Abundance and Distribution of Wintering Piping Plovers on the Coast of South Carolina: Findings from the 1997, 1998, and 1999 Mid-Winter Censuses

Sarah L. Dodd
South Carolina Department of Natural Resources
Wildlife Diversity Section
222 Alabama Street
Saint Simons Island
GA 31522
sdodd@darientel.net

Mark D. Spinks
South Carolina Department of Natural Resources
Wildlife Diversity Section
Samworth WMA
420 Dirleton Rd.
Georgetown, SC 29440

Philip M. Wilkinson
South Carolina Department of Natural Resources
Wildlife Diversity Section
Samworth WMA
420 Dirleton Rd.
Georgetown, SC 29440

Introduction

The Piping Plover (*Charadrius melodus*) is a threatened/endangered shorebird (Charadriiformes: Charadrii) that nests exclusively in North America in three regions: the Northern Great Plains/Prairie, Great Lakes, and Atlantic Coast (U.S. Fish and Wildlife Service 1996). The threatened Atlantic Coast population nests on sandy beaches from Newfoundland to the northeastern tip of South Carolina (Waites Island; Murray and McDavit 1993) (U.S. Fish and Wildlife Service 1996). The endangered Great Lakes population nests on a few sandy beaches in the upper Great Lakes, and the threatened Northern Great Plains/Prairie population breeds on alkaline lakes, reservoir beaches, and river islands from Alberta to Oklahoma (Haig and Plissner 1993). Wintering Piping Plovers inhabit mostly sandy beaches and sand and algal flats along Atlantic and Gulf coasts from North Carolina to Mexico, and to a relatively unknown extent, in the Caribbean (Haig and Plissner 1993, U.S. Fish and Wildlife Service 1996).

The decline of Piping Plovers has been attributed to loss and alteration of habitat, human disturbance, and increased predation following rapid coastal development beginning in the 1940s (see review U.S. Fish and Wildlife Service 1996). Since federal listing in 1986, most conservation efforts have focused on nesting Piping Plovers, with relatively little attention provided to nonbreeding plovers (U.S. Fish and Wildlife Service 1996, Plissner and Haig 1997). However, a multinational census of both nesting and wintering Piping Plovers was conducted in 1991 and 1996, resulting in the greatest number of breeding and wintering plovers ever recorded (Haig and Plissner 1992, Haig and Plissner 1993, Plissner and Haig 1997). Despite the extensive survey effort, only approximately a half (1996) to two-thirds (1991) of the breeding population was located during winter censuses. Relatively few wintering birds were observed on the Atlantic Coast and in the Caribbean areas surveyed (Haig and

Plissner 1993, Plissner and Haig 1997), suggesting that many wintering sites for Atlantic Coast breeders had not been located (Haig and Plissner 1993).

During the winter of 1986/87, Nicholls and Baldassarre (1990a) conducted the first extensive surveys of wintering Piping Plovers on the Atlantic coast, including South Carolina. However, due to the regional focus of their study, these authors did not survey all potential wintering sites in South Carolina. The South Carolina Department of Natural Resources (SCDNR) participated in both international winter censuses in 1991 and 1996 and also conducted similar censuses in 1990, 1992, and 1993 (Wilkinson and Spinks 1994, Haig and Plissner 1992, Plissner and Haig 1997). During these censuses, observers surveyed previously documented Piping Plover wintering sites and several additional beaches with potential wintering habitat. However, observers did not survey all potential Piping Plover habitat, especially prior to 1996 when survey effort was concentrated at major inlets with little coverage along many front beaches. Consequently, we initiated a survey of all beaches and sand bars in South Carolina to obtain a more accurate assessment of abundance and distribution of Piping Plovers during the winter. In this paper, we present results of the 1997, 1998, and 1999 mid-winter censuses, including distribution and numbers of Piping Plover, habitat characteristics of wintering sites, and numbers of people and dogs using beaches during censuses.

