APPENDIX 1. SUMMARY OF THE FINAL ROUND OF THE SHOREBIRD DISTURBANCE DELPHI

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THE DELPHI TECHNIQUE

To develop a shared definition for human disturbance and a list of priority disturbance types, we used the Delphi Technique. The Delphi Technique is an iterative, consensus-building technique used to capture expert judgments to address complex problems. This method is not meant to replace empirical evidence but to guide decision-making until empirical evidence can be obtained or to identify gaps in understanding. The results generated by a group of experts are likely to be more reliable and applicable across various settings than the opinion of a single expert. This method allows participants from varying geographic locations and types of expertise (managers, scientists, or manager-scientists) to participate while minimizing cost and logistics.

Experts were selected for the Delphi (n=54) in collaboration with Caleb Spiegel and Rebecca Longenecker at USFWS and through suggestions of the Atlantic Flyway Shorebird Initiative Human Activities subcommittee. During the selection process, experts were considered either managers or scientists. Managers were chosen if they actively manage disturbance issues for migrating shorebirds on their lands. Researchers who had published at least one study on human disturbance to shorebirds in the NE Region in the last 10 years were eligible for selection. During the first round of the Delphi, experts self-identified as manager, scientist, or both manager and scientist. We confirmed that the individuals had expertise through screening questions in our initial survey. After rounds 1 and 2 those who did not respond were removed from the list.

Here we present the results of round 4 – the final round – of the Delphi. This information will be integrated into the Best Management Practices for Evaluating and Managing Anthropogenic Disturbances to Migrating Shorebirds on Coastal Lands in the Northeastern United States document. Additionally, we intend to analyze these results further and publish them as part of a manuscript.

RESPONDENTS

We received 31 completed surveys (out of 36) in round 4 of the Shorebird- Human Disturbance Delphi. The response rate was 86%. Ninety percent of respondents indicated that they were satisfied (either “extremely satisfied” or “somewhat satisfied”) and 10% of respondents indicated that they were dissatisfied (either “extremely dissatisfied” or “somewhat dissatisfied”) with the overall Delphi process.

DISTURBANCE DEFINITION

In this round, respondents were presented with a draft definition developed through responses in the previous three rounds and were asked to provide final comments on the definition. Ninety percent of respondents indicated that they were satisfied (either “extremely satisfied” or “somewhat satisfied”) and 10% of respondents indicated that they were dissatisfied (either “extremely dissatisfied” or “somewhat dissatisfied”) with the definition.

The definition presented to participants in round 4 for feedback was:

Human disturbance of shorebirds is a human activity that causes an individual or group of shorebirds to alter their normal behavior, leading to an additional energy expenditure by the birds. It disrupts or prevents shorebirds from effectively using critical habitats and from conducting the activities of their annual cycle over and above the disturbances that occur in the absence of humans. Productivity and survival rates may also be reduced.

Based on respondents' comments, we have made the following changes to the definition:

1. Several respondents pointed out that "critical habitat" has a specific meaning under the Endangered Species Act. We have changed the phrase to read "important habitats."
2. A few respondents commented that the wording "activities of their annual cycle over and above the disturbances that would occur in the absence of humans" was confusing. We have changed the phrase to read "activities of their annual cycle that would occur in the absence of humans"

The final definition is as follows:

Human disturbance of shorebirds is a human activity that causes an individual or group of shorebirds to alter their normal behavior, leading to an additional energy expenditure by the birds. It disrupts or prevents shorebirds from effectively using important habitats and from conducting the activities of their annual cycle that would occur in the absence of humans. Productivity and survival rates may also be reduced.

DISTURBANCE TYPES

Respondents ranked the disturbance type categories (developed through previous rounds) based on their significance (in terms of frequency, extent, and/or effect on shorebird survival and behavior) during fall migration from Maine to Virginia. We calculated the average rank of each disturbance type category (Table 1). Categories with a higher numerical rank were considered more important by participants. The top ranked disturbance type category was beach driving followed by dogs and direct harassment. See below for the rest of the rankings.

Table 1. Average rankings for disturbance type categories based on their significance (in terms of frequency, extent, and/or effect on shorebird survival and behavior) during fall migration.

RANKING OF DISTURBANCE TYPES	
Category	Average Rank*
Beach Driving	10.84
Dogs	9.90
Direct Harassment	8.81
Beach Raking	8.35
Coastal Engineering	7.68
General Beachgoing	7.52
Events	5.45
Recreational Fishing	5.29
Motorized Watersports	3.87
Commercial Fishing	3.74
Unmanned Aircraft	3.42
Wind-powered Aircraft	3.13

**Calculated using the following formula: $x_1w_1 + x_2w_2 + \cdots + x_nw_n / Total$ where x = response count for answer choice and w = weight of ranked position. Weights are applied in reverse order (e.g., item ranked 1 would have a weight of 12).*

In response to a concern noted by a few participants:

1. As noted in the last summary report, we use the term fall migration as a synonym for southbound migration. This migration period begins around July 1 and ends around November 15, as defined by the USFWS. This will be detailed in the BMP.

The activities that define the categories (as provided in the last two reports) are listed in Table 2.

Table 2. Categorized disturbance types including edits from round 2 responses.

Category	Activity
Beach driving	4x4 ATV/UTV Beach buggies ORV OSV
Beach raking	Beach raking or scraping
Coastal engineering (previously Beach maintenance)	Beach nourishment Beach raking or scraping Artificial dune stabilization Construction projects
Bike riding	Bike riding Cycling Fat tire bikes
Camping	Camping on beach Bonfire
Cats	Cats Feral cat colonies
Direct harassment	Actively chasing birds
Dogs	Dogs Unleashed dogs Leashed dogs Pets
Events	Fishing tournaments Festivals Parties Sports competitions Fireworks
Falconry	Falconry Hack-raised falcons
Fishing (commercial) and aquaculture	Aquaculture Oyster racks Mariculture Horseshoe crab harvest Clamming Worm digging Seaweed Harvest
Fishing and shellfishing, recreational	Surf fishing Fishing Shell-fishing Clamming Worm-digging Crabbing Bait collection

Category	Activity
Food attractants	Feeding wildlife Leaving bait Leaving trash
General beachgoing	Walking Running/jogging Beachcombing Sunbathing Picnicking Ball playing Frisbee Other beach games Swimming Fast walking
Horseback riding	Horseback riding
Hunting	Hunting
Manned aircraft	Aircraft Helicopters Low-flying planes Banner planes Blimps Microlight aircraft Military planes Jet planes
Motorized watersports	Boats Airboats Speedboats Jet-skis
Non-motorized watersports	Kayak Canoe Paddleboard Sailboat Parasailing Kite boarding Surfing Boogie boards Kite surfing Wind surfing Skimboarding
Official patrols	Litter patrols Emergency vehicles Law enforcement patrol Lifeguards Municipal patrols Marine mammal stranding response
Other	Seaweed harvest Predator fencing Activities that exacerbate erosion
Unmanned aircraft	Drone UAVs Model aircraft Unmanned, remotely operated toys Rocket launches
Wildlife observation	Birdwatching Nature photography Bird call playbacks

Category	Activity
Wildlife research	Wildlife surveys Sea turtle surveys Banding/netting
Wind-powered aircraft	Paragliding Hang-gliding Kite flying Kite skating Sand-yachting or cart sailing

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APPENDIX 2. HIGHLIGHTS OF SHOREBIRD DISTURBANCE LAND MANAGER INTERVIEW RESPONSES

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BACKGROUND

Here, we present summarized highlights from our interviews to inform the Best Management Practices for Evaluating and Managing Anthropogenic Disturbances to Migrating Shorebirds on Coastal Lands in the Northeastern United States. We interviewed staff at coastal sites in the U.S. Fish and Wildlife Service (USFWS) Northeast Region (Virginia to Maine) to determine current management activities for human disturbance to migratory shorebirds, the current human activities at various sites, and any specific informational or management needs to improve management of fall migrating shorebirds.

INTERVIEW PARTICIPANTS

Phone interview requests were sent to 30 individuals from October 2 to December 4, 2017. Potential participants were chosen to represent a range of geographies in the Northeast Region, duties (i.e., higher level managers, field biologists, law enforcement officers, outreach staff), and organizations (i.e., federal, state, local, non-profit). The contact list for potential participants was selected in collaboration with project partners Caleb Spiegel and Rebecca Longenecker at USFWS.

In total, we interviewed 28 people from federal agencies (n=17), state agencies (n=6), towns (n=1), and nonprofits (n=4), with representation from every coastal state in the Northeast, except New Hampshire. Twenty-four participants were biologists or managers; three were law enforcement officers; and two were outreach/visitor services staff.

NOTE

Several important notes about this report:

1. We do not discuss specific sites to protect the confidentiality and anonymity of interview participants.
2. We present participants' responses below in summary form (e.g., "most," "several") rather than numerical form because these are qualitative data. We did not attempt to conduct a survey that was comprehensive or representative of all land managers in the Northeast; therefore the results are not generalizable, and we believe that quantifying responses could be misleading. The intention of these interviews was, instead, to understand the breadth of interviewee experiences and how they would use a BMP, so that we can tailor the BMP to its audience.
3. This report contains results from a subset of questions most relevant to sharing insights amongst our survey participants. Additional results will inform and be presented in the BMP document, a Masters thesis, and/or a journal article.

OCCURRENCE AND MANAGEMENT OF DISTURBANCE TYPES

We asked participants to characterize the human use and regulations at their sites during the fall migration period (July 1-November 15) using the list of disturbance types developed by this project in spring 2017. We asked participants to consider all the sites where they worked, managed, or helped make management decisions. Because of the seasonal overlap between the end of nesting season and the beginning of fall migration, many participants discussed restrictions or regulations for certain activities for nesting shorebirds that would also be in place for early fall migration.

