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Responses of Birds to Humans at a Coastal Barrier Beach: Napatree Point, Rhode Island

Thomas W. Mayo[1,*], Peter W.C. Paton[2], and Peter V. August[2]

Abstract - Human activity is one of the most important factors affecting disturbance to birds that use coastal barrier beaches in southern New England. The barrier beach at Napatree Point, RI, provides important breeding habitat for several bird species, key stopover habitat for thousands of migrating shorebirds, and is also a popular destination for people. Anecdotal evidence suggested that walkers, joggers, dogs, and watercraft were disrupting birds that foraged and roosted at this site. Our objectives were to characterize the frequency and sources of disturbance to birds and use this information to develop management recommendations to minimize the frequency of human disturbances to birds at Napatree Point. We conducted 106 hours of observation from May through August in 2013. Of 211 flight responses, the most common sources of disturbance to birds were beach walkers (57.8%), motorboats (8.5%), kayaks (8.5%), bird watchers (7.6%), and anglers (6.2%). Birds typically flushed when pedestrians (e.g., walkers, bird watchers, and anglers) were within 39 ± 24 m (median ± inter-quartile range) and watercraft (e.g., motorboats and kayaks) were within 38 ± 33 m. Flight responses were positively correlated with the number of people on the beach and the number of boats in the area. Disturbances to birds peaked in July when human visitation was highest. Using a spatially explicit density map of flight-initiation distance vectors, we identified the most important area to set as a buffer zone for human access if managers seek to reduce the frequency of human disturbances to birds at Napatree Point.

Introduction

Coastal barrier beaches in southern New England provide important habitat for breeding and migrating bird species. Avian use of critical habitats such as these can be impacted by a variety of anthropogenic factors (Glover et al. 2011, Madsen 1995, Weston et al. 2012a). Birds typically exhibit a flight response when approached by humans. The distance at which the response occurs varies among species and various stimuli including pedestrians (Burger 1981, McLeod et al. 2013), watercraft activities (Peters and Otis 2006, Rodgers and Schwikert 2002), and aircraft (Smit and Visser 1993). Previous research has shown that human activities can effectively degrade habitat quality by directly disturbing breeding, foraging, and roosting waterbirds (e.g., waterfowl, wading birds, and shorebirds), with shorebirds demonstrated to be particularly vulnerable to human disturbance (Brown et al. 2001; Burger 1981, 1986; Pfister et al. 1992). Detrimental effects include reduced foraging rates and decreased use of foraging and roosting sites

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(Fitzpatrick and Bouchez 1998, Thomas et al. 2003) and the disruption of essential breeding behaviors (Weston and Elgar 2005, 2007).

In New Jersey, Burger (1986) found that 40% of the disturbances to shorebirds were from people walking on the beach, with anglers accounting for 10–20% of disturbances. Indeed, understanding which stimuli are present in an environment and at what density they occur is important because birds respond to different anthropogenic stimuli (e.g., walkers, cars, boats) at different rates or distances (Glover et al. 2011, McLeod et al. 2013). There can also be a strong seasonal component to disturbances (Stillman and Goss-Custard 2002), with Burger (1986) documenting the highest rates of disturbance in May and August, when most migrating shorebirds are present and human use of beaches also tends to peak in the northeastern US. There is also interspecific variation in response to disturbance, with larger shorebirds (and birds in general) flushing at greater distances than smaller shorebirds in response to similar disturbances (Koch and Paton 2014, Weston et al. 2012a).