Methods

Censuses. During mid-January 1997 (8 - 21), 1998 (10 - 23), and 1999 (14 - 24), we coordinated a census of Piping Plovers on the coast of South Carolina. Observers surveyed all beaches and sand bars exposed at high tide (approximately 309 linear km; Table 1), logging 97, 83, and 77 observer-hours of survey time in 1997, 1998, and 1999, respectively. Observers surveyed the entire stretch of each beach, with the exception of portions of some beaches that lacked exposed substrate at high tide (*e.g.* Fripp Island), sections of Hilton Head Island with unsuitable shorebird habitat in 1997 and 1998, and the south end of Isle of Palms in 1998. In addition, observers surveyed a few impounded spoil disposal sites in 1998 and 1999 (approximately 21 linear km; 3.5 observer-hours). To minimize multiple counts of the same plovers, observers surveyed known Piping Plover sites located within 20 km on the same day. Observers conducted censuses within three hours of high tide, when plovers are most concentrated.

Twenty, 23, and 15 observers participated in the 1997, 1998, and 1999 censuses, respectively, with most (≥55%) sites surveyed by one person. Personnel from the SCDNR lower and upper coast Wildlife Diversity field offices censused most (≥ 80%) sites, while several volunteers experienced in bird identification censussed remaining sites. All participants received written instructions, data sheets, maps, and tide charts.

Participants observed birds with binoculars and spotting scopes from all-terrain vehicle [20 (1999) - 31(1998) % of sites], foot [15 (1999) - 28 (1997) %], motorboat [14 (1997) - 28 (1998) %), truck [0 (1997) - 13 (1999) %], or a combination of these. Observers categorized habitat as: 1) sand beach; 2) sand spit; 3) sandflat; 4) sand bar; 5) oyster-shell beach or oyster bank; 6) mudflat; 7) vegetation mat; and 8) vegetated shoreline. In addition, observers

categorized the body of water as: 1) ocean; 2) protected (*e.g.* bay, harbor, creek, lagoon); or 3) other. In 1998 and 1999, observers tallied the number of people and dogs during the census at each site and any observed disturbance to Piping Plovers.

Statistical Analysis. We did not directly compare the number of Piping Plovers among years because of the considerable variation in surveying effort among earlier census years ($\leq$ 1996) and the dramatic increase in coverage of the coast after 1996. Consequently, prior to 1997, we only used data from the two international censuses (1991 and 1996) because these censuses yielded the greatest survey effort. In addition, we restricted the analysis to data from sites (n = 21) that were surveyed in both 1991 and 1996 (and from 1997 to 1999). We tested for differences in the number of Piping Plovers among years using a Kruskal-Wallis Test (SAS 1992) using PC-SAS (Vers. 6.12).

Results and Discussion

Distribution and Abundance. The distribution and total number of Piping Plover varied little among years: 103, 94, and 100 plovers used 16, 14, and 18 sites in 1997, 1998, and 1999, respectively (Table 1, Figures 1, 2, 3). Overall, Piping Plovers wintered at 26 sites, but plovers used only nine of these sites all three years. Each winter, Piping Plovers inhabited approximately a third of coastal beaches and sand bars, using sites from Hilton Head Island to Murrells Inlet, with the exception of 1999, when plovers inhabited Waites Island, the most northeastern island in the state. At most sites, plovers wintered in small groups of five birds or less (median: 4, 3, and 2.5 in 1997, 1998, and 1999, respectively). The greatest number of Piping Plover occurred on Kiawah Island in 1997 (N = 30) and 1998 (N = 22), and nearby Deveaux Bank in 1999 (N = 24). Furthermore, the Kiawah, Deveaux Bank, Seabrook, and Skimmer Flats complex of islands situated between North Edisto River and Stono Inlet was the most important wintering area, with approximately half (57%, 1997; 51%, 1998; 43%, 1999) of the total number of plovers using these islands. A relatively large group (7 - 14%) of Piping Plovers used Harbor Island and Huntington Beach State Park each year.

