF and TWT and with permission of data owners, we provided maps of tracked shorebird movements in their areas of interest (AOI) with details on the timing of their movements and habitat use. **14** individuals of **six** species had tracked locations in their AOIs.

2. Tracking data can be biased to the individuals and/or species equipped with tracking devices. The Shorebird Collective explored eBird relative abundance data (Fink et al. 2021) to fill knowledge gaps for species with limited tracking data and to provide regional insights on shorebird species distributions and timing in GBF's and TWT's AOIs.

3. Based on the tracking and eBird data, we provided GBF and TWT with a set of recommendations on the timing, locations, and management of water deployments in their AOIs. Additional information may become available as data contributors continue to share new tracking data with the Shorebird Collective. We invited GBF and TWT to periodically check in with the Shorebird Collective on the availability of new data to support their water deployment efforts.

Images: 1. Red Knot (*Calidris canutus*) with 3.4-gram GPS tag, Tim Romano, Smithsonian; **2.** Flock of Dunlins (*Calidris alpina*), Jan Wieser, USFWS (CC); **3.** Texas wetland, Tim Romano, Smithsonian

Methods

The Shorebird Collective filtered contributed GPS and Argos satellite tracking data to remove false detections and determined the most likely movement path of each bird using mathematical models that account for spatial uncertainty of locations recorded by tracking devices. We then overlayed the cleaned shorebird tracks on maps of GBF's and TWT's AOIs. When a tracked shorebird was tracked in either AOI, we contacted the data owner to receive permission to share maps and details about the bird with GBF and TWT.

In a full report to GBF and TWT, we provided maps of tracked shorebird movements in their AOIs (see **Figure 3** for an example), with additional details on habitat use and seasonal occurrence. We also explored eBird relative abundance data (Fink et al. 2021) to fill knowledge gaps and provide additional context about shorebird species distributions and timing in the AOIs.