Napatree Point in southwestern Rhode Island is a local hotspot for breeding and migratory birds, with 1 federally listed species, *Charadrius melodus* (Piping Plover), and 3 state-listed species—*Haematopus palliatus* (American Oystercatcher), *Sternula antillarum* (Least Tern), and *Pandion haliaetus* (Osprey)—regularly nesting on the barrier beach. In addition, numerous shorebirds (e.g., sandpipers, *Sterna* spp. [terns], *Larus* spp. [gulls]) and waterbirds (e.g., *Phalacrocorax* spp. [cormorants], egrets, waterfowl) congregate at Napatree Point during spring and fall migration. Scientists from the US Fish and Wildlife Service make regular trips throughout the year to conduct bird surveys of the area, and Watch Hill Conservancy staff conduct weekly surveys. Because of the relatively large numbers of birds that forage and roost in this area, naturalists often visit the lagoon to search for rare birds. On warm summer days, over 1000 people and 300 boats have been recorded at Napatree Point (Sassi 2013). The beach on the southern side of Napatree Point is a popular destination for beach enthusiasts, while several hundred boats often moor overnight to the northeast of the lagoon in southern Little Narragansett Bay, particularly on weekends in July and August (Sassi 2013). Thus, there is high potential for humans to have a negative impact on avian use of Napatree Point.

Our objectives were to (1) quantify the various sources of human disturbance to birds (e.g., walker, angler, or bird watcher) using the lagoon at Napatree Point, (2) assess interspecific variation in flight responses among various sources of human stimuli by measuring the distance between the disturbance stimuli and the disturbed bird (Blumstein et al. 2003), and (3) use these data to develop recommendations to inform resource managers at Napatree Point on how best to minimize disturbance to resident and migratory shorebirds and waterbirds.

Methods

Study site

We conducted fieldwork in the Napatree Point Conservation Area (NPCA, hereafter Napatree Point), a 2.4-km-long x 100–300-m-wide (27.7 ha) barrier beach located in the village of Watch Hill, Westerly, RI (Fig. 1). This barrier beach is bounded to the north by Little Narragansett Bay and to the south by the Atlantic Ocean. Napatree Point is a biological preserve that is owned and managed by the Watch Hill Fire District and the Watch Hill Conservancy (Westerly, RI). Terrestrial habitats present include maritime shrubland, salt marsh, maritime beach strand, and maritime herbaceous dune (Enser et al. 2011). A 5.2-ha tidal lagoon and adjacent sandy beaches provide breeding habitat for *Limulus polyphemus* L. (Horseshoe Crab), whose eggs are a vital food resource for migratory shorebirds (Gillings et al. 2007). The lagoon and adjacent areas also have extensive *Mytilus edulis* L. (Blue Mussel) and *Zostera marina* L. (Marine Eelgrass) beds that offer key foraging habitat for shorebirds and waterbirds; therefore, this area is one of the most important biodiversity hotspots in the region.

Avian surveys

One observer (T.W. Mayo) conducted all surveys from a fixed point, surrounded by 0.5-m-tall *Ammophila breviligulata* Fern. (American Beachgrass), keeping well hidden in the dunes 115 m from the eastern edge of the lagoon (Fig. 1). This fixed