Numbers of Piping Plover from 1997 to 1999 exceed the previous high mid-winter count in South Carolina (N = 78; Plissner and Haig 1997) by about 25% and are approximately double the 1986/87 and early 1990s mid-winter counts (N $\leq$ 53; Nicholls and Baldassarre 1990a, Wilkinson and Spinks 1994). We suspect that most of the increase in numbers of Piping Plover is attributable to greater survey effort rather than to an increase in the wintering population. Observers from 1997 to 1999 surveyed more than twice the coastline than in 1996 (Plissner and Haig 1997) and seven times the coastline than in 1991 (Haig and Plissner 1992). Indeed, 11 - 32% of the plovers observed from 1997 to 1999 occurred at sites not surveyed in 1996, the year with the greatest survey effort prior to 1997. Moreover, abundance of plovers did not differ significantly among years (1991, 1996, 1997, 1998, 1999) in sites that were surveyed all five years (n = 21, Chisq. = 0.82, df = 4; P = 0.93).

From 1997 to 1999, Piping Plovers inhabited most previously documented wintering sites in at least one year: plovers occurred at 86% of sites used by plovers a decade earlier (Nicholls and Baldassarre 1990a); 91% of sites used in

the early 1990's (Wilkinson and Spinks 1994); and 92% of sites used most recently in 1996 (Plissner and Haig 1997). Sites used by Piping Plovers in earlier years, but not from 1997 to 1999, were Hunting Island, St. Phillips Island, and Sullivans Island. Observers from 1997 to 1999 documented several new Piping Plover wintering sites: Morris, Pritchard's, and Cedar islands; Debidue and Botany Bay Plantation beaches; North Santee and Lighthouse Island South sand bars; and Raccoon Key.

Habitat Characteristics of Wintering Sites. Overall, wintering Piping Plovers used sandy substrates on barrier islands, peninsula bars, and estuarine and offshore sand bars (Table 1). More specifically, plovers used sandflats (18 - 50%) and sand beaches (22 - 82%) more often than other substrates. In 1997 and 1998, most (> 65%) plovers used habitat adjacent to protected bodies of water (*e.g.* tidal lagoons and creeks), rather than the ocean. In 1999, however, only slightly more plovers used protected bodies of water (52%) than ocean (48%) habitats. Most ($\geq$ 59%) Piping Plovers occurred within 1 km of an inlet, especially plovers which used barrier islands and peninsula bars ($\geq$ 79%). No plovers used impounded spoil disposal sites, vegetated shoreline, oyster banks, or oyster-shell beaches. Generalizations on habitat characteristics should be interpreted cautiously because censuses were conducted at mid to high tides only.

The coast of South Carolina is dynamic, especially on offshore islands, where habitat changes dramatically in a short period of time. During the winter of 1997/98, we observed a natural experiment which gave us further insight into habitat selection by wintering Piping Plovers. Lighthouse Island South, an offshore sand bar in Cape Romain National Wildlife Refuge, accreted on the southwestern end and formed a large (~5 ha) protected body of water with adjacent gradually-sloping sandflats during late fall 1997. During the 1998 census, we observed eleven Piping Plovers foraging on newly-formed sandflats adjacent to the protected body of water. Prior to January 1998, no Piping Plovers had been observed on this sand bar during monthly (January - October 1997) surveys of shorebirds (S. Dodd, unpubl. data), nor during other mid-winter censuses of Piping Plover (Wilkinson and Spinks 1994, Plissner and Haig 1997). Nicholls and Baldassarre (1990b) concluded that habitat heterogeneity was a key factor influencing the wintering distribution of Piping Plovers on the Atlantic coast. We suspect that the newly-formed protected body of water and sandflats at Lighthouse Island South increased the diversity of foraging and loafing habitat on the sand bar.

Human Disturbance. A third (1999) to a half (1997 and 1998) of Piping Plovers wintered on developed beaches, however a large proportion of these plovers wintered on the northeast end of Kiawah Island, approximately 3 km from the nearest beach access or dwelling. Moreover, most sites used by Piping Plovers are undeveloped ($\geq$ 62%) and accessible by boat only ($\geq$ 56%). In 1998 and 1999, observers recorded no humans and dogs during censuses of most ($\geq$ 61%) sites used by Piping Plovers. For beaches where observers recorded both Piping Plovers and humans ($median_{1998}$ number of people and dogs: 5 and 0, respectively; $median_{1999}$ number of people and dogs: 21 and 2, respectively), no

observations of disturbance to Piping Plovers was noted. However, during the census of Huntington State Beach in 1997 we observed Piping Plovers flush in response to a bird-watcher and to recreational walkers with dogs. In addition, observers reported disturbance to other species of shorebirds by people and/or unleashed dogs at Dewees, Pawleys, and Sullivans islands, Myrtle Beach; and Folly Beach in at least one year. We cautiously conclude that most wintering Piping Plovers using the South Carolina coast are undisturbed by humans, at least in the middle of January. We recognize the limitations of our assessment of human disturbance, though, which did not quantify disturbance over a 24-hour period.