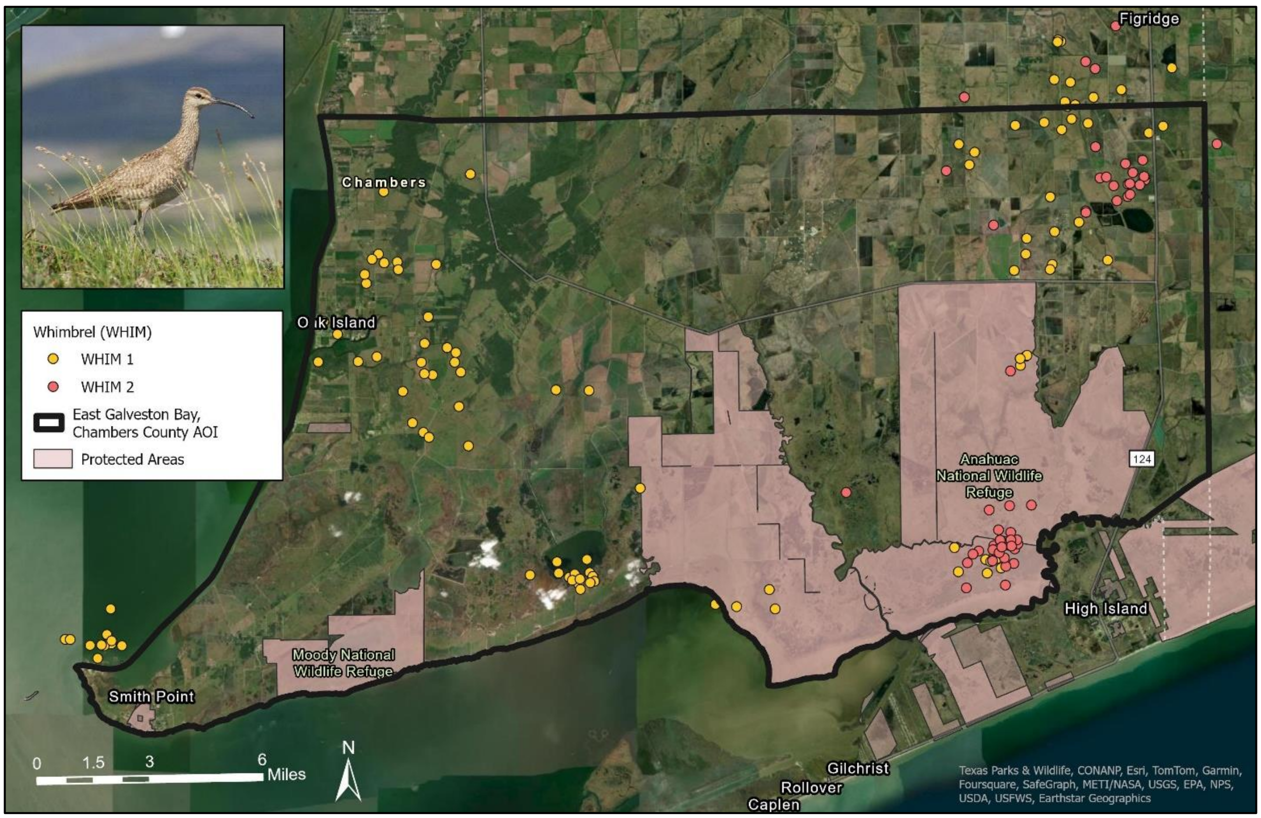


Figure 3. An example of tracked Argos satellite locations of two Whimbrels (*Numenius phaeopus*) tracked in GBF's and TWT's eastern Galveston Bay AOI (area outlined in black) in Chambers County. The two birds primarily used the eastern and western-most portions of the AOI. An additional map layer showing other protected areas, as defined by UNEP-WCMC and IUCN (2021), is also provided for additional context of shorebird use of the landscape. Note that this is a summary of tracked shorebird locations across multiple years and does not necessarily reflect the birds co-occurring in the area at the same time. Tracking points for other individuals tracked in the AOI, including three Long-billed Dowitcher (*Limnodromus scolopaceus*) and one Hudsonian Godwit (*Limosa haemastica*), are not shown in this public-facing summary report due to the privacy settings of the datasets but were provided to GBF and TWT for their internal planning use. Data from these example tracks contributed by Jennie Rausch, Canadian Wildlife Service, Environment and Climate Change Canada. See page 17 for additional data contributor information. Whimbrel photo credit: Rachel Richardson, USGS Alaska Science Center (CC).

Tracked Shorebird Locations in AOI

Tracked Birds

Of 1,480 individuals tracked by GPS and Argos satellite technologies and contributed to the Shorebird Collective[1] (**Box 1**), **18%** (*n* = 260) moved through the state of Texas during their annual cycle.

Fourteen individuals of **six** species were tracked between 2013 and 2023 during migration and while overwintering in GBF's and TWT's AOIs:

- **1** Hudsonian Godwit (*Limosa haemastica*)
- **1** Lesser Yellowlegs (*Tringa flavipes*)
- **2** Long-billed Curlew (*Numenius americanus*)
- **7** Long-billed Dowitcher (*Limnodromus scolopaceus*)
- **1** Pectoral Sandpiper (*Calidris melanotos*)
- **2** Whimbrel (*N. phaeopus*)

Tracked locations ranged from a single observation during a flyover to an overwintering duration of 185 days. Primary habitats, defined by Elliott et al. (2009), in locations where the birds were tracked include agricultural fields, coastal prairie, and tidal wetlands (see **Figure 4** for an example map of shorebird use of habitat use in the eastern Galveston Bay AOI).

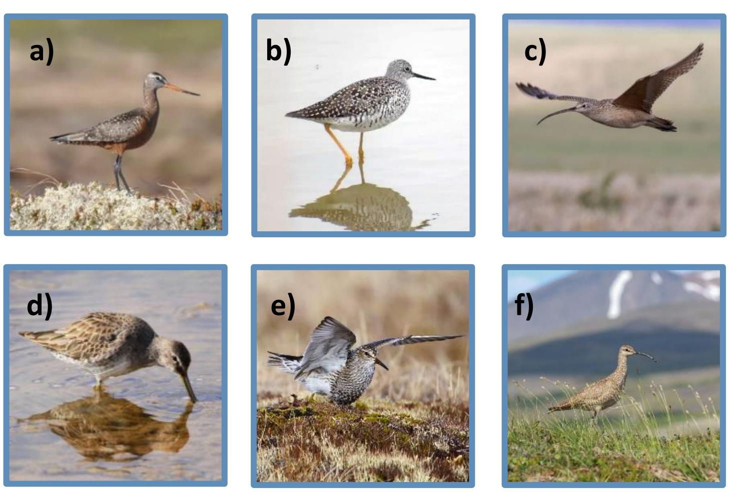
Box 1. Summary of shorebird tracks in areas of interest

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

260 individuals of **12** species tracked in Texas

14 individuals of **6** species in GBF's and TWT's AOIs in Chambers and Matagorda Counties

Note that while the number of tracked individuals is limited, these birds could act as sentinels that may highlight where many more birds are present since many shorebird species travel in flocks. Thus, we recommended additional survey work be done on the ground to confirm the importance of specific locations used by tracked shorebirds in the AOIs. Additional information may become available as data contributors continue to share new tracking data with the Shorebird Collective. We invited GBF and TWT to periodically check in with the Shorebird Collective on the availability of new data to support their water deployment efforts.



Images: a) Hudsonian Godwit (*Limosa haemastica*), Kristine Sowl, USFWS (CC); **b)** Lesser Yellowlegs (*Tringa flavipes*), Jill Shannon, USFWS (CC); **c)** Long-billed Curlew (*Numenius americanus*), Andy Boyice, Smithsonian; **d)** Long-billed Dowitcher (*Limnodromus scolopaceus*), John Magera, USFWS, CC; **e)** Pectoral Sandpiper (*Calidris melanotos*), Peter Pearsall, USFWS (CC); **f)** Whimbrel (*N. phaeopus*), Rachel Richardson, USGS Alaska Science Center (CC)