Most participants said beach driving was allowed at their sites. All sites where driving was allowed had restrictions on driving during shorebird nesting season and early migration. More than half of participants said dogs were allowed on at least one site they managed. Leash laws were variable across sites, from having no restrictions to requiring dogs to be leased at all times. However, all federal properties where dogs were allowed required them to be leashed at all times. Many of the participants said events were held at sites where they worked, managed, or helped make management decisions. Some participants said fireworks were allowed on their sites, but most said that even if fireworks were not allowed, many of their neighboring properties had fireworks. Most participants said these fireworks displays were done early in the migration season around 4th of July. Also, most fireworks displays by municipalities were required to be shot off from offshore barges, limiting impacts to shorebirds. Some participants mentioned sending technicians or volunteer monitors to help with managing crowds during events at neighboring sites they partnered with but did not actively manage.

Most participants said commercial fishing or aquaculture was allowed at or near their sites. Because of water rights or laws, many commercial fishing or aquaculture operations are regulated by states, not by the property owner of the adjacent land. Commercial aquaculture operations were more commonly discussed than commercial fishing, as most commercial fishing was conducted farther off-shore.

Beachgoing, recreational fishing/shellfishing, and watersports (motorized and nonmotorized) were allowed at least at one site where each person worked. However, there was variation in the amount or location of human use allowed. Some sites did not allow beachgoing unless someone in the party was actively fishing. Others reported also managing off-shore islands where no human use was allowed. Everyone mentioned restrictions on beachgoing, fishing, and boat landings during nesting season. In many cases, these restrictions overlapped with early fall migration.

Some participants, mostly those who worked for or with municipalities, said beach raking or scraping was allowed at their sites. Again, all participants mentioned restrictions on raking/scraping during nesting season. Most participants discussed coastal engineering projects (including restoration projects to protect or improve habitat) conducted at sites they manage. Most of these projects were not conducted every year. Examples of projects conducted regularly (i.e., every year or every few years) were dune stabilization and beach nourishment. Several participants mentioned timing restrictions on coastal engineering projects that included the fall migration period.

All participants who worked at federal properties mentioned regulations for drones or other types of unmanned aircraft. For other properties, drones were regulated during nesting season, but in many cases, regulations during migration were not clear or varied widely by site. Most participants described drones as an emerging potential disturbance issue. Additionally, a few participants said model aircraft were allowed on their sites. Similarly, several sites had restrictions for kites or other wind-powered aircraft. About a quarter of participants said their sites did not allow kites at any time, and all others mentioned kites being restricted around nesting areas. A few participants mentioned paragliding or hang-gliding, but in general, these activities were uncommon, even where they did occur.

Fat tire bikes were the most commonly mentioned activity not included on our list of potential disturbance

types. These bikes were described by many as another emerging activity that was increasing in popularity. Other activities not included on our list were: horses, rocket launches, birders/photographers, researchers, illegal camping, and ultralight aircraft. Many participants discussed how birders or nature photographers would accidently cause disturbances by getting too close to birds.

Across these human activities, most participants indicated that the majority of management for fall migrating shorebirds was limited to the period when migration overlaps with breeding season. A few participants said they would close sections of beach during migration where and when they knew birds stopped over in significant numbers. Many participants discussed the various challenges to managing human use during fall migration. Several mentioned that it was more difficult for beachgoers to understand why migrants needed protection (i.e., easier for people to understand why protecting chicks is important). Others mentioned conflict with recreationists as limiting management for fall migrating shorebirds (discussed in more detail below).

MONITORING DURING FALL MIGRATION

Most participants reported that their sites conduct some type of monitoring for shorebirds during fall migration. Of those, several sites participated in International Shorebird Surveys (ISS), and a few sites reported doing Integrated Waterbird Management and Monitoring (IWMM) surveys. Additionally, several participants said they conducted species-specific monitoring, with most of those conducting Piping Plover surveys and fewer monitoring Red Knots. Additionally, several participants reported that they monitored for fall migrants but did not specify what type of monitoring surveys were done. Those who do not currently monitor for fall migrating shorebirds indicated that their sites have conducted monitoring in the past.

Some sites reported that they conducted some sort of monitoring for human disturbance. However, in most cases, this monitoring was conducted opportunistically (e.g., anecdotal observation when in the field for other purposes). Some participants reported conducting counts during a shorebird survey for dogs, people, and/or vehicles. Additionally, a few participants said their sites had participated in human disturbance research projects in the past.

In some cases, monitoring described by participants was used to make management decisions at a site or sites, though not all decisions were specifically about disturbance management. Monitoring influenced water levels and drawdown times at freshwater impoundments. Other participants discussed how bird count data informed participants on where important bird habitat areas are at their sites. Additionally, several participants said that determining these locations can be useful during a permitting process, so participants can make decisions about issuing a special use permit or putting a project under a time of year restriction. In one instance, a participant reported that shorebird surveys were important for extending a vehicle closure, as the surveys showed that birds were spending more time in the area during the fall migration than originally thought. In other cases, disturbance monitoring was helpful for participants or biologists to determine where to spend more time enforcing rules or addressing noncompliance issues.

MANAGEMENT OVERLAP

We asked participants to describe how their management for shorebirds may benefit other non-shorebird species and vice versa. While discussing this management, participants also described how the timing of certain management practices can provide benefits to shorebirds during non-target times (e.g., management for breeding birds may benefit migrants).

Participants reported that fencing off areas provides benefits to both shorebirds and non-shorebirds. Areas that are fenced off for shorebirds may provide areas of low human disturbance for other species, like endangered plants (e.g., seabeach amaranth, seabeach knotweed), endangered tiger beetles, diamondback terrapins, and other bird species. Additionally, in many cases, closures for endangered breeding shorebirds and terns create protected areas for early season fall migrants. One participant discussed how requirements

for creating buffers around resting seals may also help shorebirds in those areas. Participants also discussed the cases where areas fenced off for endangered beach plants creates places with reduced disturbance for shorebirds. One participant suggested that fencing put up for endangered plants may have contributed to plovers showing back up in an area they had previously been absent.

Participants also discussed how managing and restoring habitats for certain species or at certain times could also benefit shorebirds. One participant described how restrictions on dredging or other kinds of coastal engineering projects for finfish and shellfish spawning in the fall would likely benefit migrating shorebirds by reducing disturbances at those times of year. Others discussed how marsh restoration projects at their sites were creating habitat for shorebirds; though, as one interviewee discussed, in some cases this habitat creation would be only temporary until open marsh areas became revegetated. In other cases, marsh restoration conducted to restore ecosystem functioning also benefited shorebirds. Participants also described how managing impoundment water levels at certain times would benefit shorebirds and other waterbirds by creating foraging or roosting areas.

Lastly, a few participants discussed how management implemented at other times of year could benefit migrating shorebirds. Some participants said that predator management for breeding shorebirds (and terns) could benefit both migrating shorebirds and other non-shorebird species, including other breeding waterbird species. Additionally, one participant mentioned that managing areas to make them appealing for horseshoe crabs also makes them good areas for migrating shorebirds; though, as one participant stated, this benefit is likely mostly for spring migrating shorebirds.

CONFLICTS WITH RECREATIONISTS

We asked participants if they or their sites experienced any issues with conflict and which (if any) user groups were involved in those conflicts.

Everyone mentioned getting pushback or negative comments from individual recreationists. While fairly common, most agreed that these negative interactions were outweighed by positive feedback or outreach. In general, participants said that most beachgoers were accustomed to restrictions and closures for nesting birds. Though in areas with lots of tourism, this acceptance may not be as common because the beachgoers are constantly changing.

At some locations, user groups created more pushback than individuals and in some ways influenced management. In most cases, participants described these conflicts as making managing more difficult, requiring more time and outreach than issues without conflict. Common user groups that were involved in these issues were fishing groups, dog walkers, ORV/OSV users, kite surfers and parasailers, and boaters (both motorized and nonmotorized).

In some cases, these conflicts (both from individuals and user groups) influenced management decisions for migrating shorebirds. Some participants mentioned being hesitant to extend closures beyond the breeding season requirement to avoid potential conflict. At sites where people were less friendly towards breeding bird closures, one participant mentioned their biological field staff changed the timing of their monitoring surveys to avoid potential negative interactions with beachgoers.

A few participants mentioned that they had good working relationships with certain user groups. Because we did not ask specifically about positive relationships with user groups, it may be the case that other sites had similar experiences that were not mentioned. One participant said their site often worked closely with kayak rental companies or kayak groups to reduce disturbance issues. Several others mentioned how birders and birdwatching organizations usually had a close relationship with their sites and were quick to report issues of disturbance or make sure other birders/photographers were minimizing their disturbance.

SUMMARY & NEXT STEPS

We would like to thank our participants for their participation in this interview phase of the project. We presented results in this report that we hope will help participants see how their site-based actions fit into the broader picture of management for human disturbance to fall migrating shorebirds in the Northeast Region. Further, results from these interviews will be used to identify informational gaps or needs that, when possible, will be addressed by the BMP. A final draft of this BMP will be completed by fall 2018.

APPENDIX 3. METHODS FOR MONITORING SHOREBIRD DISTURBANCE AT REFUGES DURING SOUTHWARD MIGRATION

These methods were piloted in 2017 at three Northeast National Wildlife Refuges, so reference is made to "Refuge" and "Refuge Biologists" throughout. However, the methods may be adapted for use by other groups.

METHODS OVERVIEW

Surveys will be conducted on coastal beach habitat. Each site to be surveyed will be further divided into subsites. Subsites should be selected based on management type (ex: closed, open to the public) within the refuge, in consultation with Refuge biologists (see below for more guidance).

Three types of surveys will be conducted- transect surveys, point counts, and behavioral observations. Sample datasheets for all survey types are included at the end of this appendix. Transect surveys and point counts should be done on one pass through the site and behavioral observations on another pass (e.g., transects/ point counts on the "first pass," followed by behavioral observations in the "second pass" or return trip, although the order should be alternated). If possible, all surveys should be done with two observers, and these methods are written accordingly. Using double observers can allow the researcher to detect differences in detection probabilities and may increase detection probabilities. Transect surveys and point counts will be done simultaneously by two observers without sharing results. Behavioral observations will be conducted as a team. Surveyors should ensure the consistency and accuracy of their measurements by following the steps for **alignment of paired observers**, if applicable, found at the end of this appendix.

All surveys should be conducted on foot, if possible. Surveys should be scheduled with attention to ensuring diversity of day of week (i.e., weekend/holiday vs. weekday), time of day, and tidal stage.