Conclusions. Overall, Piping Plovers wintered in small groups on a few scattered barrier islands, peninsula bars, and sand bars (Table 1, Figures 1, 2, 3). At wintering sites, plovers tended to use sandy substrates adjacent to protected bodies of water within 1 km of an inlet. A total of 94 (1998) to 103 (1997) mid-wintering plovers inhabited beaches on the South Carolina coast. The Deveaux Bank, Kiawah, Seabrook, and Skimmer Flats group of islands was the most important area for Piping Plovers ($N_{1997} = 59$; $N_{1998} = 48$; $N_{1999} = 43$), ranking with other wintering areas considered internationally important (see Haig and Plissner 1993, Plissner and Haig 1997). Moreover, this complex of islands qualifies as an Important Bird Area (IBA; American Bird Conservancy) because it provided wintering habitat for approximately 2% of the Atlantic Coast and Great Lakes breeding populations of Piping Plover (based on breeding data from the 1996 International Census; Plissner and Haig 1997).

We suggest that future censuses of Piping Plovers include surveys of all beaches, sand bars, and associated sand and mud flats in a particular state or region. Our results demonstrate that habitat not used by Piping Plovers one year can change dramatically to be used by a large group of plovers by the next year. Consequently, without surveying the entire coast, it is difficult to assess population trends accurately. Over the years, as more sites along the South Carolina coast have been surveyed, the total number of Piping Plovers has also increased. We found no significant difference in the abundance of plovers among years in sites surveyed in both international census years (1991 and 1996) and from 1997 to 1999, suggesting that the increase in numbers is due to greater survey effort rather than an increase in the wintering population. If all beaches are surveyed during each census, the number of plovers can be compared directly among years.

As the South Carolina coast continues to be developed, it is critical that we protect threatened populations of Piping Plover as well as other species of shorebirds that use coastal habitats. The number of people living on the coast of South Carolina is expected to increase each year by 0.3%, with an additional 17,700,000 annual visitors (S.C. Department of Health and Environmental Control 1998). Monitoring the distribution and abundance of Piping Plovers is important because it provides data for evaluating potential coastal development, beach renourishment, and dredging activities, all of which can affect coastal habitats. For example, data from our censuses were used to evaluate future development at Waites and Morris Islands, beach renourishment at Hilton Head

Island, and channel dredging at Stono Inlet. With the projected increase in the coastal population, we think it is also critical to monitor human use of the coast, including beaches protected from development. Our results show that over a three-year period wintering Piping Plovers used half the beaches in South Carolina, including several developed beaches. This suggests the need to modify existing beach-recreation policies as the number of people and their dogs increase. To minimize disturbance from dogs, we urge property owners and land managers to create and/or enforce leash laws.