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

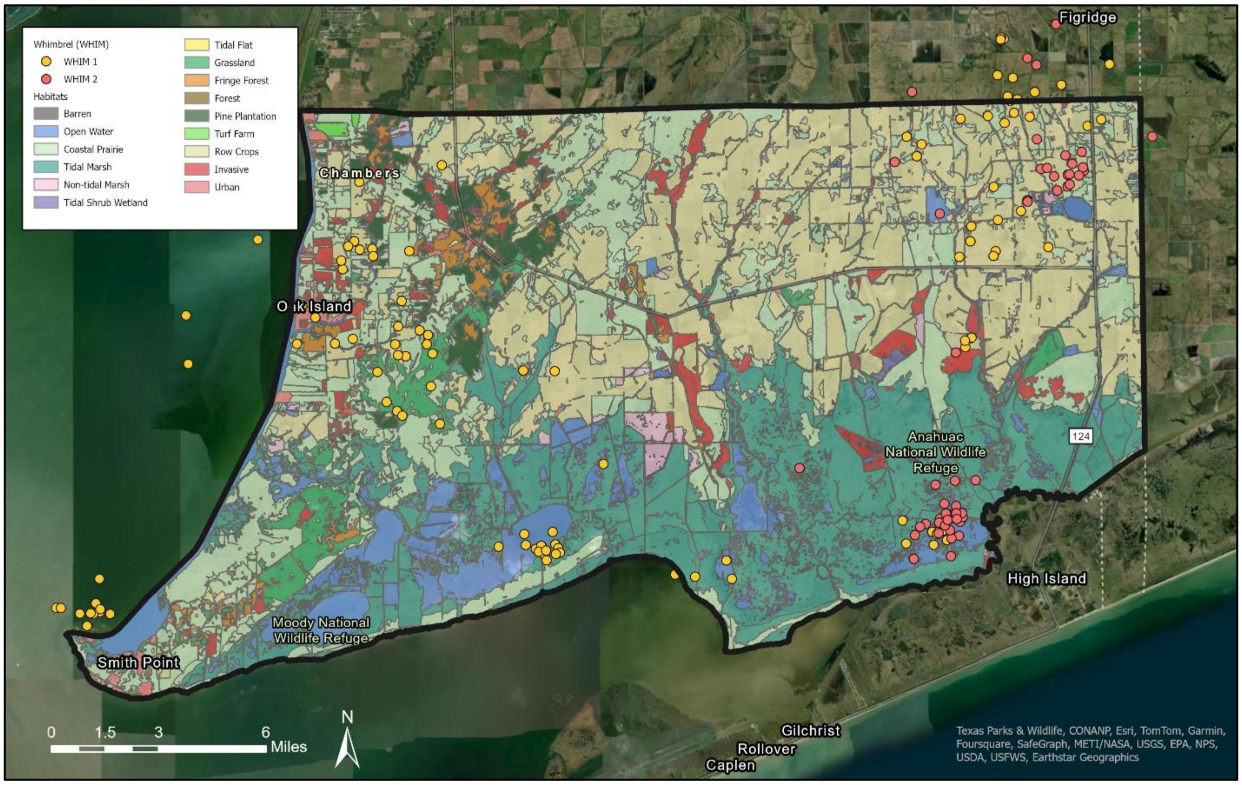


Figure 4. An example of tracked Argos satellite locations of two Whimbrels (*Numenius phaeopus*) tracked in GBF's and TWT's eastern Galveston Bay AOI (area outlined in black) in Chambers County overlayed with habitats, as defined by Elliott et al. (2009). Primary habitats used by the two Whimbrels include row crops, tidal marsh, and coastal prairie. Data from these example tracks contributed by Jennie Rausch, Canadian Wildlife Service, Environment and Climate Change Canada. See page 17 for additional data contributor information.

eBird Data

Tracking data from individual birds may not always reflect population patterns when the number of tracked individuals is limited. For example, satellite tracking data can provide detailed information on habitat use and timing of movements of the tracked birds but may not show movement or timing patterns for a species, or group of species, as a whole. Community science data from eBird[2] can help fill these knowledge gaps. We examined eBird relative abundance data (Fink et al. 2021) in GBF's and TWT's AOIs to fill knowledge gaps for species without tracking data and to check if patterns in community science data matched with the tracking data. In most cases, eBird relative abundance data largely agreed with the spatial distribution of the tracking data in GBF's and TWT's AOIs. These data can provide GBF and TWT with additional context about the potential value of the AOIs to shorebirds and could be used as an additional tool to support their water deployment efforts.

[2] eBird is an online database allowing community members to submit their bird sighting observations, which are then available to researchers. There are over 820,000 birdwatching participants who have contributed more than 1.3 billion observations from around the world, making eBird a powerful tool. Learn more on eBird's website: link to eBird website.

Timing of Shorebird Movements

Tracked Birds

Knowing when during the year shorebirds migrate through a region can help identify critical times to create flooded shorebird habitat. We provided GBF and TWT with data on the timing of occurrence for GPS and Argos satellite tracked shorebirds tracked within their AOIs (see **Figure 5** for an example map showing timing of tracked locations for Whimbrels in the eastern Galveston Bay AOI) as well as throughout the Western Gulf Coastal Plain Ecoregion (**Figure 6**). We extended the analysis over the entire region because some tracked individuals moved hundreds of kilometers throughout the region in a matter of days or during the overwintering period.

Areas of Interest

Tracked locations for shorebirds in GBF's and TWT's AOIs primarily occurred during spring migration (i.e., March through May) with additional tracked locations occurring during the fall migration and overwintering periods (i.e., October-February). **Figure 5** provides an example map showing the timing of tracked locations for Whimbrels in the eastern Galveston Bay AOI.