Survey equipment

Make sure you have all of the equipment you will need before beginning the surveys, including:

- Datasheets: Ensure you have the appropriate number and type (transect, point count, and behavioral observation) before beginning.
- Binoculars and spotting scope
- GPS unit: During your first visit, mark and save all point locations for future survey visits with an easy-to-use naming system (e.g., subsiteabbreviation_pointnumber).
- Subsite maps: Bring printed maps of each subsite, containing aerial imagery, any important site features for orientation (piers, walkways), the subsite extent, and the location of the transect and point counts.
- Kestrel/handheld weather meter: Select a meter that measures the temperature (C°), wind speed (km/hr), and wind direction. You can use a smartphone that gives information from the nearest weather station, but this likely will not be as accurate as measuring on-site.
- Watch/stopwatch/smart phone: A device that will beep every 30 seconds when conducting the behavioral observations.

- Range finder: Using a rangefinder will ensure accurate measurement of distances, especially when conducting point counts.
- Clicker counter: Using a counter may be beneficial for counting disturbance types and/or shorebirds at busy sites (i.e., large numbers of people and/or birds).

Subsite Selection

Each site, depending on its size, should be broken down into subsites. Points should be 400m apart. It is recommended that subsites are selected based on management type. We also suggest selecting subsites based on disturbance levels at the site, including both high and low disturbance subsites.

Species Selection

These field methods are designed to focus on the focal species (see below) selected by the Atlantic Flyway Shorebird Initiative (AFSI). However, depending on site specific needs, biologists may choose to focus on different or additional shorebird species. If using different species, make sure to edit the datasheets appropriately.

Focal species:

- American Oystercatcher
- Semipalmated Sandpiper
- Red Knot
- Whimbrel
- Wilson's Plover
- Marbled Godwit
- Piping Plover
- Purple Sandpiper
- Red-necked Phalarope
- Ruddy Turnstone
- Sanderling
- Snowy Plover
- American Golden Plover
- Greater Yellowlegs
- Lesser Yellowlegs

Disturbance Types Selection

Like for selecting focal species, these field methods were designed to focus on a set of potential disturbance types (see below). For further explanation of disturbance types, see **Description of potential target human disturbances**. However, potential disturbance types may need to be added or removed, depending on what types of human activities are present at a site. Disturbance types may also be broken down further or combined (e.g., combining walking and jogging). It may additionally be useful for surveyors to keep track of potential violations at a site (e.g., someone brings a dog to a site where dogs are not allowed) and report these violations to the appropriate contact at the survey site.

Potential target human disturbances

- Beach driving: both parked and driving
- Dogs, noting leashed and unleashed
- General beachgoing: People
- Anglers
- Motorized watersports: boats and other personal watercraft
- Commercial fishing
- Unmanned aircraft: drones, etc.

- Wind-power aircraft: kites, parasailing, etc.
- Other, human- explain potential disturbance
- Other, non-human- explain potential disturbance, including species, if known

Subsite Categorization

On the first visit of the season to each subsite, record the following information (this does not have to be recorded again unless conditions change). It may be helpful to sketch a site map that includes the features below:

- Locations of human access points (take GPS points)
- List all human activities permitted at the site (talk to Refuge staff about this)
- Locations of management activities: exclosures, fencing, closed/open areas
- Locations of facilities: piers, swimming areas, parking lots, bathrooms, trash, etc.

TRANSECT SURVEYS

Transect surveys will be conducted as continuous counts along a transect. Depending on the tide, surveyors will walk on wet sand near the high tide line to minimize disturbance to foraging birds during surveys. To further avoid disturbing birds, the surveyors will walk around any birds encountered on the transect, leaving as large a buffer as possible, and will follow all Refuge-specific guidelines for minimizing disturbance. Each transect survey will be conducted for the entire length of a subsite and is equal to the width of the beach (i.e., water to dunes).

Record the following on the data sheet for each survey:

- Date/time start and time end
- Site/subsite
- Observer(s) (list your own initials first)
- Tidal stage
- Weather conditions- wind speed/direction, temp, cloud cover (Sky)
- Time of first high tide
- GPS track name

When an individual bird or group of birds from a focal species is detected, surveyors will count the number of birds of each focal species present within the group. While conducting these continuous counts, surveyors will also count potential disturbances to birds (see **Description of potential target human disturbances** for explanations of the disturbance types). Every 400m at fixed locations on the transect, stop and conduct a visual point count (see "Point Counts" below).

Notes:

- Birds and disturbance sources will be counted up to 200m from the surveyors. The transect width is equal to the width of the beach or 200m, whichever is less.
- In-movement: Birds and disturbances (e.g., people, dogs) that move into the surveyed area from behind the surveyors will not be counted. Fly-overs will not be counted, regardless of direction of approach. Only birds that land within 200m (when coming from in front of the researchers) will be counted. This rule should be followed for both the transect surveys and the point counts.
- If possible, at least 2 surveys per subsite will be conducted in each tidal stage. We divide the tidal cycle into four, 3-hour tidal stages that are repeated to cover the entire 24-hour day. Those stages are: low, mid-rising, high, and mid-falling.

POINT COUNTS

Every 400m at fixed locations on the transect, surveyors will conduct visual point counts. Researchers will use the same methods above for avoiding disturbance to birds. Coordinates of each point will be taken on a GPS

unit at the time of the first survey. The coordinates will be used to relocate the point for subsequent (repeat visit) surveys and years. Surveyors will orient themselves in a common direction (ex: north) and count all focal species in a complete circle around the point up to 200 m. Surveyors will then repeat and count all potential target human disturbances (see above for definition of focal species and potential human disturbances) in a complete circle around the point up to 200 m. The 200 m-radius survey area for each point should not overlap with the survey area for any other points.

There is no set amount of time for each point count to be conducted, but the counts should be as instantaneous as possible. Depending on the number of focal shorebird species and surveyor preference, you may count each species or disturbance type separately. If there are a large number of birds or people at the point, it may also be helpful to count disturbance types first (in a complete circle around the point), then birds (or vice versa).

BEHAVIORAL OBSERVATIONS

Behavioral observations will be conducted in the opposite pass of walking the subsite transect from the monitoring/point count surveys. For example, transect surveys/point counts will be conducted walking north to south on the beach, and behavioral observations will be done as researchers return walking south to north. The researchers will rotate the order of the monitoring transects/point counts with the behavioral observations to avoid systematic influence or bias of which direction they walked first.

Surveyors will conduct 3-minute focal species observations at the same fixed locations that were used for the point counts. The focal species for the behavioral observations – Whimbrel, Red Knot, Semipalmated Sandpiper, Piping Plover, and Sanderling – were selected from the focal species list above based on habitat, foraging guild, and protected status. Depending on specific informational needs, a site may choose different focal species. At the point count locations, researchers will select a focal flock within 200m and observe one of the focal species in the middle of the flock for 3 minutes, and then move on to the next species, until all of the species present from the list of 5 focal species are observed for 3 minutes. Depending on location and focal species, up to 5 behavioral observations may be conducted for a point. For example, if you locate only Sanderling at a point, there will be just one behavioral observation. If you locate none of the focal species, then no observations will be done at that point. If you locate all five focal species, then there will be 5 observations for the point.

Researchers should rotate the order in which the focal species are observed. While the behavioral observations are being conducted, the researchers should try to keep a 50m buffer between themselves and the focal bird (see minimum approach distances in Livezey, Fernandez-Juricic, & Blumstein, 2016).

During the 3-minute observation, the researchers will record the instantaneous behaviors of the individual every 30 seconds. The instantaneous behaviors will be recorded as the following behaviors: foraging, walking, maintenance (resting, preening, etc.), alert/vigilant, flying, other. One researcher will use their scope for observation while the other records the data. If only one person is conducting the observations, then the observer should use a voice recorder to record the behaviors. All potential disturbances occurring within 200m of the flock will also be recorded (see above for potential disturbances). If a disturbance event occurs (defined as birds changing their behavior in reaction to a human source), the time and source of the disturbance will be recorded, if possible.

Notes:

- If the focal individual can no longer be observed (e.g., bird flies away, observer can't determine which bird is being observed, view is obstructed), locate another individual and restart the behavioral observation. However, if only one individual is present at the point and it can no longer be observed, continue the sample and record "out of sight" as the behavior code.

DESCRIPTION OF POTENTIAL TARGET HUMAN DISTURBANCES:

--Note: Surveyors should not count themselves. Record all potential disturbances up to 200m.

- Beach driving: Count vehicles (4x4, ATV/UTV, beach buggies, ORV, OSV), including both parked vehicles and vehicles in motion
- Dog, unleashed
- Dog, leashed
- Walkers: include dog walkers
- Joggers
- Ball players: This category includes those actively engaged in a game.
- People, stationary: This category includes people who are stationary on the beach (those sitting in chair, on towel, reading, napping, etc.). If a person changes their activity during the count, do not record their new behavior.
- People, swimming: This category includes all people in the water. Do not count people who are using some type of watercraft (motorized or nonmotorized) or who are resting (stationary) in the intertidal area.
- Motorized watersports: Count any type of personal water craft (PWC)- boats, airboats, power or speed-boats, jet skis. Record boats up to 200m offshore. Note if you see a boat on the beach.
- Nonmotorized watersports: Count any type of watercraft that does not use a motor or engine- kayaks, canoes, stand-up paddleboards, kite surfing, kite boarding, surfing, wind surfing, parasailing, etc. Count sailboats if they are not currently using a motor/engine. Record nonmotorized watercraft up to 200m offshore. Note if you see a boat or board on the beach.
- Unmanned aircraft: Record the following up to 200m in any direction (including above): drone, UAVs, model aircraft, remotely operated toys.
- Wind-powered: Record the following: kites, paragliding, hang-gliding, kite skating, sand-yachting, or cart sailing. Do not include kite surfing or other type of water-based activity that uses a kite or sail.
- Anglers: Count the number of people actively fishing or checking the rods. Count others who may be near the rods under the other beachgoing categories above, depending on their activity.
- Aquaculture: Record people engaged in any of the following: aquaculture, oyster racks, mariculture, horseshoe crab harvest, crabbing. Note if you see the presence of aquaculture or fishing gear (e.g., crab pots, oyster racks) up to 200m.
- Raptors: Count falcons, hawks, etc. that fly over or are present in the study area (within 200m).
- Cats: Count cats observed in the study area (within 200m).
- Other: Explain. Record with short description.
    - Note evidence of events such as fire rings, fireworks and firework debris, beer cans, etc.
- Other- nonhuman: Count gulls, foxes, coyotes, or raccoons if you see an active disturbance event occurring. Record with description of event (animal cause, distance to bird, etc.).