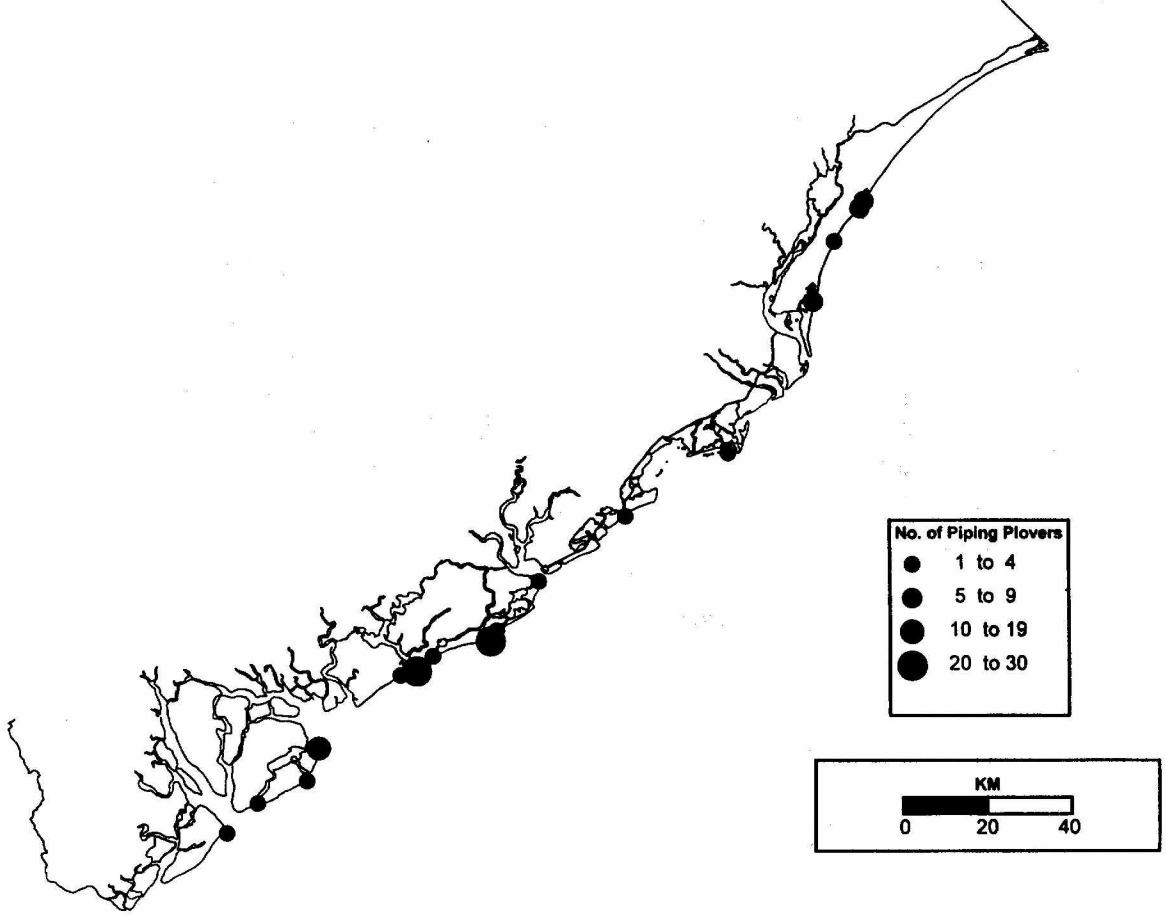

Figure 1. Distribution of wintering Piping Plovers on the coast of South Carolina during January 1997.