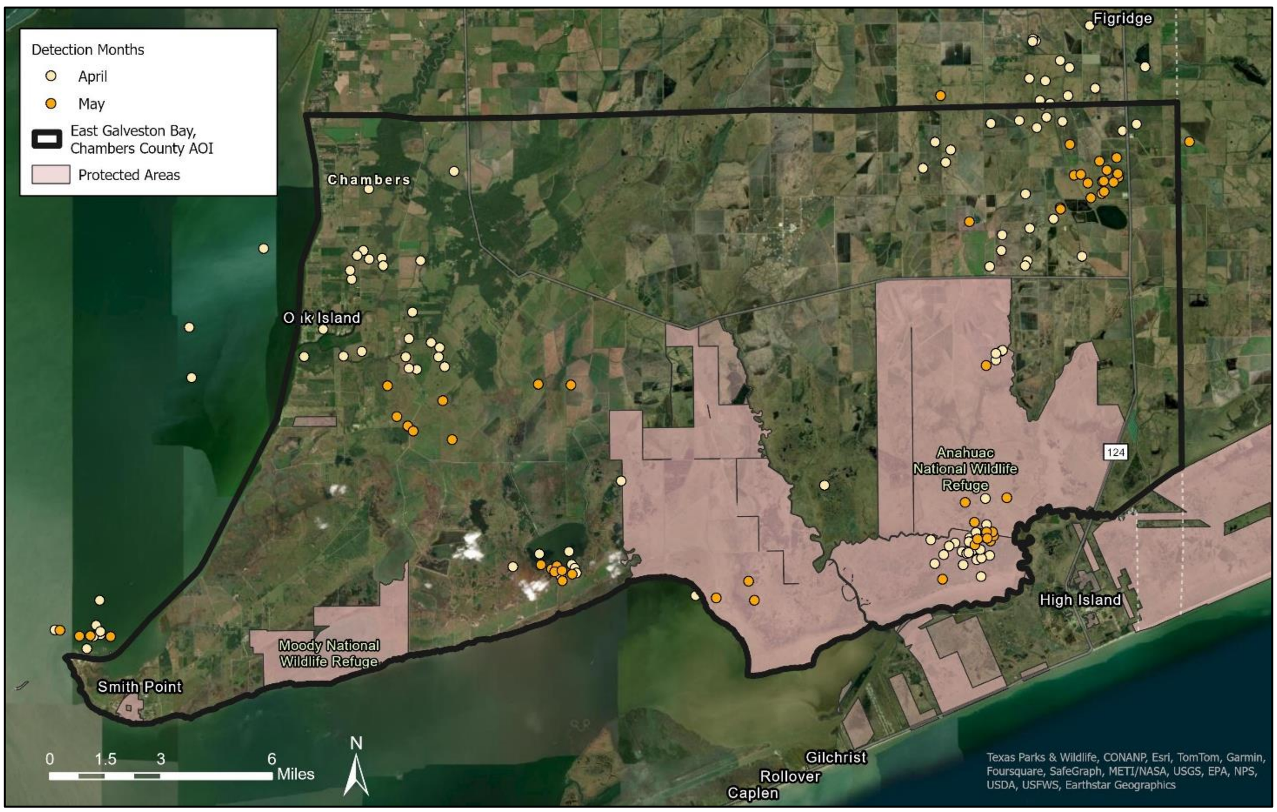


Figure 5. An example of tracked Argos satellite locations of the two example Whimbrels (*Numenius phaeopus*) featured in Figures 3 and 4, grouped across months, in GBF's and TWT's eastern Galveston Bay AOI (area outlined in black) in Chambers County. Both individuals were tracked in the AOI on northbound migration during the months of April and May. An additional map layer showing other protected areas, as defined by UNEP-WCMC and IUCN (2021), is also provided for additional context of shorebird use of the landscape. Note that this is a summary of tracked shorebird locations across multiple years and does not necessarily reflect the birds co-occurring in the area at the same time. Data from these example tracks contributed by Jennie Rausch, Canadian Wildlife Service, Environment and Climate Change Canada. See page 17 for additional data contributor information.

Western Gulf Coastal Plain Ecoregion

Tracking data for some species in the Western Gulf Coastal Plain Ecoregion show **two migration windows**, with individuals migrating through and stopping in the region en route to (**late July – October**) and from (**March – early June**) their overwintering destinations further south (e.g., **Figure 6**, Pectoral Sandpiper). A proportion of the population of some species also **overwinter** in the region (e.g., **Figure 6**, Black-bellied Plover, Long-billed Dowitcher), while others only move through the region during spring migration because they migrate south along the Atlantic Flyway in the fall (e.g., **Figure 6**, Hudsonian Godwit, Whimbrel). Additionally, some species breed in the Western Gulf Coastal Plain Ecoregion (e.g., Black-necked Stilt, Willet) but no satellite tracking data are currently available for these species.