ALIGNMENT OF PAIRED OBSERVERS

On the first day of training for a new pair of observers, researchers will conduct transects (monitoring) and point count surveys together to ensure correct identification of birds and classification of disturbance sources. They will discuss the data they are collecting, particularly any differences in data collected between researchers. If differences occur, pause the survey and discuss what each observer recorded and why, with the goal of reaching agreement on what should have been recorded. Data collected during this day will not be entered in a database.

One the second day of training, researchers will conduct monitoring and point count surveys on their own but stop after every point to compare data and discuss discrepancies, determining any issues in identification of birds or definition of disturbances. Data collected during this day will not be entered in the database.

A third day of training may be necessary if the observers are not consistent. Please note that there may be some differences in detectability (i.e., one observer may not see a flock or individual bird) but that it is essential there are not systematic issues with differences in identification of birds or definition of disturbance types.

On the first day of collecting actual data, monitoring and point count surveys will be conducted as described in the methods above. At the end of a monitoring transect of a subsite, the researchers will compare data. Differences in data will discussed. Data will not be changed. If there are still major discrepancies between researchers this day, observers will return to training together. At the end of the training period, researchers will conduct the surveys as described above.

Human Disturbance Transect Data Sheet

Site: _____Subsite: _____ Date:_____ Transect ID: _____ Observer(s): _____

Air temperature: _____Sky: _____ Wind speed: _____ Wind direction: _____ Tidal stage: _____ First high tide: _____ Visit #: _____

Transect Coordinates (*coplete on first visit only*)		
	Latitude	Longitude
Endpoint 1		
Endpoint 2		

Time start: _____ Time end: _____

Focal Species Counts

Species	**No. of Birds**	**Species**	**No. of Birds**
Sanderling		Greater Yellowlegs	
Piping Plover		Lesser Yellowlegs	
Ruddy Turnstone		Red-necked Phalarope	
Semipalmated Sandpiper		American Golden Plover	
American Oystercatcher		Snowy Plover	
Red Knot		Wilson's Plover	
Whimbrel		Purple Sandpiper	
Marbled Godwit		"Peep" sandpiper	

Disturbance Sources

Disturbance Type	**Number**	**Disturbance Type**	**Number**	**Disturbance Type**	**Notes**
Vehicle		Motorized watersports		Other, human	
Dog, unleashed		Nonmotorized watersports		Other, non-human	
Dog, leashed		Unmanned aircraft			
Walkers		Wind-powered			
Joggers		Anglers			
Ball players		Aquaculture			
People, stationary		Raptors			
People, swimming		Cats			

Subsite: first letter of site, section name **Transect ID**: Subsite code, date **Air temp:** Celsius **Sky:** 0 = 0-25% cloud cover; 1 = 25-75% cloud cover; 2 = 75%-100% cloud cover; 4 = fog/smoke; 5 = rain **Wind speed** (km/h): average **Wind direction:** N, NE, E, SE, S, SW, W, NW **Tidal stage:** 1= low, 2= mid rising, 3= high, 4=mid falling **First high tide:** time of first high tide of day (hh:mm)

Human Disturbance Point Count Data Sheet

Site: _____ Subsite: _____ Point ID: _____ Observer(s): _____

Date:_____ Visit #: _____ Time start: _____ Time end: _____

Point Coordinates (*complete on first visit only*): Latitude:_____ Longitude: _____

Focal Species Counts

Species	**No. of Birds**	**Species**	**No. of Birds**
Sanderling		Greater Yellowlegs	
Piping Plover		Lesser Yellowlegs	
Ruddy Turnstone		Red-necked Phalarope	
Semipalmated Sandpiper		American Golden Plover	
American Oystercatcher		Snowy Plover	
Red Knot		Wilson's Plover	
Whimbrel		Purple Sandpiper	
Marbled Godwit		"Peep" sandpiper	

Disturbance Sources

Disturbance Type	**Number**	**Disturbance Type**	**Number**	**Disturbance Type**	**Notes**
Vehicle		Motorized watersports		Other, human	
Dog, unleashed		Nonmotorized watersports		Other, non-human	
Dog, leashed		Unmanned aircraft			
Walkers		Wind-powered			
Joggers		Anglers			
Ball players		Aquaculture			
People, stationary		Raptors			
People, swimming		Cats			

Notes:

Subsite: first letter of site, section name **Point ID:** first two letters of subsite name, two-digit point number **Visit #:** 1, 2, 3, etc

Human Disturbance Behavioral Observation Data Sheet

Site: _____ Subsite: _____ Date:_____ Point ID: _____ Observer Name: _____

Recorder Name: _____ Air temperature: _____ Sky: _____ Wind speed: _____ Wind direction: _____ Tidal stage: _____

First high tide: _____ Visit #: _____ Point Coordinates (*complete on first visit only*): Latitude:_____ Longitude: _____

Behavioral Observation

Species	Time Start	Time 1 0:30	Time 2 1:00	Time 3 1:30	Time 4 2:00	Time 5 2:30	Time 6 3:00	Comments*

Behavior Codes: For= foraging; W= walking; M=maintenance (preening, resting, etc.); A= alert/vigilant; Fly=flying; AGR= aggression; OS=out of sight; O= other, explain
*Record disturbance events in the comments, note disturbance type, distance from bird, and time.

Disturbance Sources

Disturbance Type	Number	Disturbance Type	Number	Disturbance Type	Notes
Vehicle		Motorized watersports		Other, human	
Dog, unleashed		Nonmotorized watersports		Other, non-human	
Dog, leashed		Unmanned aircraft			
Walkers		Wind-powered			
Joggers		Anglers			
Ball players		Aquaculture			
People, stationary		Raptors			
People, swimming		Cats			

Subsite: first letter of site, section name **Point ID:** first two letters of subsite name, two-digit point number **Observer:** Person observing birds **Recorder:** Person recording data **Air temp:** Celsius **Sky:** 0 = 0-25% cloud cover; 1 = 25-75% cloud cover; 2 = 75%-100% cloud cover; 4 = fog/smoke; 5 = rain **Wind speed** (km/h): average **Wind direction:** N, NE, E, SE, S, SW, W, NW **Tidal stage:** 1= low, 2= mid rising, 3= high, 4=mid falling **First high tide:** time of first high tide of day (hh:mm)

APPENDIX 4. FIELD-TESTING SHOREBIRD DISTURBANCE MONITORING METHODS REPORT

November 16, 2018
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BACKGROUND

In 2017, we developed and tested a set of field methods to collect data for evaluating shorebird disturbance at a site. These methods were developed with input from project partners at USFWS and shorebird researchers at Virginia Tech. The methods provide a potential set of common metrics for monitoring and measuring the effects of human disturbance to shorebirds at migratory stopovers, in order to better quantify, track, and compare responses to current and future management actions across sites. Development of common metrics for monitoring and measuring the effects of disturbance could improve our understanding of shorebird disturbance at sites within the Northeast region, help managers evaluate the effectiveness of their actions across sites at a regional scale, and facilitate more efficient cross-site collaboration.

The objective of this pilot study was to develop and field test a set of methods, which could be used for future coordinated monitoring efforts. Specifically, these methods can be adapted across multiple sites and management entities to facilitate coordination across broader geographies and timescales, in order to better understand trends across wider segments of populations, more effectively compare success of management actions across sites and regions, and avoid duplication of efforts. Pilot testing allowed us to make adjustments to the methods to improve the feasibility and ease of collecting data.

The purpose of this report is to present the data collected from this pilot season and discuss the preliminary data analyses. The results presented in this report represent two months of data collection, and therefore, these results should not be generalized beyond what is discussed in this report. More robust analyses can be run using these methods but a larger dataset (i.e., more sites and years) would be required.

METHODS

Study Sites and Subsites

Surveys were conducted at 3 sites: Amagansett National Wildlife Refuge (NWR) on Long Island, New York, Elizabeth A. Morton NWR on Long Island, New York (Figure 1), and Chincoteague NWR in Virginia. Sites were further divided into subsites and selected based on management type (ex: closed, open to the public) within the refuge, in consultation with Refuge biologists.

Amagansett and Elizabeth A. Morton National Wildlife Refuges

Amagansett NWR and Elizabeth A. Morton NWR are part of the Long Island National Wildlife Refuge Complex. Due to its small area (quarter mile of beach), Amagansett NWR (ANWR) only included a single subsite (Figure

2). This refuge is closed to the public inland of the high tide line during breeding season for Least Terns and Piping Plovers. The closed area is indicated by a rectangular fence that runs the length of the refuge.

Morton NWR (MNWR) was divided into three subsites (Figure 3), two of which were closed to the public (MPEC and MNOY) and one quarter mile stretch of beach open for public recreation (MPUB). MPEC was on the Little Peconic Bay side of the Jessup's Neck peninsula and was 1.5 miles in length. MNOY was on the Noyack Bay side of the peninsula and was 1 mile in length.

Figure 1. Map of Long Island showing the locations of Amagansett and Elizabeth A. Morton National Wildlife Refuges.

Figure 2. Map showing Amagansett National Wildlife Refuge subsite, transect, and point count locations.

Figure 3. Map showing subsites, monitoring transects, and point count locations at Elizabeth A. Morton National Wildlife Refuge. MPUB transect is shown in pink. MPEC transect is shown in blue. MNOY transect is shown in green.