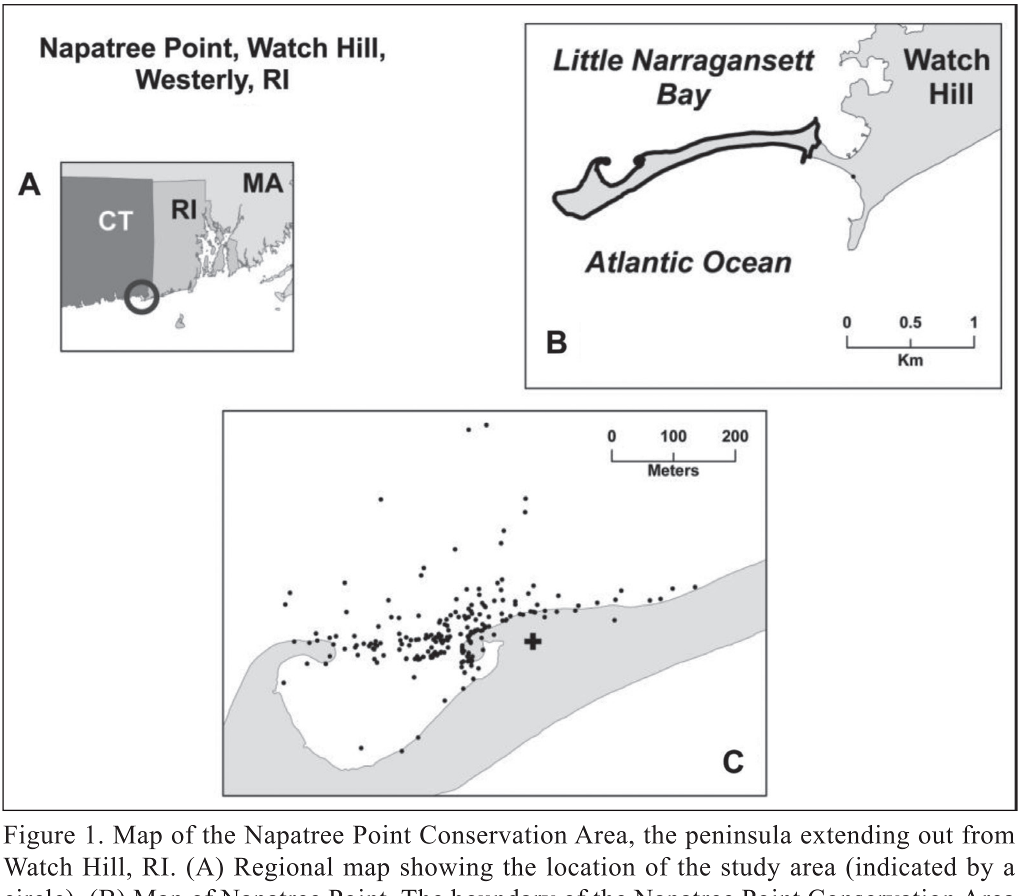

Figure 1. Map of the Napatree Point Conservation Area, the peninsula extending out from Watch Hill, RI. (A) Regional map showing the location of the study area (indicated by a circle). (B) Map of Napatree Point. The boundary of the Napatree Point Conservation Area is shown in the bold outline. (C) Observation zone for this study. The location of the observer (+) and locations of flocks (●) that were disturbed during observations are shown.

point was far enough from foraging and roosting birds to prevent disturbance while simultaneously allowing the observer to quantify when birds were flushed by anthropogenic sources within the study-area boundaries. These boundaries extended from the western edge of the lagoon to the first abandoned Osprey nest pole east of the vantage point. All disturbances witnessed were within the observation zone shown in Figure 1C; disturbances witnessed outside of the observation zone were not recorded. T.W. Mayo used a 60x spotting scope and 10 x 42 binoculars to make observations from 09:00 to 16:00 on weekends and holidays, when human visitation rates were highest. He completed observations under all weather conditions except during inclement weather (heavy rains and thunderstorms) that shortened some of the observation periods.

The observer counted potential sources of anthropogenic disturbance (i.e., pedestrians, watercraft, or aircraft) and weather information (i.e., air temperature, wind speed, and percent cloud-cover in 25% increments) every 30 min within the observation zone. He categorized watercraft as a motorboat, sailboat, canoe/kayak, paddleboard, or jet ski; and pedestrians as a walker (walking only), jogger (obviously running), birder (actively using binoculars or a spotting scope), angler (carrying a fishing rod or actively fishing), or ATV (driving in an all-terrain vehicle, which was restricted to management staff because no other vehicles are allowed on Napatree Point). We categorized aircraft as a helicopter, airplane (always single-engine fixed-wing craft), or a kite on a string.