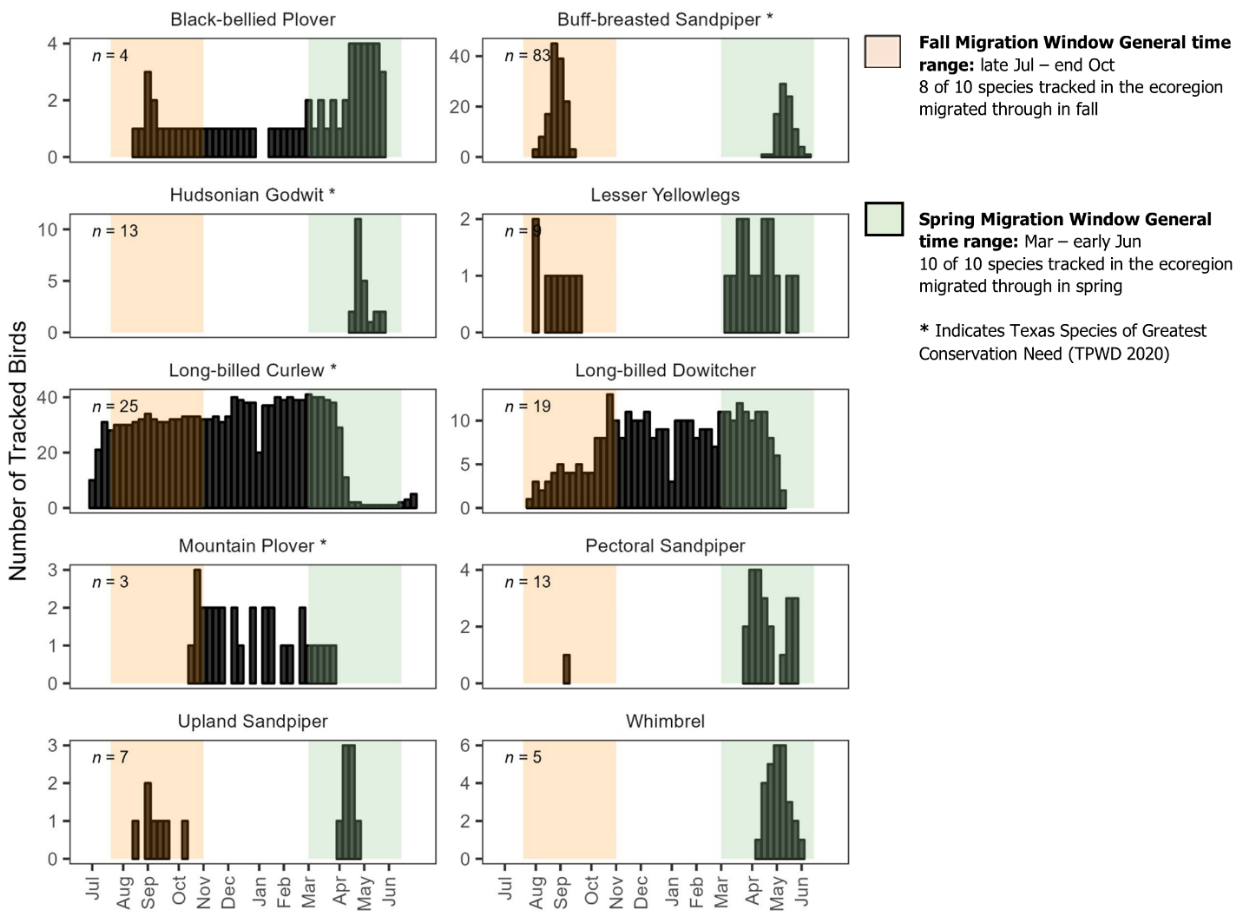


Figure 6. Seasonal timing of movements from GPS and Argos satellite tracked shorebirds in the Western Gulf Coastal Plain ecoregion of Texas. See page 17 for additional data contributor information. Note that some individuals were tracked in more than one year.

eBird Data

To provide GBF and TWT with additional data on the timing of shorebirds tracked in the region, we examined how shorebird eBird relative abundance data (Fink et al. 2021) varied throughout the year in the two AOIs. In most cases, eBird relative abundance data in the region largely agreed with the timing of the tracking data in the two AOIs. GBF and TWT can use these data as an additional tool to inform the timing of their water deployment efforts.

Timing of Water Deployments

Based on the tracking and eBird data, we provided GBF and TWT with a summary of the timing of shorebird movements within the Western Gulf Coastal Plain ecoregion (**Figure 7**), in addition to a set of recommendations on the timing of water deployments in their AOIs (**Box 2**). Ideally, we recommended that GBF and TWT should aim to get water on the ground two to four weeks prior to the expected arrival of shorebirds to allow the invertebrate population to grow (Iglesia and Winn 2021).

Box 2: Recommendations for timing of water deployments in GBF's and TWT's AOIs based off the contributed tracking and eBird community science data.

Fall Water Deployments	Spring Water Deployments
➢ Ideally, water should be **deployed early July and sustained through October** to provide habitat for the first wave of southbound migrant shorebirds. ➢ If possible, water should be sustained at levels suitable for shorebirds (≤ 4 Inches) for as long as possible throughout the fall and winter. ➢ **If water cannot be sustained on the ground during fall**, water should be deployed **early August** to provide water for shorebirds during the peak of fall migration. . ➢ Water **deployments in mid-October** could benefit a second wave of migrant shorebirds that arrive later and **tend to overwinter** in the region.	➢ Ideally, water should be **deployed mid-February and sustained through early June** to provide habitat for northbound migrant shorebirds. ➢ If possible, water should be sustained at levels suitable for shorebirds (≤ 4 Inches) for as long as possible throughout the spring and early summer. ➢ **If water cannot be sustained on the ground during spring**, water should be deployed **early April** to provide water for shorebirds during the peak of spring migration. ➢ **Spring water deployments have the potential to support a higher number of species because a subset of shorebird species only migrate through the region in spring.**