Chincoteague National Wildlife Refuge

Chincoteague NWR (CNWR) is located on the Virginia side of Assateague Island (Figure 4). The Refuge is one of the most visited in the United States and also is a critically important stopover site for migratory shorebirds. This site was divided into 5 subsites, based on visitor access (Figure 5). All subsites at Chincoteague were 1.5 miles long. The southernmost subsite, CHOOK, was closed to all public use from March 15-August 31. The adjacent subsite, COSV, was completely closed to public use from June 21-August 15. The closure dates for this subsite depend on Piping Plover breeding activity. Both of these subsites allowed over-sand vehicles (OSV) when open to public use. An additional subsite, CSWILD, allowed OSVs from May 23-August 31. This subsite was open to nonmotorized public use year-round, even when OSVs were not allowed. The other two subsites, CREC and CNWILD, did not allow OSVs but were open to public use year-round.

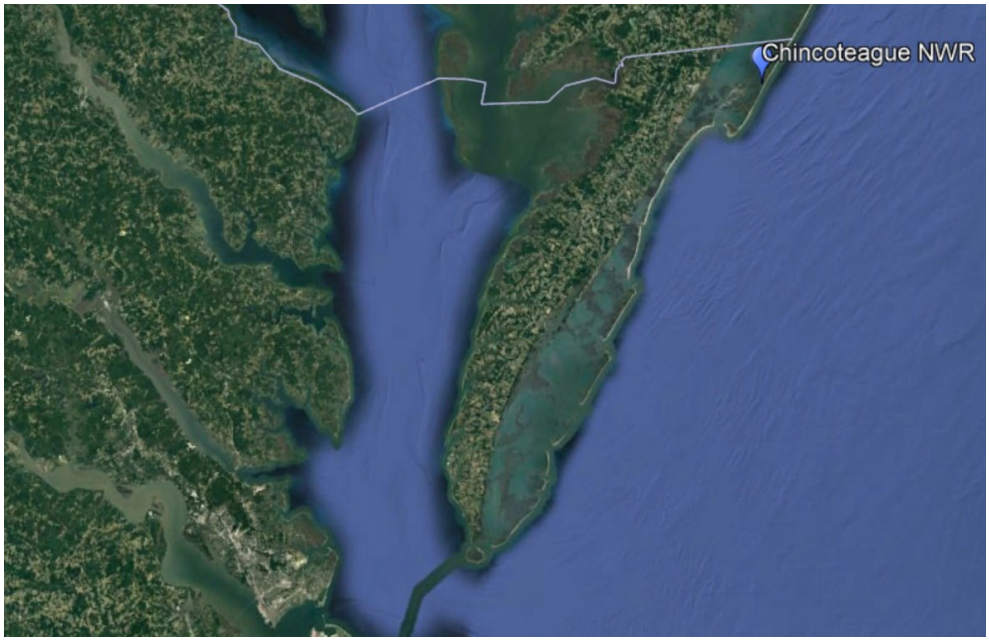

Figure 4. Map of Eastern Virginia showing the location of Chincoteague National Wildlife Refuge.

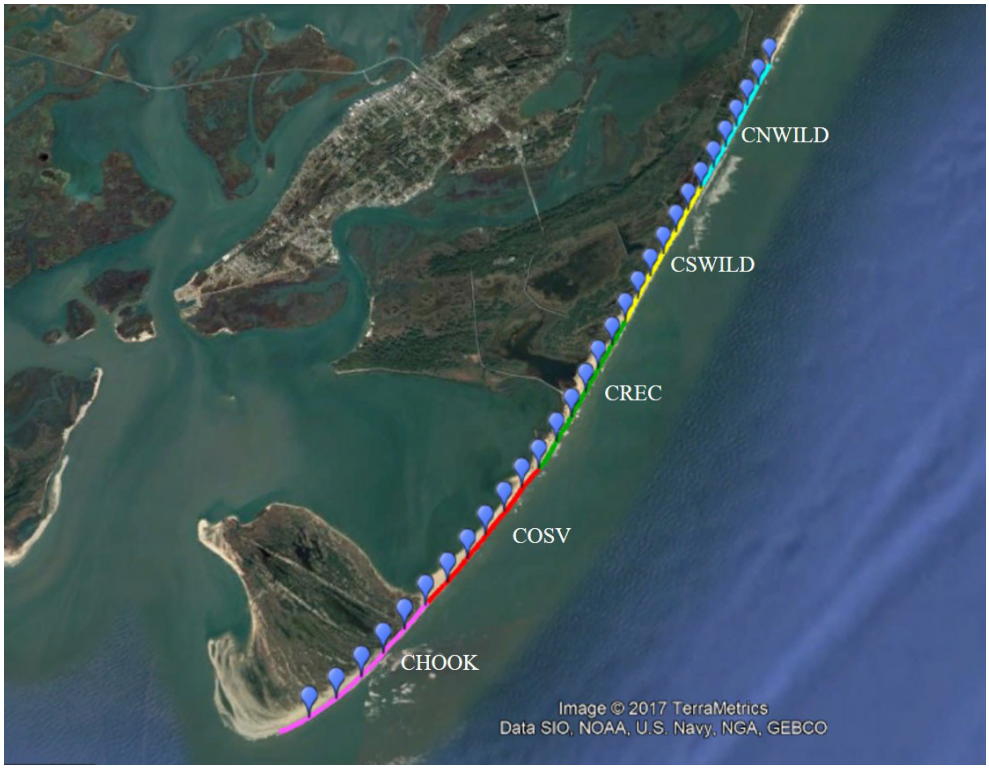

Figure 5. Map showing subsites, monitoring transects, and point count locations at Chincoteague National Wildlife Refuge. CHOOK transect is shown in pink. COSV transect is shown in red. CREC transect is shown in green. CSWILD transect is shown in yellow. CN-WILD transect is shown in blue.

Focal species

Atlantic Flyway Shorebird Initiative (AFSI) focal species were targeted for the pilot study: Sanderling, American Oystercatcher, Semipalmated Sandpiper, Red Knot, Whimbrel, Wilson's Plover, Marbled Godwit, Piping Plover, Purple Sandpiper, Red-necked Phalarope, Ruddy Turnstone, Snowy Plover, American Golden Plover, Greater Yellowlegs, and Lesser Yellowlegs.

At Chincoteague NWR, we adjusted our focal species based on consultation with the refuge biologists, in order to more adequately include expected species. We added Semipalmated Plover, Whimbrel, and Black-bellied Plover to our species list and excluded Greater Yellowlegs, Lesser Yellowlegs, and American Golden Plover. None of the species removed from the list were observed at Amagansett or Elizabeth A. Morton NWRs, and we did not observe Whimbrel or Black-bellied Plover at these sites. We did, however, have counts of Semipalmated Plovers from these sites as "incidentals," and these counts were included in our analyses.

Potential disturbance types

The potential disturbance types chosen for this pilot study were based on the disturbance type categories developed during a group prioritization process (see **Appendix 1. Summary of the Final Round of the Shorebird Disturbance Delphi** for more information about this process). Potential disturbances included: beach driving, dogs (leashed and unleashed), walkers, joggers, sun bathers, ball players, beachgoing-other, beach raking, coastal engineering (beach nourishment, construction, artificial dune stabilization), motorized watersports, unmanned aircraft, kites, anglers, commercial fishing gear or boats, events, direct harassment, cats, and raptors.

Data collection

Data were collected at each subsite using transect surveys, point counts, and behavioral observations (see **Appendix 3. Field Methods for Monitoring Shorebird Disturbance at Refuges during Southward Migration**). These methods may be used to address different questions related to evaluating and monitoring effects of human disturbance on shorebirds, and each has unique strengths and weaknesses (see **Considerations for Developing Standardized Field Methods to Evaluate Shorebird Disturbance** section of main document for more details).

All surveys were conducted on foot. Transect surveys and point counts were conducted simultaneously by two observers without sharing results. Behavioral observations were conducted as a team.

Transect surveys were conducted as continuous counts of all focal species along a transect. All potential disturbances were also counted simultaneously on the transect. Each transect survey was conducted for the entire length of a subsite and was equal to the width of the beach (i.e., waterline to dunes).

Visual point counts were conducted every 400m along the transect at fixed points. Researchers counted all focal species and all potential disturbances within a 200m circle around each point. Due to the various sizes of the subsites, the numbers of points varied by subsite.

Behavioral observations were conducted by walking a subsite transect in the opposite direction from a transect/point count survey. Researchers conducted 3-minute focal species observations at the same fixed points as the point counts. The focal species for behavioral observations were a subset of the species list for the monitoring and point count surveys: Whimbrel, Red Knot, Semipalmated Sandpiper, Piping Plover, Ruddy Turnstone, and Sanderling. These species were selected based on foraging guild and protected status. To conduct an observation at a point, researchers selected a nearby focal flock within 200m of the point and observed one individual of the focal species in the middle of the flock for 3 minutes, and then moved on to the next species, until all of the species present from the list of 5 focal species were observed. Researchers rotated the order in which the focal species were observed at each point. During the 3-minute observation,

researchers recorded the instantaneous behaviors of the focal individual every 30 seconds. Instantaneous behaviors were recorded as the following: foraging, walking, maintenance (i.e., resting, preening), alert/vigilant (i.e., actively scanning surroundings), aggression (i.e., chasing or harassing other birds), flying, other. All potential disturbances occurring within 200m of the flock also were recorded. When a disturbance event occurred (defined as birds changing their behavior in a perceived reaction to a human source) during the 3-minute observation, the time and source of the disturbance were recorded. One researcher conducted the observations while the other recorded the data. The same observer conducted all behavioral observations.

Surveys were conducted at the Long Island sites (Morton and Amagansett NWRs) from July 11- July 31, 2017. We surveyed both Long Island sites for 11 survey days. Surveys were conducted at Chincoteague NWR from August 5-September 4, 2017. We conducted survey at Chincoteague NWR for 23 survey days. Surveys were scheduled with attention to ensuring diversity of day of week (i.e., weekend/holiday vs. weekday), time of day, and tidal stage. Tidal stage included four, 3-hour tidal stages: 1=low, 2=mid-rising, 3=high, and 4=mid-falling.