Each time an individual bird or flock of birds took flight within the observation zone, the observer recorded the location of the anthropogenic-disturbance stimulus and the species and location of the bird(s) that flushed. These locations were recorded in the field on an analog map of the study zone. We employed ArcGIS (Environmental Systems Research Institute, v10.2 software, Redlands, CA) to create analog maps developed from high-resolution (10-cm pixel size) digital orthophotography. We identified from the orthophotography or with GPS coordinates (<3 m horizontal accuracy) permanent beach landmarks, coastline, and natural features as reference points on the analog map. There were enough reference features on the analog map to accurately locate disturbance events on the ground to within ~5–10 m. We could not accurately map the exact location of airborne sources of disturbance because of the lack of spatial reference in the sky and the speed with which aircraft moved.

We recorded whether the disturbance source caused flight responses by individual or multiple birds and, when possible, recorded the species that were flushed. This identification was relatively easy when individual birds flushed but was difficult when a large, multispecies flock flushed at once. Because our study design was based on observations of naturally occurring human disturbances and the concomitant flight responses in birds, we did not experimentally create stimuli to disturb birds.

To determine flight-initiation distances (Blumstein et al. 2003), we scanned the analog maps recorded in the field into digital image format, georegistered the digital images, and converted bird locations when initially flushed and their corresponding disturbance source to point-features in a GIS. In order to display the spatial pattern of disturbance stimuli and where birds were when they responded, we performed a number of GIS-based analyses. For each disturbance event, we created a line vector that extended from the first bird flushed to the source of disturbance. The length of the vector represented the flight-initiation distance (FID) between the flushed bird and the disturbance source. We mapped these vectors to provide a visual representation of the spatial distribution of disturbances in and around the lagoon.

We used the default kernel-density algorithm in ArcGIS v 10.2 software to create a density map (meters of disturbance vector per km^2) of disturbance vectors. To develop a spatially-explicit management zone to protect nesting, foraging, and roosting shorebirds and waterbirds at Napatree Point, we extracted the top 50% (i.e., greater than the median disturbance density) of areas in the disturbance-density map to determine where most disturbance events took place. By buffering this area by 40 m, the recommended additional buffer by Rodgers and Smith (1995), we established a management zone where pedestrians and watercraft were likely to intrude in the highest disturbance-density area (Fig. 2). We excluded disturbances caused by aircraft from the density analysis because they were not ground-based events and we could not map their locations as accurately as disturbances that occurred on the ground.

We conducted all statistical analyses using Microsoft Excel and R software (R Core Team 2013). Results of a Shapiro-Wilk test showed that our data were not