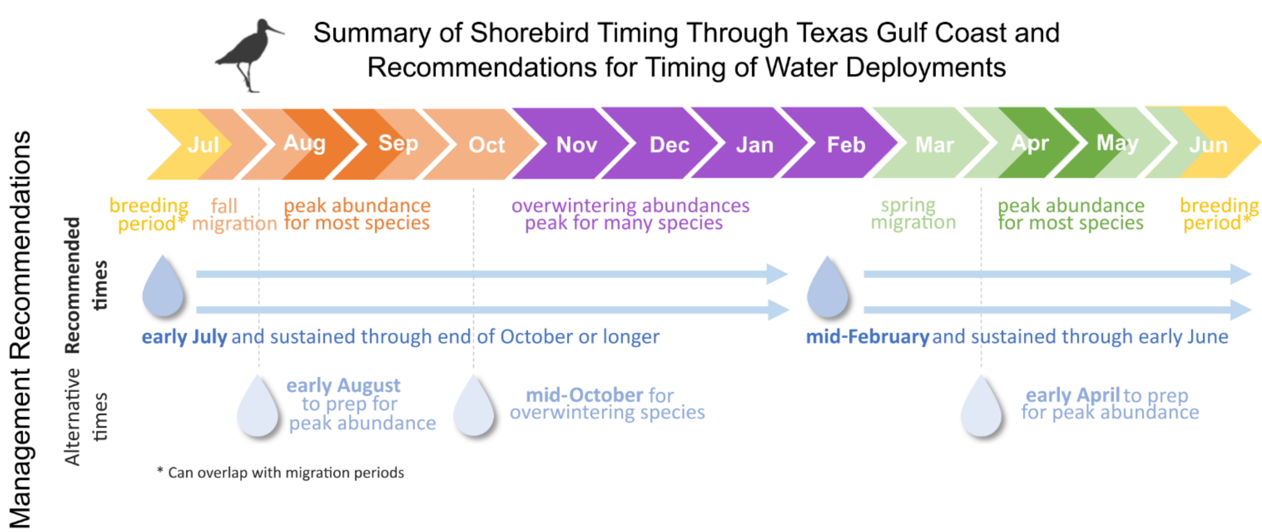


Figure 7. A simplified guide to the timing of shorebird migration and movements through the Western Gulf Coastal Plain in Texas and recommended water deployment times for the creation of shallow flooded habitat to support shorebirds.

Habitat Management Considerations

Water depths and density and height of vegetation are critical factors to consider when managing habitats for shorebirds. We provided GBF and TWT with a set of shorebird habitat management recommendations to consider when moving forward with their water deployment efforts.

Water Levels ≤ 4 Inches

Shallow water foraging areas are essential shorebird habitat. Most shorebird species require water depths **no more than 4 inches** for foraging and probing into the ground for food (Iglecia and Winn 2021). In areas where flooding can be controlled, water levels should be set and sustained at the shallow depths (≤ 4 Inches) desired for shorebirds (preferred) or left to drain naturally if deeper depths are necessary. When possible, efforts should be taken to maintain these consistent low water levels after water deployment.

Minimal Vegetation

Shorebirds typically prefer open habitats with sparse vegetation (Iglecia and Winn 2021). Flooded areas should be in **open landscapes** with **minimal to no vegetation** above the water line or in the surrounding area (Iglecia and Winn 2021).

Other Habitat Considerations

Some shorebird species use upland habitats or have a preference for turf farms, such as Buff-breasted Sandpipers (*Calidris subruficollis*, Lanctot et al. 2010, which are listed as a Texas Species of Greatest Conservation Need, TWPD 2020). If irrigating turf farms is of interest, the Shorebird Collective could work with project partners to identify best management practices. Additionally, caution should be taken when deploying fresh water in brackish environments as it is unknown how changes in salinity could impact the shorebird prey base.

Images: 1. Long-billed Dowitcher (*Limnodromus scolopaceus*), Andy Boyce, Smithsonian; **2.** Hudsonian Godwits (*Limosa haemastica*) in shallowly flooded field, Krista Lundgren, USFWS; **3.** Buff-breasted Sandpiper (*Calidris subruficollis*), Jake Bonello, USFWS (CC)

Summary and Potential Next Steps

The report from the Shorebird Collective provided a detailed summary of shorebird use of GBF's and TWT's AOIs in Chambers and Matagorda Counties in Texas to help them prioritize locations and timing of freshwater deployments. Below we provide a summary of key findings, recommendations, and next steps for GBF and TWT to consider when moving forward with their water deployment efforts.

What: Prioritizing timing and location of water deployments

The Shorebird Collective used contributed tracking data and eBird community science data to help GBF and TWT prioritize the timing and location of water deployments in their AOIs.

Where: Cropland; Coastal Prairie; Tidal Wetlands

Of the tracks contributed to the Shorebird Collective, **14** individuals of **six** species were tracked in their AOIs. Primary habitats used by the birds include **agricultural fields, coastal prairie, and tidal wetlands**. These data largely agreed with species distribution maps based on eBird relative abundance data.

When: Early July; Mid-February; Mid-October

To benefit the most shorebird species, we recommended that water should be deployed in **early July and sustained at suitable levels through October** to provide shorebird habitat for the first wave of southbound migrants in the fall, and **mid-February and sustained at suitable levels through early June** to provide habitat for northbound migrants in the spring. Spring water deployments have the potential to support a higher number of species because a subset of shorebird species only migrate through the region in spring. Water could also be deployed **mid-October and sustained at suitable levels through spring** to provide habitat for overwintering species that spend a large portion of their year in the area.

Next Steps: Monitoring; Outreach; Habitat Analyses

Monitoring: We recommended that monitoring of shorebirds and other wildlife should be done in areas where water is or will be deployed to assess the effectiveness of GBF's and TWT's water deployment and habitat creation efforts.

Outreach: The Shorebird Collective could work with GBF and TWT to provide maps of relevant shorebird tracks and movements at different scales (e.g., locally or showing movements across the hemisphere). For example, the Shorebird Collective could provide maps and facts about a tracked shorebird that used a landowner's property (pending data owner approval) to inspire interest in creating shorebird habitat with water deployments.