Data analysis

Summary statistics are presented for all survey types. For the point count and transect data, we conducted all statistical analyses using the program R (R Development Core Team). We used negative binomial regression models to examine how different types of disturbance impacted shorebird counts. Due to small sample sizes of shorebird species, we ran these models on the most commonly observed species - Sanderling (SAND) - at the site where they were observed most frequently--Chincoteague NWR. For these analyses, we combined walkers and joggers into the category “active people” because of their similarity and to increase sample sizes. Survey effort was the amount of time in minutes spent surveying during each transect or at each point count location. While the data from the pilot study did not allow these robust analyses for all species or sites, we offer this as an example of the types of analyses that may be conducted.

We then used Akaike’s Information Criterion to rank models in our candidate set. We considered the top model(s) to be those within <2 ΔAICc (Burnham and Anderson 2004). We used these ranked models to examine differences in the results between point count and transect models.

We summarized behavioral observation data into time budgets, where we calculated the proportion of time focal species were observed engaged in each recorded behavior. We present these summarized data for all sites for Piping Plover (PIPL), Ruddy Turnstone (RUTU), Sanderling, and Semipalmated Sandpiper (SESA).

RESULTS AND DISCUSSION

We conducted 195 transect surveys, 946 point counts, and 522 behavioral observations during 34 days. Greater Yellowlegs, Lesser Yellowlegs, American Golden Plover, Marbled Godwit, Red-necked Phalarope, Snowy Plover, Wilson’s Plover, and Purple Sandpiper were not observed during any of the surveys. Additionally, the following disturbance types were not observed: beach raking, coastal engineering, unmanned aircraft, cats, events, and direct harassment.

Transect surveys

The five most commonly observed species during the transect surveys were Sanderling (93% of all birds observed), Willet (2%), Ruddy Turnstone (1.5%), Semipalmated Plover (1.5%), and Piping Plover (1%) (Table 1). The most commonly observed disturbance types were sunbathers (68% of all disturbances observed), beachgoing-other (20%), and walkers (6%) (Table 2). Counts of beachgoing-other included people in the water and people whose activity could not be determined.

Table 1. Counts of species observed during transect surveys at each subsite through the field season. Species that were not observed are not included.

Site	Transect	Open*	SAND		PIPL		RUTU		SESA		AMOY		REKN		WILL		SEPL		WHIM		BBPL	
Observer			**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
ANWR	ANWR	1	81	133	38	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CNWR	HOOK**	0	5853	5834	1	1	55	55	6	6	32	30	10	10	136	136	83	64	0	0	58	55
	NWILD	1	3408	3441	1	1	27	30	9	5	0	0	0	0	36	45	45	33	1	1	26	27
	OSV**	0	4909	5120	60	65	124	137	4	3	23	28	106	103	106	111	69	65	0	0	8	10
	REC	1	976	939	4	5	13	11	0	0	0	0	0	0	32	42	11	8	0	0	3	3
	SWILD	1	2864	3184	0	0	39	50	9	16	0	0	0	0	40	43	76	105	4	3	14	18
MNWR	NOY	0	31	21	11	19	24	14	0	0	1	0	0	0	0	0	7	0	0	0	0	0
	PEC	0	3	3	32	35	0	0	0	0	0	0	0	0	0	0	5	6	1	1	0	0
	PUB	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**Open (1) or closed (0) to public access*
***Open to public use for part of the season*

Table 2. Counts of a subset of disturbance types observed at each subsite throughout the field season during the transect surveys.

Site	Transect	Open*	OSV		Dogs		Walker		Jogger		Ball Player		Sunbather		Beachgoing - other		Angler	
Observer			**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
ANWR	ANWR	1	0	0	1	1	30	43	8	8	8	8	77	61	12	21	0	0
CNWR	HOOK**	0	14	18	0	0	7	4	0	0	0	0	0	7	0	0	2	0
	NWILD	1	1	1	0	0	20	23	0	0	0	0	14	16	0	0	0	0
	OSV**	0	71	73	0	0	104	91	4	2	4	2	226	231	95	52	7	12
	REC	1	2	2	2	2	479	650	113	133	113	133	7517	8175	1924	2561	18	16
	SWILD	1	16	17	0	0	84	87	0	0	0	0	182	160	63	50	10	8
MNWR	NOY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PEC	0	1	1	0	0	1	0	0	0	0	0	2	2	3	5	0	0
	PUB	1	0	0	0	0	0	0	0	0	0	0	56	49	38	61	2	2

**Open (1) or closed (0) to public access*
***Open to public use for part of the season*

We conducted 108 transect surveys at Chincoteague NWR. For the transect surveys, the global model was the top ranked model (Table 3). The adjusted R^2 of this model was 0.78. Five variables were significant predictors within the top ranked model (Table 4). Two of the variables were counts of potential disturbance types: active people (combined counts of walkers, joggers, and ball players) and sunbathers. Both active people and sunbathers had a negative influence on Sanderling counts. The model indicates that sunbathers had more of an effect on Sanderlings than active people.

The other three significant predictors were wind speed, date, and public access. Wind speed and public access both had a negative influence on Sanderling counts. Our results indicated that open areas have a negative effect on Sanderling counts, showing that fewer Sanderlings are present when the beach is open to public use. Lastly, as expected, date had a positive effect on counts of Sanderlings, likely due to the progression of the migration season with more birds arriving at the site later in our season.

Table 3. Results of model selection examining effects of disturbance on counts of Sanderlings at Chincoteague National Wildlife Refuge during the transect surveys. We present the model results, including β coefficients, of all models in our candidate set.

Model	A	S	V	WI	TS	D	O	E	κ	AICc	ΔAICc	w_i
Global[1]	-0.13	-0.34	0.05	-0.12	-0.01	0.27	-0.40	0.01	8	1292	0.00	0.99
People	-0.18	-0.34				0.18		0.02	4	1321	28.53	0.00
Inactive		-0.50				0.17		0.02	3	1326	33.83	0.00
Active	-0.47					0.22		0.02	3	1341	48.57	0.00
Open						0.30	-0.64	0.02	3	1419	126.78	0.00
Weather				-0.16	-0.03	0.27		0.02	4	1438	146.06	0.00
Vehicle			0.02			0.09		0.01	3	1442	150.02	0.00

Variable abbreviations: Active people-walkers, joggers, ball players (A); Sunbathers (S); Vehicle (V); Wind speed (WI); Tidal stage (TS); Date (D); Open or closed to public access (O); Survey effort (E)
[1]Global model=A+S+V+WI+TS+D+O+E

Table 4. Parameter estimates for the best performing model examining effects of disturbance on counts of Sanderlings at Chincoteague National Wildlife Refuge during the transect surveys.

Variables	β coeff	SE	Lower 95% CI	Upper 95% CI	p value
Active people	-0.13	0.06	-0.24	-0.01	0.03
Sunbathers	-0.34	0.06	-0.46	-0.22	<0.01
Vehicle	0.05	0.03	-0.01	0.11	0.08
Wind speed	-0.12	0.03	-0.19	-0.06	<0.01
Tidal stage	-0.01	0.03	-0.07	0.05	0.68
Date	0.27	0.10	0.07	0.48	0.01
Public access	-0.40	0.08	0.25	0.56	<0.01
Survey effort	0.01	0.01	-0.00	0.03	0.07

Point count surveys

The five most commonly observed species during the point count surveys were Sanderling (94% of all birds observed), Willet (2%), Ruddy Turnstone (1%), Semipalmated Plover (1%), and Black-bellied Plover (1%) (Table 5). The most commonly observed disturbance types were sunbathers (60% of all disturbances observed), beach-going-other (27%), and walkers (6%) (Table 6).

Table 5. Counts of species observed at each subsite throughout the field season during the point count surveys. Species that were not observed are not included.

Site	Transect	Open*	SAND		PIPL		RUTU		SESA		AMOY		REKN		WILL		SEPL		WHIM		BBPL	
Observer*			**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
ANWR	ANWR	1	98	87	15	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CNWR	HOOK**	0	4852	4756	2	3	69	62	1	0	23	17	3	11	136	132	40	35	0	0	50	53
	NWILD	1	3511	3590	0	1	20	17	4	6	0	0	0	5	33	33	21	16	1	1	25	21
	OSV**	0	2532	3587	35	38	88	73	6	2	7	12	70	59	84	65	61	58	0	0	9	7
	REC	1	665	737	0	0	6	5	0	0	0	0	0	0	26	19	2	1	0	0	2	2
	SWILD	1	2292	2597	0	0	36	34	7	7	0	0	0	0	45	46	61	46	4	3	17	20
MNWR	NOY	0	27	18	0	1	13	11	0	0	0	0	0	0	0	0	5	0	0	0	0	0
	PEC	0	4	2	21	20	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
	PUB	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**Open (1) or closed (0) to public access*
***Open to public use for part of the season*

Table 6. Counts of a subset of disturbance types observed at each subsite throughout the field season during the point count surveys.

Site	Transect	Open*	OSV		Dogs		Walker		Jogger		Sunbather		Ball Player		Beachgoing - other		Angler	
Observer*			**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
ANWR	ANWR	1	3	1	10	14	30	43	1	3	644	602	34	43	114	287	0	0
CNWR	HOOK**	0	14	14	0	0	12	10	0	0	18	23	0	0	0	0	2	0
	NWILD	1	1	1	0	0	11	19	0	0	27	26	0	0	2	0	0	0
	OSV**	0	80	79	0	0	119	110	2	2	591	557	2	13	252	231	26	21
	REC	1	0	1	0	0	316	441	10	13	4019	4467	38	50	1754	2341	9	7
	SWILD	1	14	16	0	0	52	58	1	4	138	164	0	3	52	40	4	3
MNWR	NOY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PEC	0	0	0	0	0	1	1	0	0	2	2	0	0	4	5	0	0
	PUB	1	0	0	0	0	0	0	0	0	56	51	0	0	31	65	2	2

**Open (1) or closed (0) to public access*
***Open to public use for part of the season*

We conducted 648 point counts at Chincoteague NWR. For the point count surveys, the global model was the top ranked model (Table 7). The adjusted R^2 for this model was 0.43. Eight variables were significant predictors within the top ranked model (Table 8). Three of these variables were counts of potential disturbance types: active people (combined counts of walkers, joggers, and ball players), sunbathers, and vehicles. Active people and sunbathers both negatively impacted Sanderling counts. However, vehicles had a slight positive effect.