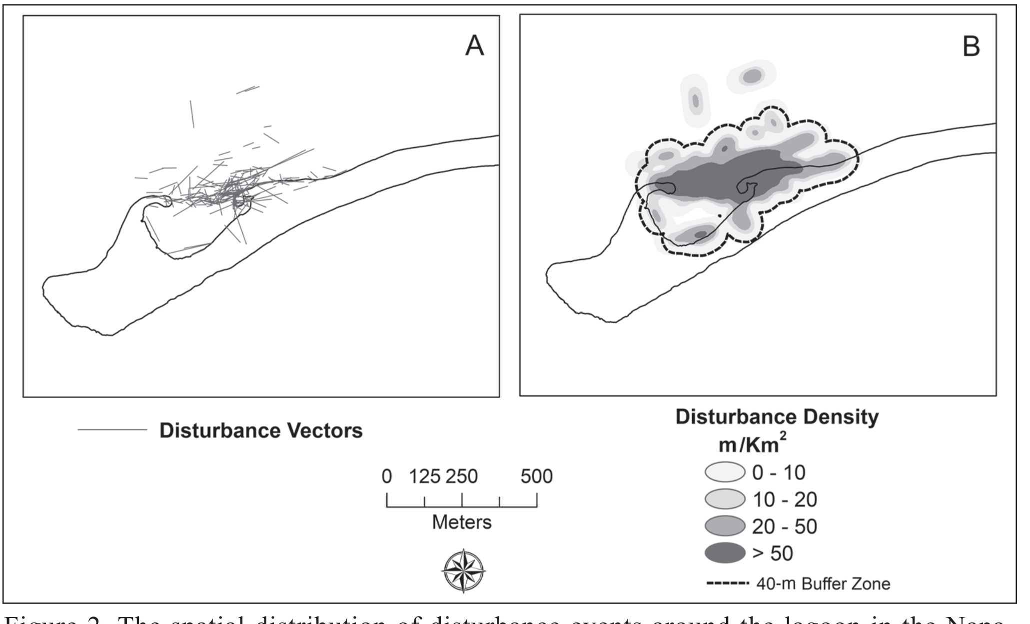

Figure 2. The spatial distribution of disturbance events around the lagoon in the Napatree Point Conservation Area during 2013. Left panel shows vectors depicting locations of anthropogenic stimuli and the closest disturbed avian flock. Right panel is a density map of the disturbance vectors. We classified disturbance vectors into approximate quartiles of disturbance density that are expressed as meters of disturbance vector per square kilometer (m/km^2). The broken line is a 40-m buffer away from the top 50% of disturbance densities.

normally distributed; therefore, we used non-parametric Spearman rank-correlation tests to measure dependence among variables.

Results

We detected a total of 211 disturbance events during 106 hours of observation (average = 1.99 disturbances per hour) over 21 days of field observations from mid-May to late-August 2013. We detected an average of 11 ± 9 (median ± interquartile range, absolute range = 3–19) disturbance events per observation day, peaking from early to mid-August. The frequency of disturbances (disturbances per observation hour/day) tended to increase as weather became warmer (mean temperature; Spearman $r = 0.43$, $P < 0.06$), and when pedestrian use of the observation zone increased (number visitors/day; Spearman $r = 0.76$, $P < 0.001$, $n = 19$, Fig. 3). We counted a total of 2779 pedestrians during the 30-min observation windows on 19 of the 21 days of sampling; no pedestrian or watercraft counts were done in May. On average, we observed 28.9 pedestrians per hour per day, with the highest human-activity rates between 12:00 and 14:30; indeed, 97% of all disturbance events occurred between the hours of 10:00 and 15:00. We counted a total of 2936 watercraft (primarily motorboats) during the study. We found a significant positive correlation between the number of watercraft and pedestrian counts (Spearman $r = 0.82$, $P < 0.001$, $n = 19$, Fig. 3).

Disturbances to birds were caused most often by people walking along the beach (57.8%), motorboats (8.5%), kayakers (8.5%), birders (7.6%), aircraft (6.6%), and anglers (6.2%) (Table 1). Single-disturbance events caused multiple flocks to flush slightly more often than they caused a single flock to flush (114 and 97 disturbances, respectively; Table 1). Multiple disturbances typically occurred when a jogger, birder, or walker continued to travel along the shore or lagoon edge, whereas single disturbances typically occurred when a walker approached the lagoon and then decided to turn back. Stationary disturbances (e.g., anglers) generally caused fewer multiple flushes (Table 1).

We documented disturbances to 25 avian species, with *Larus argentatus* (Herring Gull), *Sterna hirundo* (Common Tern), Least Tern, and American Oystercatcher the most frequently disturbed species (Appendix 1). We documented 16 occasions when Piping Plovers (federally listed as threatened), and 15 occasions when *Sterna dougallii* (Roseate Tern; federally listed as endangered) were flushed (Appendix 1). The FID was greatest for aircraft (median distance = 117.5 m) and lowest for pedestrians and watercraft (38.7 m and 38.4 m, respectively; Table 1). Disturbances were concentrated at the entrance to the lagoon, where large numbers of birds and disturbance stimuli (walkers, birders, and boats) tended to congregate (Fig. 2).

Discussion

Previous research has shown that human disturbance can have negative impacts on migratory-bird use of a coastal stopover site (Pfister et al. 1992, Thomas et al.