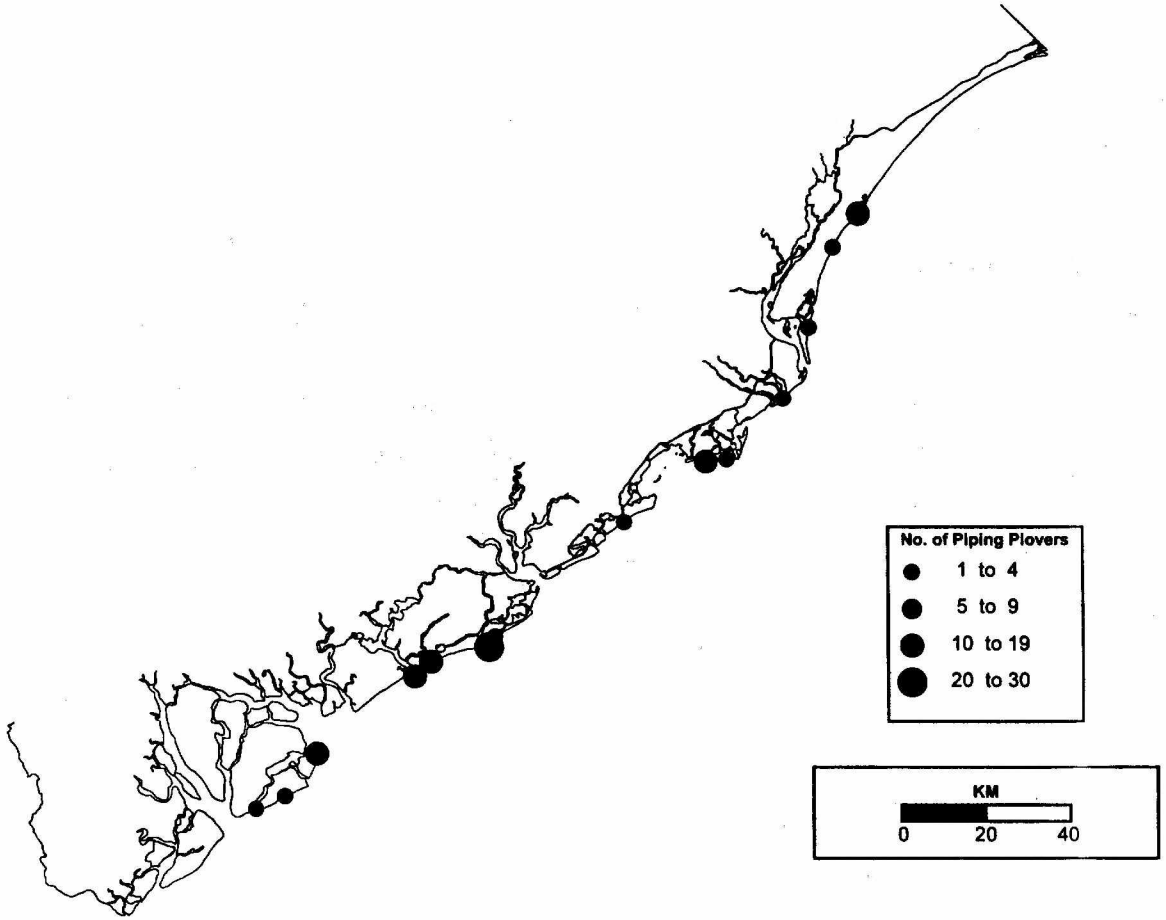

Figure 2. Distribution of wintering Piping Plovers on the coast of South Carolina during January 1998.