Additionally, the two other significant variables were weather-related: wind speed and tidal stage. Similar to the transect surveys, wind speed had a negative effect on Sanderlings. Tidal stage had a positive effect on Sanderling counts, indicating that higher tidal stages had a positive effect on Sanderling counts. The remaining three significant variables were date, public access, and survey effort. Date and survey effort had positive effects, and public access had a negative effect. Again, date positively affected counts due to the number of migrating Sanderlings increasing as the migration season progresses. Survey effort had a positive effect, suggesting that spending more time observing birds at each point increases detection. However, the effect of this variable was relatively small (β=0.11). Like for the transect surveys, our results indicated that open areas have a negative effect on Sanderling counts.

Table 7. Results of model selection examining effects of disturbance on counts of Sanderlings at Chincoteague National Wildlife Refuge during point count surveys. We present the model results, including β coefficients, of all models in our candidate set.

Model	A	S	V	WI	TS	D	O	E	κ	AICc	ΔAICc	w_i
Global[1]	-0.28	-0.42	0.10	-0.22	0.09	0.43	-0.42	0.11	8	5933	0.00	1.00
People	-0.31	-0.44				0.20		0.17	4	6010	77.84	0.00
Inactive		-0.54				0.14		0.15	3	6079	146.63	0.00
Active	-0.44					0.17		0.18	3	6128	195.55	0.00
Open						0.23	-0.52	0.10	3	6221	288.71	0.00
Weather				-0.24	0.07	0.28		0.14	4	6230	297.39	0.00
Vehicle			0.04			0.08		0.14	3	6263	330.36	0.00

Variable abbreviations: Active people-walkers, joggers, ball players (A); Sunbathers (S); Vehicle (V); Wind speed (WI); Tidal stage (TS); Date (D); Open or closed to public access (O); Survey effort (E)
[1]Global model=A+S+V+WI+TS+D+O+E

Table 8. Parameter estimates for the best performing model examining effects of disturbance on counts of Sanderlings at Chincoteague National Wildlife Refuge during the point count surveys.

Variables	β	SE	Lower 95% CI	Upper 95% CI	p value
Active people	-0.28	0.03	-0.34	-0.21	<0.01
Sunbathers	-0.42	0.03	-0.48	-0.35	<0.01
Vehicle	0.10	0.02	0.05	0.15	<0.01
Wind speed	-0.22	0.03	-0.28	-0.16	<0.01
Tidal stage	0.09	0.03	0.03	0.14	<0.01
Date	0.43	0.06	0.30	0.55	<0.01
Public access	-0.42	0.07	-0.55	-0.28	<0.01
Survey effort	0.11	0.02	0.05	0.17	<0.01

Behavioral observations

We observed 92 "disturbance events" during our behavioral observations, which were defined as a bird changing its behavior in a perceived reaction to a human source. While this is a fairly subjective measure of disturbance, counting these disturbance events allows for potential disturbances to be recorded outside of the 30-second survey time points.

Sanderlings were observed at 54% of the points surveyed (Table 9). Ruddy Turnstones were observed at 15% of the points. Piping Plovers were observed at 8% of points. Red Knots and Semipalmated Sandpipers were both

observed at around 2% of points. Whimbrels were observed at >1% of points. At 18% of the point locations, no birds were observed. Like for the other surveys, the most commonly observed potential disturbance types during the behavioral observations were sunbathers, beachgoing-other, and walkers (Table 10).

Table 9. Total number of behavioral observation surveys of each species at each subsite

Site	Subsite	Open*	SAND	PIPL	RUTU	SESA	REKN	WHIM	None observed***
ANWR	ANWR	1	7	16	0	0	0	0	3
CNWR	CHOOK**	0	65	1	15	3	4	0	1
	CNWILD	1	60	0	13	1	0	1	0
	COSV**	0	71	20	36	2	6	0	1
	CREC	1	62	1	5	1	0	0	4
	CSWILD	1	72	0	21	4	0	4	1
MNWR	MNOY	0	6	5	5	1	0	0	41
	MPEC	0	3	8	2	1	0	0	56
	MPUB	1	0	0	0	0	0	0	10
Percent of total observations			54.1	8.0	15.2	2.0	1.6	0.8	18.3

**Open (1) or closed (0) to public access*
***Open to public use for part of the season*
****Number of surveys where no birds were observed*

Table 10. Counts of a subset of potential disturbance types observed at each subsite throughout the field season during the behavioral observation surveys.

Site	Transect	Open*	OSV	Dogs	Walker	Jogger	Ball Player	Sunbather	Beachgoing-other	Angler
ANWR	ANWR	1	0	1	66	7	2	85	50	0
CNWR	HOOK**	0	4	0	6	0	0	4	0	0
	NWILD	1	0	0	46	1	0	13	6	2
	OSV**	0	67	2	242	6	0	173	41	25
	REC	1	0	0	246	14	47	2704	1040	2
	SWILD	1	38	0	135	3	0	159	33	8
MNWR	NOY	0	2	0	0	0	0	0	0	0
	PEC	0	0	0	0	0	0	0	1	0
	PUB	1	0	0	0	0	0	44	52	2

**Open (1) or closed (0) to public access*
***Open to public use for part of the season*

Piping Plovers

In areas closed to the public (Figure 6b), Piping Plovers spent a larger proportion of time foraging than in areas open to public access (Figure 6a). They spent more time walking in areas open to the public. They were also observed exhibiting alert or vigilant behaviors in open subsites (2% of the time), while they were not observed exhibiting these behaviors in closed subsites. These data suggest that Piping Plovers spend more time engaged in active behaviors at subsites open to public access and less time foraging.

Figure 6a

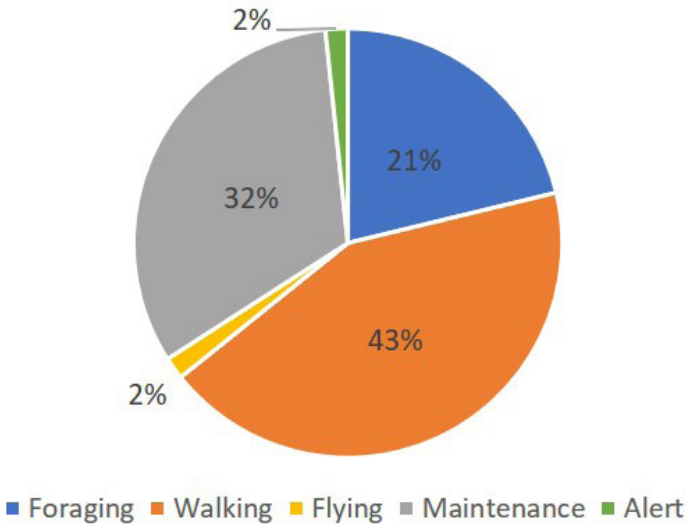

Figure 6b

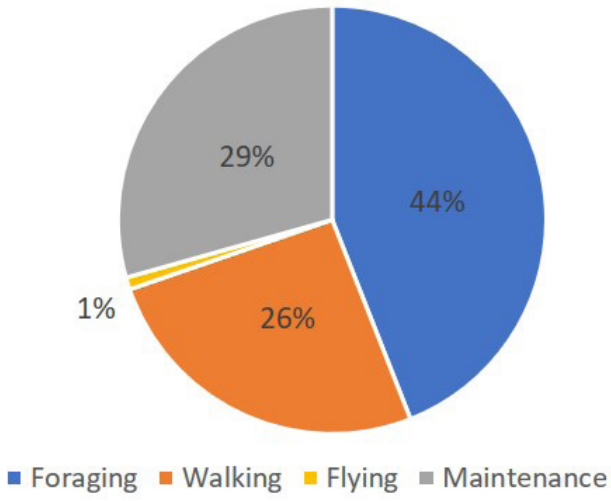

Figure 6. Proportion of behaviors observed for Piping Plovers at Amagansett, Morton, and Chincoteague NWRs in areas (6a) open to public access (n=32) and (6b) areas closed to public access (n=19).

Ruddy Turnstone

In subsites closed to the public (Figure 7b), Ruddy Turnstones spent more time engaged in maintenance behaviors than in subsites open to the public (Figure 7a). They were observed spending a higher proportion of time walking in open subsites. However, they were observed flying an equal proportion of time in open and closed subsites. Like for Piping Plovers, Ruddy Turnstones appear to spend a larger proportion of their time engaged in foraging behaviors at subsites closed to the public, though the differences between the proportions at closed or open subsites was not as great as for Piping Plovers.

Figure 7a

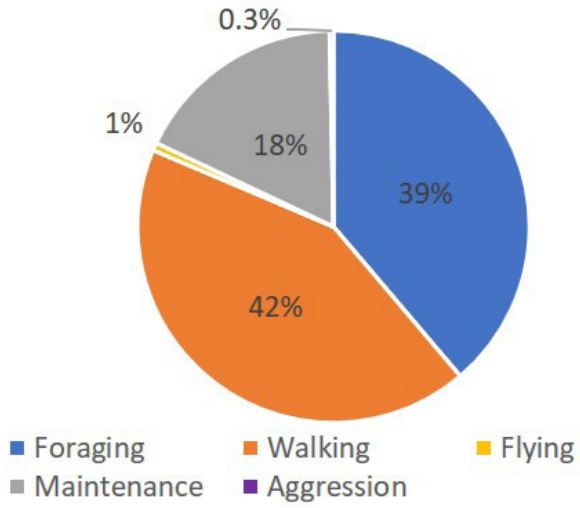

Figure 7b

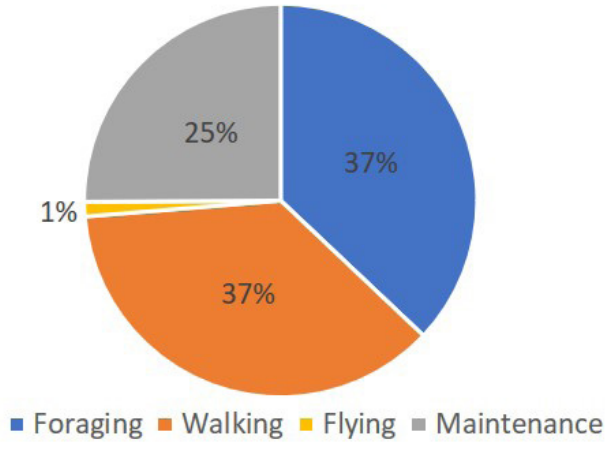

Figure 7. Proportion of behaviors observed for Ruddy Turnstones at Amagansett, Morton, and Chincoteague NWRs in areas (7a) open to public access (n=54) and (7b) areas closed to public access (n=43).