2003); therefore, we were interested in relationships between anthropogenic stimuli and bird responses at Napatree Point. We found that pedestrians walking along the

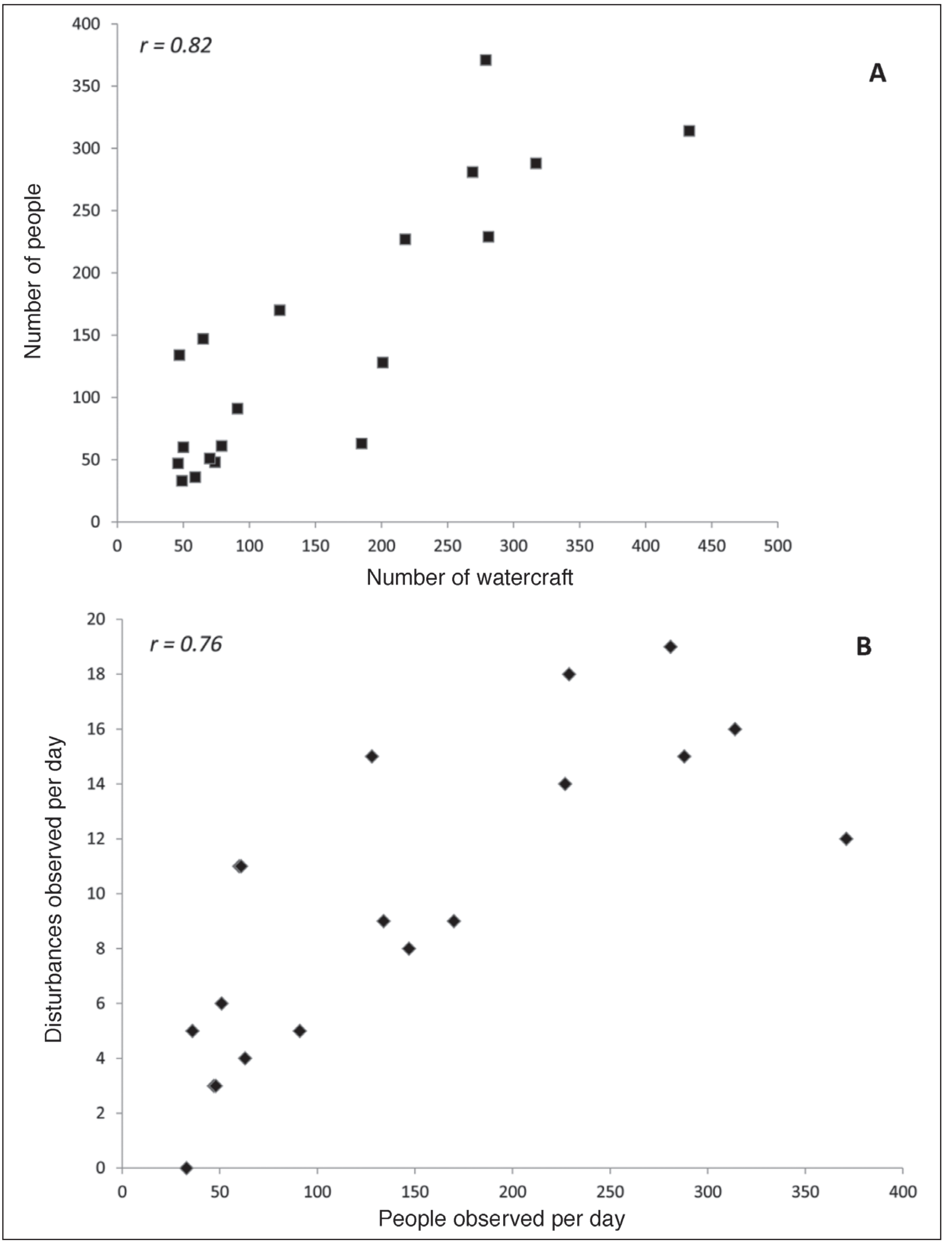

Figure 3. Relationship between the daily total number of people observed at Napatree Point Conservation Area and the number of boats anchored or moving through the site (A) and between disturbance rates (disturbances per day) and visitors per day (B). Spearman rank correlations were used to calculate *r* values (*n* = 19 days).