Habitat Analyses: Tracking data in this report reflect past use by the shorebirds (i.e., movement data from 2013 to 2023). If beneficial to GBF and TWT, the Shorebird Collective could conduct a more detailed analysis examining the habitat conditions and water levels (if available) used by the tracked birds to further refine water deployment efforts. Additionally, as new data are contributed to the Collective, we could review and provide routine updates on relevant tracks that may further inform GBF's and TWT's ongoing water deployment efforts.

About Coastal Texas and Shorebirds

The Gulf Coast is considered one of the most significant regions in the United States for shorebirds (Elliot and McKnight 2000). Along the Texas coast in particular, the variety of wetland, riparian, and coastal prairie habitats provide critical breeding, stopover, and/or wintering habitat for at least 38 Nearctic shorebird species (Elliot and McKnight 2000). For shorebirds using the midcontinent, areas along the Texas coast also provide the first and/or last suitable habitat for individuals migrating to and from more distant wintering sites in Central and South America, providing an important area for shorebirds to rest and refuel before and/or after a strenuous journey over the Gulf (Withers 2002).

Select areas of eastern Galveston Bay and Colorado-Lavaca Estuary (also known as the Matagorda Bay system, Schoenbaechler and Gurthrie 2011) are the two main focal areas for GBF's and TWT's water deployment efforts. Both areas host a myriad of riparian and coastal prairie habitats and provide critical habitat for shorebirds, waterfowl, waterbirds, and other coastal wildlife species. The eastern Galveston Bay AOI, for example, covers approximately 167,000 acres of land in Chambers County, Texas and contains several important shorebird areas, including Moody National Wildlife Refuge (NWR), Candy Abshier Wildlife Management Area (WMA), and Anahuac NWR[3] (Elliott and McKnight 2000, **Figure 8a**). Similarly, the Colorado-Lavaca Estuary AOI covers 355,000 acres of land in Matagorda County and also contains several important shorebird areas, including Mad Island WMA and Big Boggy NWR (Elliott and McKnight 2000, **Figure 8b**).

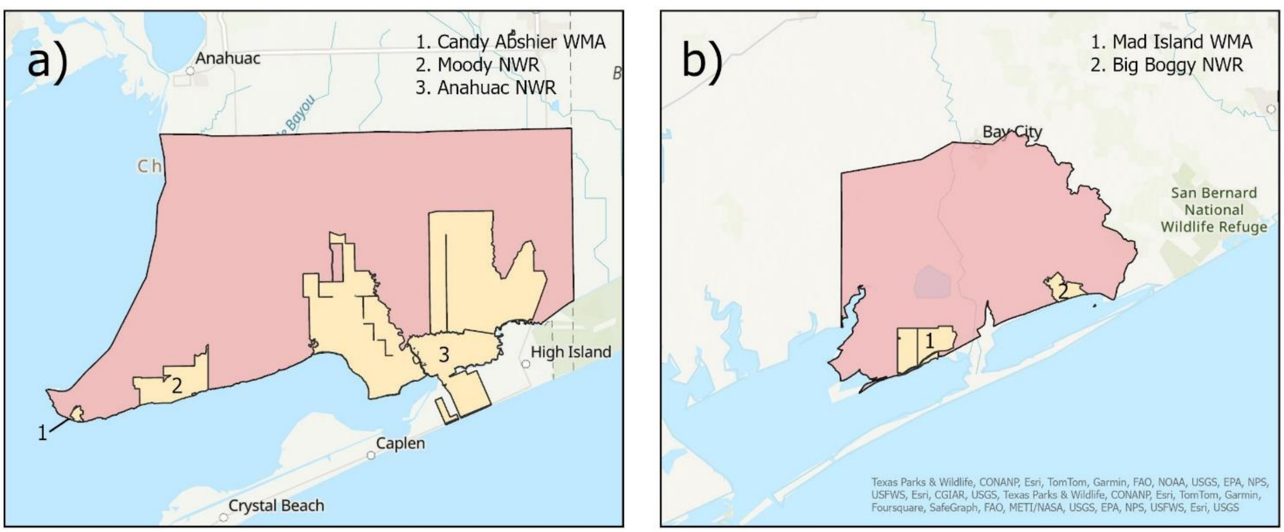


Figure 8. Important shorebird areas within GBF's and TWT's AOIs for freshwater deployments in **a)** eastern Galveston Bay, Chambers County; **b)** Colorado-Lavaca Estuary, Matagorda County.

[3] Anahuac NWR is a designated Western Hemisphere Shorebird Reserve Network (WHSRN) site, hosting more than 2,200 Whimbrels during migration every April and May, in addition to providing important stopover habitat for several other shorebird species (WHSRN 2023). 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 120 WHSRN sites in 20 countries covering over 38.9 million acres of shorebird habitat across the Americas. Learn more at on WHSRN's website: [link to WHSRN website].

Shorebirds Background

Shorebirds are a diverse group of birds in the order Charadriiformes, including sandpipers, plovers, avocets, oystercatchers, and phalaropes. There are approximately 217 shorebird species in the world (O'Brien at al. 2006), 81 of which occur in the Americas. 52 species breed in North America (Morrison et al. 2000) and 35 species breed in Latin America and the Caribbean (Lesterhuis and Clay 2019). They 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. Across their vast range, shorebirds depend on a variety of habitats, including coastlines, shallow wetlands, mudflats, lake and pond edges, grasslands, and fields.