Sanderling

Sanderlings spent an equal proportion of time foraging, walking, and flying in open (Figure 8a) and closed areas (Figure 8b). They also spent an almost equal proportion of time engaged in maintenance behaviors and aggressive behaviors (e.g., chasing) towards other shorebirds, with a slightly higher proportion of these behaviors in open subsites. We also observed a very small proportion of time spent engaged in alert or vigilant behaviors in open subsites.

While we observed more Sanderlings in closed subsites, we noticed that Sanderlings were the only species that were consistently observed continuing to forage or roost in areas of high human use. Therefore, it appears Sanderlings are likely not as affected by potentially disturbing activities as the other species studied.

Figure 8a

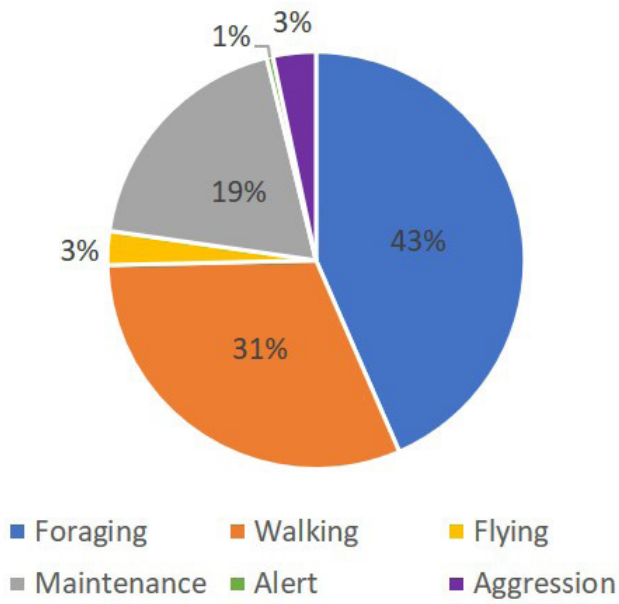

Figure 8b

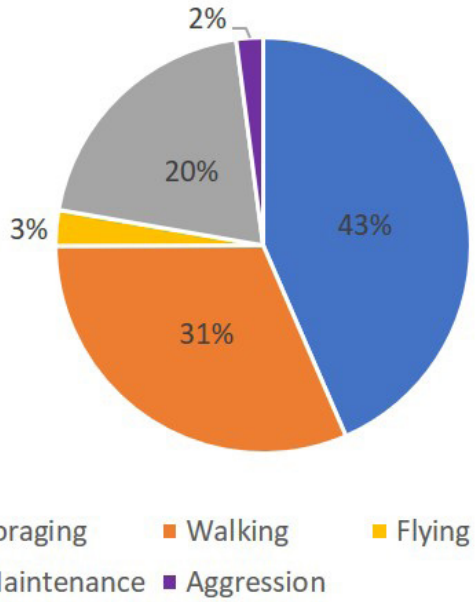

Figure 8. Proportion of behaviors observed for Sanderlings at Amagansett, Morton, and Chincoteague NWRs in areas (8a) open to public access (n=248) and (8b) areas closed to public access (n=98).

Sanderling foraging. William Majoros

Semipalmated Sandpiper

Like for Piping Plovers, Semipalmated Sandpipers spent a greater proportion of time foraging in closed subsites (Figure 9b), though this difference was less pronounced than for Piping Plovers. They spent more time engaged in maintenance behaviors in open subsites (Figure 9a). They spent an equal proportion of time walking in both open and closed subsites. Lastly, they spent an almost equal proportion of time flying in both types of subsites.

Figure 9a

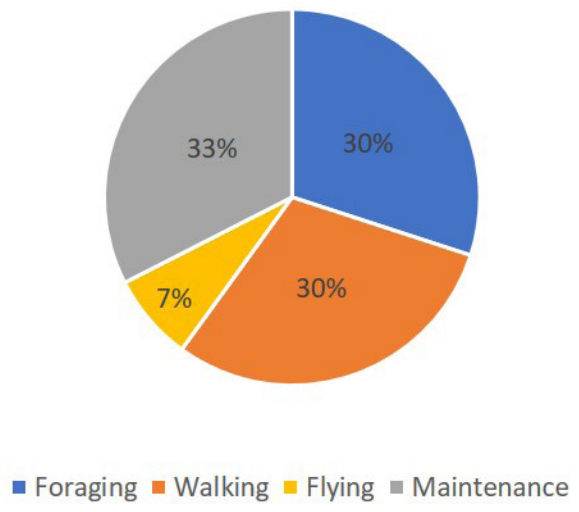

Figure 9b

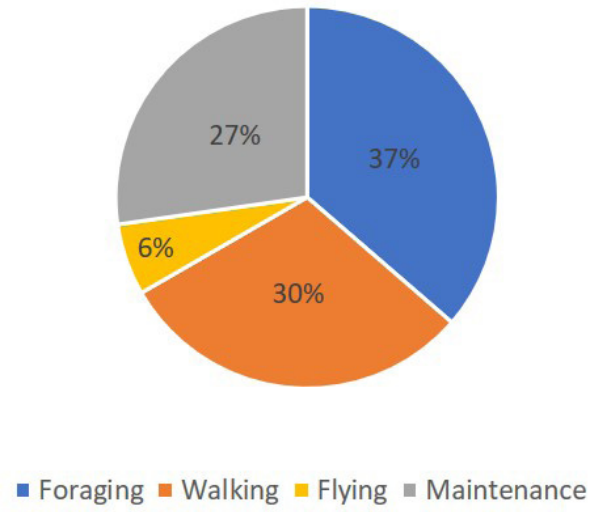

Figure 9. Proportion of behaviors observed for Semipalmated Sandpipers at Amagansett, Morton, and Chincoteague NWRs in areas (9a) open to public access (n=7) and (9b) areas closed to public access (n=6).

CONCLUSION

Pilot testing of these methods allowed valuable lessons to be learned and for improvements to be incorporated (e.g., adjusted some disturbance categories, added more detail to datasheets). Because the purpose of this study was to field test these methods, as stated above, these results should not be generalized beyond what is presented in this report.

Comparison of survey methods

While the transect and point count survey model results cannot be directly compared, they had several similarities. For both surveys, the global model was the top model. For both global models, active people and sunbathers negatively affected Sanderling counts. Date had a significant positive effect in both models, again likely due to the progression of the migration season. Lastly, public access had a significant negative effect with similar effect sizes in both models.

However, based on the R^2 values of the top models for both survey types, the global model did not perform as well for the point count data. The transect surveys may have performed better in this pilot study due to characteristics of the site, Chincoteague NWR, and the study species, Sanderlings. Chincoteague NWR has a long, linear beach that is clearly divided into management sections. This allowed us to easily subdivide sections of the beach into transects of equal length that had a consistent management strategy throughout. Additionally, Sanderlings are generally not as disturbance sensitive as other species. We observed at this site that Sanderlings were generally more spread out than other species, like Red Knots. Because of this, it may not have been as necessary to capture fine-scale spatial variability, like point counts allow.

If possible, we recommend conducting both transects and point counts, as these methods can be used to answer different questions (see **Considerations for Developing Standardized Field Methods to Evaluate**

Shorebird Disturbance). However, managers using these methods may be constrained by time or staff, and therefore, may have to choose between the different survey methods tested in this study. While transects performed better in this analysis, we recommend that managers wanting to select one of these survey methods (transects or point counts) follow a similar approach to this report. While these methods cannot be directly compared, it is possible to examine and compare broad trends between the methods. We recommend trying both types of surveys for an entire migration season and then comparing the results between the different methods, like in this report.

Limitations

The surveys for this pilot study were conducted in July and August, a period that does not fall with peak migration season for sites surveyed. This timing affected what birds and disturbances were seen. For instance, at all refuges surveyed certain areas of the beach were closed to public use to protect nesting birds, and during the peak migration season at these sites, these areas would be open to public use. Surveys were conducted during the early migration season due to constraints on the availability of the surveyors. Sites using these methods should conduct surveys over the entire migration, making sure to capture the peak migration at their site.

Future use

These methods represent one potential set of common metrics for evaluating shorebird disturbance at a site. Using similar methods across multiple sites and management types can facilitate coordination among these sites and may help understand trends across multiple areas. A more standardized approach may also help compare success of management actions across sites and avoid duplication of efforts. Additional data collection is needed before conclusions about how the individual methods described in this report complement one another to provide a complete picture of shorebird disturbance can be drawn.

Before adopting these methods at a site, they should be modified based on site-specific information and needs, and survey objectives should be clearly defined before beginning any data collection. Depending on the types of information a manager wants to gather, certain adjustments can be made to this set of methods. For example, because behavioral observations may be very time consuming, a manager may choose not to conduct them if time-limited but should be aware that they may lose the ability to actually link disturbance to observed abundance. Managers may also consider including habitat characteristics in their surveys, depending on resources, time, and research question. Specific adjustments (e.g., changing types of disturbances counted, types of behaviors recorded, species counted) may be made, depending on site location, human use, research questions, and availability of resources for conducting surveys. Additionally, consultation with a statistician may be beneficial when developing a sampling design and to ensure that the sampling design and field methods will result in data that addresses the specific survey objectives.

APPENDIX 5. RELEVANT LITERATURE: HUMAN DISTURBANCE OF SHOREBIRDS DURING MIGRATION

This list of relevant literature includes all literature cited in the Best Practices document and additional resources on human disturbance to migrating shorebirds or human behavior related to the priority disturbance types or management that may not have been cited directly in the Best Practices document.

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