beach and the eastern edge of the lagoon accounted for approximately 75% of all bird-disturbance events, which was similar to previous research on coastal barrier beaches (Burger 1986, Lafferty 2001) and beaches worldwide (Weston and Elgar 2005, 2007), except where vehicles dominated (Schlacher et al. 2013). In general, we found that birds were less likely to flush when approached by a slow-moving pedestrian, such as a person actively fishing (i.e., anglers), compared to an active jogger or walker, a result which concurred with past research (Burger 1981, Glover et al. 2011). Other studies have shown that, compared to people walking alone, people walking dogs can have a greater impact on bird responses at a beach (Thomas et al. 2003) and longer FIDs (Glover et al. 2011), but dogs were only observed near the lagoon on 2 occasions during this study. In both cases, it was our subjective assessment that the people accompanying the dogs appeared to be the source of disturbance and not the pets. In one instance, the dog was leashed, while in the other, the dog was free-running. An active campaign by NPCA staff to alert beach enthusiasts that dogs are prohibited on Napatree Point by town ordinance from 8:00 AM to 17:00 PM during the summer apparently has been quite effective (unlike many other efforts to manage dogs on beaches; Williams et al. 2011). However, boaters and local beach enthusiasts often walk their dogs in the conservation area in the early morning hours when many

Table 1. Sources and relative frequency of disturbances to birds at the Napatree Point Conservation Area Lagoon. Multiple flushes occur when 1 source of disturbance causes multiple flocks of birds to flush their foraging or resting grounds at different times or cause a single flock to flush more than once. Each distinct disturbance event per source was counted separately. Number - number of distrubance events; % total = percent total disturbances; % multiple = percent of disturbance type causing multiple flushes

Type of disturbance	Number	% total	% multiple	Median (25th percentile, 75th percentile) of distance (m) between disturbance and flushed birds
Pedestrians				
Total	157	74.4	59.2	38.7 (27.7, 51.7)
Bird watchers	16	7.6	62.5	32.8 (26.6, 48.8)
Anglers	13	6.2	46.2	41.1 (39.1, 54.4)
Jogger	5	2.4	80.0	32.6 (28.4, 61.5)
Walker	122	57.8	59.0	37.7 (27.8, 51.2)
ATV	1	0.5	100.0	
Watercraft				
Total	40	19.0	40.0	38.4 (29.7, 62.6)
Motorboat	18	8.5	38.9	38.4 (29.6, 52.9)
Sail boat	1	0.5	100.0	
Kayak/canoe	18	8.5	38.9	45.5 (29.8, 61.8)
Jet ski	1	0.5	0.0	
Paddleboard	2	0.9	50.0	
Aircraft				
Total	14	6.6	35.7	117.6 (86.6, 141.4)
Helicopter	4	1.9	75.0	95.0 (82.0, 112.6)
Kite	1	0.5	0.0	
Airplane	9	4.3	22.2	135.0 (89.8, 157.3)

birds are actively foraging; thus, we are concerned that dogs are not banned on the beach 24 hours per day to minimize disturbance to birds using this key habitat (Burger 1986, Burger et al. 2004).

Estimates of FID have significant ramifications for management of shorebird and waterbird breeding and stopover habitat (Blumstein et al. 2003, Koch and Paton 2014, Rodgers and Smith 1995, Weston et al. 2012a). The median FID we documented when birds were disturbed by walkers or boats (~40 m) is similar to distances reported in previous studies (e.g., Blumstein 2003, Burger and Gochfeld 1991, Thomas et al. 2003), but less than values reported for some larger species of shorebirds documented in other areas (e.g., Koch and Paton 2014), perhaps due to different methods of observation and analysis between studies. The disturbance-density map we developed provides guidance for Napatree Point resource managers on possible regions from which pedestrians and boats should be excluded during migration periods and breeding season in order to reduce disturbance to birds (Ikuta and Blumstein 2003, Rodgers and Smith 1995).