Long-billed Curlew (*Numenius americanus*); Tim Romano, Smithsonian

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, Rosenberg et al. 2019, Smith et al. 2023), making them one of the most vulnerable bird groups in North America. Habitat loss and alteration, 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 many species depending on habitats across multiple countries under different political jurisdictions. Despite these trends and logistical challenges, many public and private groups are working to protect shorebirds and the habitats they depend on.

Flock of Marbled Godwits (*Limosa fedoa*) next to a shorebird scientist; Tim Romano, Smithsonian

Scientists attaching a GPS transmitter to a Red Knot (*Calidris canutus*) to track its migration; Tim Romano, Smithsonian

About Shorebird Tracking Data

Tracking data provide valuable insight into where shorebirds move and are located throughout the year (**Figure 9**). These data can 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 devices (often called "tags") which are attached directly to individual birds (typically with either leg bands, harnesses, or glue) and may be carried by the birds year-round. Tag types of the tracked birds shared with GBF and TWT were satellite tags.

Black-bellied Plover (*Pluvialis squatarola*) with <5g solar satellite tag; Ryan Askren, USGS/Smithsonian

Satellite tags work by sending signals to orbiting satellites that re-transmit 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, generally <10 meters), while Argos tags can have location error of 500-2,500 meters. The Shorebird Collective compiled both contributed GPS and Argos satellite data to support GBF and TWT. Link for more information on satellite tags.

One key benefit of tracking data compared to other data types such as survey or count data is that they give detailed information on movements and habitat use of individual animals in areas that are otherwise difficult to access, such as remote areas or private lands. Therefore, the birds themselves show us where they are, independent of the need for direct human observation.

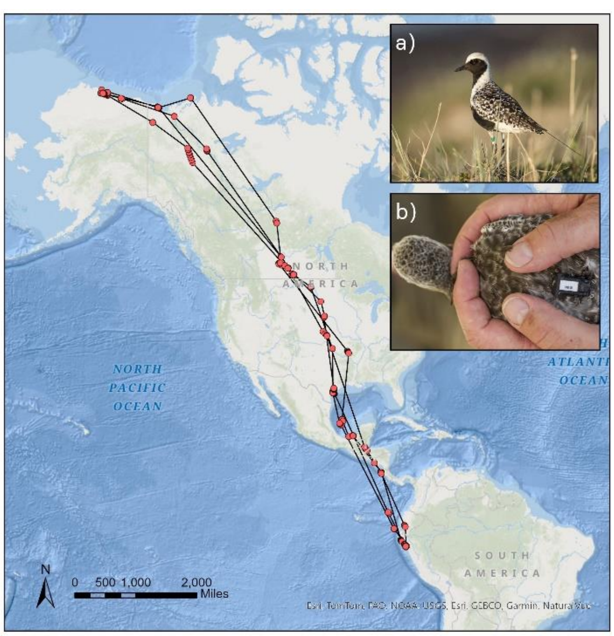


Figure 9. Full cycle track line across two years for an individual Black-bellied Plover (*Pluvialis squatarola*); contributed by Autumn-Lynn Harrison, Smithsonian Migratory Bird Center; David Newstead, Coastal Bend Bays and Estuaries Program; and Lee Tibbitts, U.S. Geological Survey, Alaska Science Center. Photos: **a)** Breeding male Black-bellied Plover with leg flag and <5g solar satellite tag, Ryan Askren, USGS/Smithsonian; **b)** Satellite tag attached to the back of a Black-bellied Plover; Tim Romano, Smithsonian.

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 on our webpage: link to Shorebird Collective webpage.

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

Hudsonian Godwit Track

Nathan Senner*[1,2], Jennifer Linscott[1], Jorge Ruiz[3], Mitch Weegman*[4,5], Bart Ballard*[6], Juan Navedo[3]

Associated Citation: Linscott, J. A., Navedo, J. G., Clements, S. J., Loghry, J. P., Ruiz, J., Ballard, B. M., Weegman, M. D., and Senner, N. R. 2022. Compensation for wind drift prevails for a shorebird on a long-distance, transoceanic flight. *Movement Ecology*, 10(1), 1-16.

Lesser Yellowlegs Track

Callie Gesmundo*[7], Jim Johnson*[7], Katie Christie[8], Laura McDuffie[9], Christian Friis[10], Christopher Harwood[7], Benoit Laliberte[10], Erica Nol[11], Jennie Rausch[10], Audrey Taylor[12], Jay Wright[13], U.S. Department of Defense, Joint Base Elmendorf-Richardson[14]

Unpublished Data, U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, U.S. Geological Survey, Alaska Science Center, Canadian Wildlife Service, Environment and Climate Change Canada, Trent University, University of Alaska Anchorage, Ohio State University

Long-billed Curlew Tracks

Andy Boyce*[15], Jeff Kelly[16], Kate Goodenough[16], Paula Cimprich[16]

Unpublished data, Great Plains Science Program

Jay Carlisle*[17], Stephanie Coates[17]

Unpublished data, Intermountain Bird Observatory Long-billed Curlew Project

Long-billed Dowitcher Tracks

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Unpublished Data, Department of Ornithology, Max Planck Institute for Biological Intelligence

Pectoral Sandpiper Track

Bart Kempenaers*[18], Mihai Valcu[18]

Associated Citation: Kempenaers, B., and M., Valcu. 2017. Breeding site sampling across the Arctic by individual males of a polygynous shorebird. *Nature*, 541(7638), 528-531.

Whimbrel Tracks

Jennie Rausch*[10], Fletcher Smith[19,20], Bryan Watts[19], Brad Winn[21]; Julie Paquet[10]

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