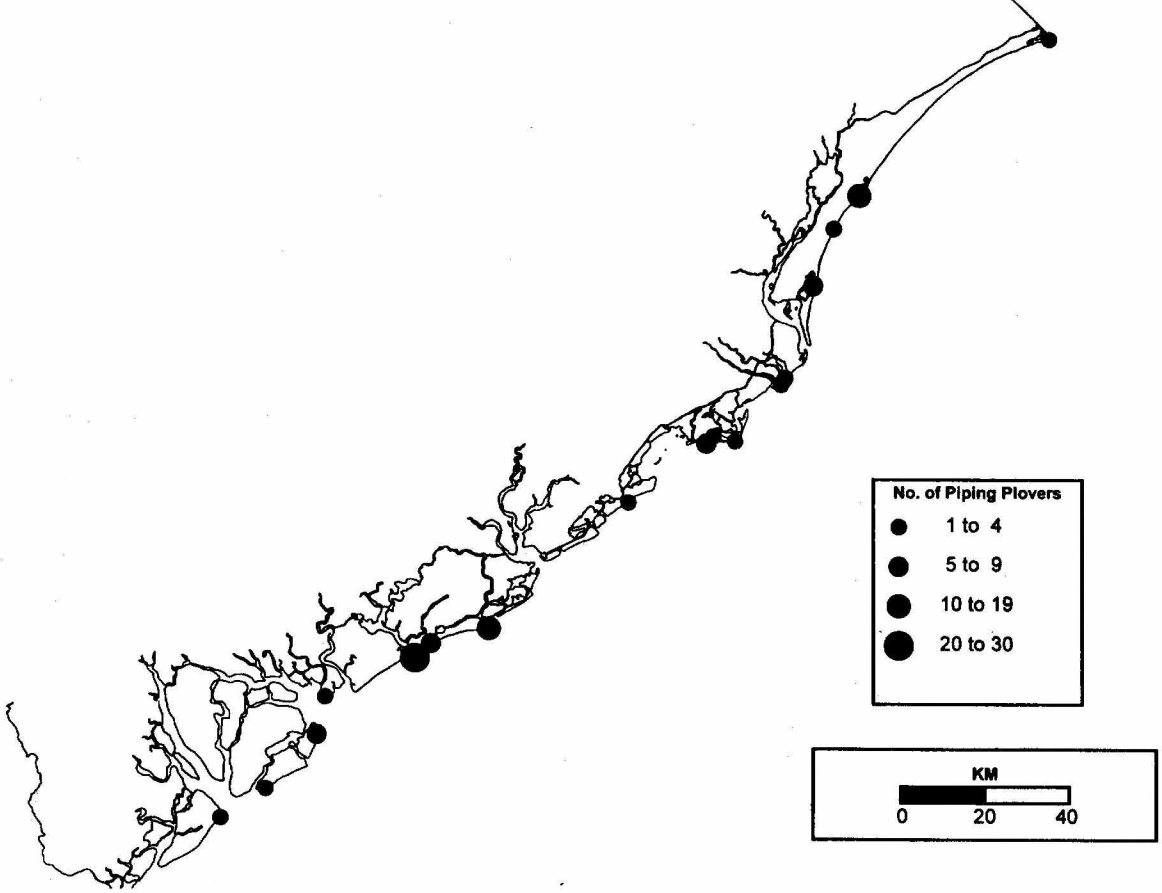

Figure 3. Distribution of wintering Piping Plovers on the coast of South Carolina during January 1999.

Table 1. Number of Piping Plover, description of sites, and habitat used by plovers during mid-winter (January) censuses of the South Carolina coast; 1997, 1998, 1999.

Site	Number of Piping Plover			Site Description[a]	Piping Plover Habitat[b]			Linear km Surveyed[c]
	1997	1998	1999		1997	1998	1999	
Waites Island, Little River Inlet	0	0	2	I, II b, d 1, 3, 4, 6			I b 1	5.0
Route:Garden City-Hog Inlet (Myrtle Beach area)	0	0	0	I, II a 1, 3				52.0
Garden City-south point (Murrells Inlet)	5	0	0	I, II f 1, 3	I f 1			1.0
Huntington Beach State Park	7	10	14	I, II a 1, 3, 6	II a 3, I a 1	II a 1	I, II a 1	4.8
Litchfield Beach	1	1	1	I, II f 1, 3, 6	II f 3	II f 1	II f 1	6.4
Pawleys Island	0	0	0	I, II b 1, 2, 3, 4				8.0
Debidue Beach	0	0	8	I, II b 1, 2, 3			II b 1	8.0
North Island	5	2	0	I, II b 1, 3, 4, 6, 8	II b 4	I b 1		15.2
Sand Island	0	0	0	I, II b 1, 2, 3, 6				4.6
South Island	0	0	1	I, II b 1, 2, 3, 6			II b 1	7.0
North Santee sand bar	0	1	2	I, II d 1, 3, 4		II d 1	II d 3	1.6
Cedar Island	0	0	1	I, II b 1, 3, 8			II b 3	2.7
Murphy Island	0	0	0	I, II b 1, 3, 6				9.6
Cape Island	2	2	2	I, II b 1, 2, 3, 4, 6	I b 1	II b 1	I, II b 1	12.2
Lighthouse Island	na	na	na					0.0
Lighthouse Island South	0	11	9	I, II d 1, 2, 3, 4		II d 3	I, II d 1; II d 3	1.6
Raccoon Key	0	0	1	I, II b 1, 2, 3, 5, 6, 8			II b 3	9.9
White Banks[d]	0	0	0	I, II e 3, 5, 6, 8				2.1
Marsh Island[d]	0	0	0	I, II e 3, 4, 5, 6, 8				0.5
New Island	0	na	na	II d 3				0.1
Bull Island	2	2	3	I, II b 1, 2, 3, 4, 6, 8	I b 1	II b 1	I b 1	9.3
Price's Inlet sand bar	na	na	0	I, II d 2, 3, 4				1.0
Capers Island	0	0	0	I, II b 1, 3, 8				3.3
Dewees Island	0	0	0	I, II b 1, 2, 3, 4				4.3
AIW spoil sites-Harbor R. and Capers Crk.[d]	0	0	0	III g 9				2.0
Isle of Palms[e]	0	0	0	I b 1, 2, 3, 4				9.6
Sullivans Island	0	0	0	I, II b 1, 2, 4, 6				5.8
Morris Island	1	0	0	I, II b 1, 3, 6, 7	I b 1			7.2
Folly Beach	0	0	0	I, II b 1, 3				10.4
Bird-Key-Stono	na	na	na					0.0
Skimmer Flats	1	3	0	I, II c, d 1, 2, 3, 4	II d 3	II c 1		2.4
Kiawah Island	30	22	11	I, II b 1, 2, 3, 6	I b 2, II b 1, II b 3, II b 6	I, II b 1	I b 1; I, II b 3; II b 6	15.8
Seabrook Island	4	10	8	I, II b 1, 2, 3, 4, 6	II b 3, II b 6	II b 1	II b 2	5.5
Deveaux Bank	24	13	24	I, II d 1, 2, 3, 6	II d 2, II d 3, II d 6	I, II d 1	I, II d 1, II d 3	7.0
Botarty Bay Island	0	0	0	I, II b 1, 2				2.9
Botany Bay Plantation Beach	2	0	0	I, II b 1, 2, 3, 5, 6	II b 3			3.4
Interlude	0	0	0	I, II b 1, 3, 6				1.2
Eddingsville Beach	0	0	0	I, II b 1, 3, 5				3.7
Edisto Island	0	0	0	I, II b 1, 2				8.6
Pine Island	0	0	0	I b 1				2.8
Otter Island	0	0	3	I, II b 1, 4, 6			I, II b 1	5.3