An area to the east of the lagoon is generally fenced off most years with symbolic fencing and signage to prevent people from entering Piping Plover nesting areas, which is a standard operating procedure for Rhode Island beaches where this threatened species nests (Melvin et al. 1991). Such fencing appears associated with high compliance in some international beaches (Weston et al. 2012b). We propose placement of symbolic fencing and signage around our buffered protection zone (Fig. 2) so that foraging, roosting, and nesting shorebirds and waterbirds would be protected from anthropogenic disturbance sources. We have no easy way to reduce aircraft disturbance to the site, but based on our surveys, aircraft do not appear to have a major impact on birds at Napatree Point. Elsewhere throughout the region, kite-boarders are becoming a disturbance source at migratory stopover locations, but this recreational activity is currently not prevalent at Napatree Point. Furthermore, understanding the hourly pattern of disturbances to birds is helpful to managers. Stationing beach patrols and naturalists near the lagoon between 12:00 PM and 14:30 on warm weekend days to educate pedestrians and boaters about this significant resource could be the most effective opportunity to teach beach patrons of the importance of minimizing disturbance to wildlife.

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Appendix 1. Interspecific variation in the total number of disturbance events by various anthropogenic stimuli at Napatree Point Conservation Area during 2013.

	Aircraft			Pedestrians					Watercraft				
Species	Heli-copter	Kite	Plane	ATV	Birder	Angler	Runner	Walker	Motor boat	Kayak/ canoe	Paddle-board	Sail boat	*n*
Haematopus palliatus Temminck (American Oystercatcher)	1	1	5		6	4	2	41	4	3			67
Gavia imer (Brünnich) (Common Loon)	1				1	1		2	1				6
Phalacrocorax auritus (Lesson) (Double-crested Cormorant)	2		5		2	2		10	5	2	1	1	30
Egretta thula (Molina) (Snowy Egret)		1		1	2	1		12		3			20
Ardea alba L.(Great Egret)					1			4		1			6
Pandion haliaetus L. (Osprey)					2	1	1	3	1	1			9
Pluvialis squatarola L. (Black-bellied Plover)	1	1	2		1	3	2	9	1	2			22
Charadrius semipalmatus Bonaparte (Semipalmated Plover)	1	1	3		2	3		6	1				17
Charadrius melodus Ord (Piping Plover)	1	1	2		2	1		9					16
Actitis macularius L. (Spotted Sandpiper)								3					3
Tringa semipalmata (Gmelin) (Willet)			1		3	1		10					15
Arenaria interpres (L.) (Ruddy Turnstone)	1	1	2		2	4	1	13	2				26
Calidris alba (Pallas) (Sanderling)		1			1	2		12	2	2			20
Calidris canutus (L.) (Red Knot)					1		1	4					6
Calidris alpina (L.) (Dunlin)										1			1
Calidris pusilla (L.) (Semipalmated Sandpiper)								3					3
Limnodromus griseus (Gmelin) (Short-billed Dowitcher)		1						3					4
Larus smithsonianus Coues (American Herring Gull)	1	1	6		5	7	2	56	9	7	1	1	96
Larus marinus L. (Great Black-backed Gull)	1		2		2	1		16	1	1	1	1	26
Sterna hirundo L. (Common Tern)	2		6	1	7	4	3	52	7	8	1	1	92
Sterna dougallii Montagu (Roseate Tern)		1			1	1		9		1	1	1	15
Sternula antillarum Lesson (Least Tern)	2	1	6	1	9	4	3	53	4	7	1	1	92
Rhynchops niger L. (Black Skimmer)			1	1	1	2		4					9
Hirundo rustica L. (Barn Swallow)			1					2					3
Aegelaius phoeniceus (L.) (Red-winged Blackbird)						1		2					3
% of all events	2.3	1.8	6.9	0.7	8.4	7.1	2.5	55.7	6.3	6.4	1.0	1.0	607