Table 1. Continued.

Site	Number of Piping Plover 1997	1998	1999	Site Description[a]	Piping Plover Habitat[b] 1997	1998	1999	Linear km Surveyed[c]
Harbor Island	10	13	7	I, II b 1, 2, 3	I, II b 2	I b 1, II b 3	I b 1	3.5
Hunting Island	0	0	0	I b 1, 3				3.4
Fripp Island	4	0	0	I b 1, 3, 4	I b 1			0.5
Pritchards Island	0	1	0	I, II b 1, 3		I b 1		1.9
Little Capers Island	4	3	2	I, II b 1, 2, 3	I b 1	I b 1	I, II b 1	4.8
Bay Point Island	0	0	0	I, II b 1, 2, 3				4.8
Bay Point Shoal	na	0	0	I d 4				0.8
St. Phillips Island	0	0	0	I, II b 1, 2, 3, 4				1.8
Joiner Bank	1	0	0	I d 4	I d 4			2.0
Hilton Head Island[e]	0	0	1	I, II b 1, 3			II b 3	22.2
Daufuskie Island	0	0	0	I b 1				1.1
Turtle Island	0	0	0	I b 1, 6, 8				0.3
Savannah River Spoil Site	ns	0	0	III g 9				19.0
South Carolina Total	103	94	100					329.8

[a] Body of water: I) ocean; II) protected bay, harbor, lagoon, creek or river; III) other. Shoreline: a) mainland; b) barrier island; c) spoil island; d) bar; e) other island; f) peninsula bar; g) impounded spoil disposal site. Substrate: 1) sand beach; 2) sand spit; 3) sandflat; 4) sand bar; 5) oyster-shell beach or oyster bank; 6) mudflat; 7) vegetation (algal) mat; 8) vegetated shoreline.

[b] Habitat in which Piping Plover(s) observed.

[c] Distance measured using either a hand-held GPS unit (Garmin 38) or estimated with USGS-DLG maps.

[d] Surveyed later than census period in 1997 and/or 1998: AIW - 28 February 1997 and 28 January 1998; Marsh Island and White Banks - 27 February 1997.

[e] South end of Isle of Palms not surveyed in 1998 (~ 6.4 km surveyed). Only areas with potential shorebird habitat surveyed on Hilton Head Island in 1997 and 1998 (~ 5 km).

na Habitat not available because island was under water or only marsh exposed at high tide.

ns Not surveyed.

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